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LeMesurier

Measuring the 2ZERO KPIs

Measuring the value of the Key Performance Indicators of the 2ZERO Partnership

D1.2 – Initial Direct KPIs contribution assessment

Coordination and Support Action (CSA)
Project No. 101137477 | HORIZON-CL5-2023-D5-01-05

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Quality Control

Ver.	Date	Editor	**Changes**
0.1	**25/11/2024**	**Verena Wagenhofer, AVL**	**Design of deliverable structure.**
0.2	**9/07/2025**	**Verena Wagenhofer, AVL**	**Now including the data available from the project reporting process, as recorded by CINEA.**
0.3	**17/07/2025**	**Simon Edwards, RIC**	**Reviewed, slight corrections suggested and comments for consideration made. The Summary was reworked.**
1.0	**1/09/2025**	**Simon Edwards, RIC**	**Final version to be submitted**

Legal Disclaimer

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SUMMARY

Overview

The 2ZERO Partnership KPIs are multiple and various, relating to the three-layer approach for the Objectives of 2ZERO, as expressed in its Strategic Research and Innovation Agenda (SRIA)[1]. The *Le*Mesurier Coordination and Support Action (CSA) is determining a common framework for monitoring these multiple and various Key Performance Indicators, KPIs (including their sources, methods and reporting formats). It generates values for the KPIs and their expected variation for the coming decade, based upon the results of the projects being conducted within the Partnership and the assessment of the impact of these projects' results.

Within *Le*Mesurier, the accounting of these KPIs is dependent on the characteristics of the KPIs themselves. Within the project the KPIs have been classified as two types, either Direct or Compound.

- Direct KPIs: many of the KPIs are “single count” parameters, i.e. data available from direct reference to single sources, which are suggested within the SRIA document. These parameters can be captured in documentation and demonstrations. However, some of these single counts are likely to be projections for the duration of 2ZERO given the timeframe of the measurement of the KPIs, that is between 2025 and 2035; whereupon multiple sources of such projections would be valuable, in order to determine a range within which the results of 2ZERO are likely to occur.
- Compound KPIs: some of the KPIs are “compound parameters”, derived from multiple input data, to give an aggregate measure of some aspect of the road transport system and the effect that 2ZERO is likely to have upon it. Again, these parameters are also likely to be projections: hence, models which combine the effects of the multiple input data in order to derive these compound parameters will need to be used.

Work Package 1 of the *Le*Mesurier project, this report, relates primarily to the Direct KPIs. The work to make the first measurement of these Direct KPIs, following the process described in D1.1, “Methods, framework and baselines to assess the Direct KPIs”, and the results of that measurement are reported here. The report is extensive since a significant amount of information is given for each of the over forty Direct KPIs. A brief summary of each of the major aspects of the report is given in this section.

The process to make the initial measurement of the Direct KPIs from the first selection of running 2ZERO projects has been applied successfully. At the time of reporting, an overview showing the status of the measurement of each Direct KPI has been made. This is given on the following page. The four columns (Accomplished, Progressed, Static and Inconclusive) reflect the opinion of WP1 on the progress of the 2ZERO project portfolio to achieving these KPIs as at the time of writing. The column headings in the table can be interpreted as, for each KPI:

Accomplished	(dark green)	Measured and reached
Progressed	(light green)	Measured and progression
Static	(amber)	No progress measured
Inconclusive	(grey)	Measurement inconclusive

About ten of the 2ZERO KPIs are assessed as already achieved, although the Partnership is only about halfway through its expected duration. About twenty-five further 2ZERO KPIs are found to be measurable and progressing: hence, a positive assessment for about 85% of the 2ZERO KPIs can be given. Only six (about 15%) of the 2ZERO KPIs are found to be static or cannot be conclusively measured yet. The learnings from this initial measurement have been recorded and input into the activities of the Recommendations work package of *Le*Mesurier.

[1] See https://www.2zeroemission.eu/what-we-do/strategic-research-and-innovation-agenda-sria/

Table 1: An overview of the status of each measured Direct KPI

	Identifier	KPI description	Status after initial assessment			
			Accomplished	Progressed	Static	Inconclusive
Public sources	GO.KPI.1	Proportion of climate related spending (climate mainstream) in Horizon Europe spending	■			
Public sources	GO.KPI.2	FTE jobs supported in entities involved in Horizon projects addressing the European Green Deal per year				■
Public sources	*GO.KPI.3*	*Reduction of CO2 emission from road transport for all types of vehicles*	*Compound KPI, not included in this assessment*			
Public sources	GO.KPI.4	Number of new vehicle registration of zero tailpipe emission vehicle in Europe in 2030, both for passenger cars/light duty vehicles (L Cat included) and for commercial vehicles	■			
Public sources	GO.KPI.5	Increased affordability of the zero tailpipe emission vehicles		■		
Public sources	GO.KPI.6	Number of (publicly available) electric recharging and hydrogen refuelling stations available in the EU in 2030	■			
Public sources	*SO.KPI.1*	*Ability to determine realistically and reliably the energy intensity (tank-to-wheel)*	*Compound KPI, not included in this assessment*			
Public sources	*SO. KPI.2*	*Reduce GHG of mobility of people and goods (expressed in tonCO2eq /pkm or tkm and toe /pkm and toe/tkm)*	*Compound KPI, not included in this assessment*			
Project consultation	SO.KPI.3	Reduction of development time and effort		■		
Project consultation	SO.KPI.4	Improvement of the integration of EVs into the grid (and related improvement on the load curve management and integration of Renewable Energy Sources)		■		
Project consultation	SO.KPI.5	Improvement of charging efficiency demonstrated - For slow charging (3kW up to 22kW) - For fast (>150 kW) and ultra-fast charging (> 300 kW)		■		
Project consultation	SO.KPI.6	Development of well-established decision-making tools and stakeholder engagement practices to implement integrated deployment strategies for boosting e-mobility as project follow-ups	■			
Project consultation	SO.KPI.7	Well established fleet managerial tools to smoothly incorporate zero tailpipe vehicles in transportation fleets	■			
Project consultation	SO.KPI.8a	SO.KPI.8a: Number of (public and private) transport operators implementing zero tailpipe business models and use cases for freight transport and people mobility	■			
Project consultation	SO.KPI.8b	Demonstrated innovative use cases using zero tailpipe trucks for regional, medium and long-haul addressing payloads from 7.5 tn to 40+ tn by 2025-2027		■		
Project consultation	SO.KPI.9	Commonly accepted LCA approach		■		
Project consultation	SO.KPI.10	Implementation of an LCI database			■	
Project consultation	SO.KPI.11	Feasibility of advanced circular economy strategies in zero emission mobility solutions demonstrated by performed use cases		■		
Project consultation	OO.KPI.1	Demonstration of technologies, components, systems and their integration in vehicles enabling affordability, high efficiency and fast charging capability		■		
Project consultation	OO.KPI.2	Demonstrator vehicles and concepts realized in 2Zero with an optimized cost vs. benefit and an expected positive impact on cost drivers		■		
Project consultation	OO.KPI.3	Demonstrator vehicles and concepts realized in 2Zero with an optimized cost vs. benefit and an expected positive impact on cost drivers		■		
Project consultation	OO.KPI.4	Demonstration of technologies, components, systems and their integration in vehicles enabling affordability, high efficiency and fast charging capability			■	
Project consultation	OO.KPI.5	Optimal balance between battery size, user needs and re-charging infrastructure capabil-ities identified from EU funded projects		■		
Project consultation	OO.KPI.6	More efficient technologies and solutions developed in EU funded projects for the development of low-power charging infrastructure (<22 kW) and high/ultrahigh-power charging (>300 kWh, up to 1MW for long haul trucks)		■		
Project consultation	OO.KPI.7	Safe, secure and smooth communication exchange between vehicle and charging infrastructure, including communication with the grid and roaming platforms (including access of third parties to the charging infrastructure)			■	
Project consultation	OO.KPI.8	Definition of dynamic load management profiles for specific smart and bidirectional charging scenarios (office building, private house/garage, public space) by EU funded projects, allowing effective grid load management that can lead to increase RES penetration		■		
Project consultation	OO.KPI.9	Demonstrated charging operations answering the freight and logistics requirements avoiding logistics losses penetration	■			
Aggregated, statistical data from EC/CINEA	OO.KPI.10	Breakdown of EU funding across stakeholder types	■			
Aggregated, statistical data from EC/CINEA	OO.KPI.11	Breakdown of members in the association	■			
Aggregated, statistical data from EC/CINEA	OO.KPI.12	Share of funding going to SMEs	■			
Aggregated, statistical data from EC/CINEA	OO.KPI.13	Number of organisations reached in the engagement activities of projects: Advisory boards, dissemination activities		■		
Aggregated, statistical data from EC/CINEA	OO.KPI.14	Number of projects launching standardisation activities		■		
Aggregated, statistical data from EC/CINEA	OO.KPI.15	Number of standardisation committee working on topics related to the partnership area		■		
Aggregated, statistical data from EC/CINEA	OO.KPI.16	IPR (Patent / Utility Model / Industrial Design / Copyright / Trade Mark / Confidential Information) generated in funded projects		■		
Aggregated, statistical data from EC/CINEA	OO.KPI.17	Number of publications from funded projects		■		
Aggregated, statistical data from EC/CINEA	OO.KPI.18	2Zero contribution to roadmaps preparation		■		
Aggregated, statistical data from EC/CINEA	OO.KPI.19	SRIA updates		■		
Aggregated, statistical data from EC/CINEA	OO.KPI.20	Number of policy recommendations issued by funded projects		■		
Aggregated, statistical data from EC/CINEA	OO.KPI.21	Total number of events organised by funded projects		■		
Aggregated, statistical data from EC/CINEA	OO.KPI.22	Number of events organised by the Association		■		
Aggregated, statistical data from EC/CINEA	OO.KPI.23	Number of events organized by supporting platforms		■		
Aggregated, statistical data from EC/CINEA	OO.KPI.24	Number of professionals trained in funded projects		■		
Aggregated, statistical data from EC/CINEA	OO.KPI.25	Number of training materials provided by funded projects				■
Aggregated, statistical data from EC/CINEA	OO.KPI.26	Number of members of the public reached by funded projects				■
			10	**25**	**3**	**3**
			41 Direct KPIs			

Methods and Procedure

The *Le*Mesurier project employs a comprehensive approach to measure the values of the 2ZERO Key Performance Indicators (KPIs). The methods for the assessment of the Direct KPIs include timing and scheduling, data management, project consultation, public data research, questionnaire design, interview design and the design of the deep-dive project analysis as complementary action.

The activities related to the KPI assessment follow a structured timetable, utilize shared working spaces for data management and conduct thorough public data research to understand the KPIs. Questionnaires and interviews are designed to gather detailed information from project coordinators, and deep-dive analyses are conducted to explore causal pathways from project outputs to impacts.

Direct KPI Assessment

The assessment of Direct KPIs involves consulting public data sources, project questionnaires and coordinator interviews. Each KPI is evaluated based on related Horizon Europe 2ZERO calls, project responses and progress towards targets. The KPIs assessed include climate-related spending, FTE jobs supported, new vehicle registrations, affordability of zero tailpipe emission vehicles, availability of recharging and refuelling stations, reduction of development time and effort, integration of electric vehicles into the grid, charging efficiency, decision-making tools, fleet managerial tools, transport operator implementations, innovative use cases, LCA approaches, LCI database implementation, circular economy strategies, and demonstration of technologies and components.

Public Data Research

Before the consultation of the 2ZERO projects, all project partners involved conducted desk research to see how much of the information required for the KPI assessment could be obtained from public sources such as open databases, dashboards or project webpages. This activity had two main objectives:

- The partners needed to get to know and understand the Direct KPIs and what information was needed for a comprehensive assessment.
- Information gathered could be included in the questionnaires before they were sent to project coordinators. This way project coordinators had a starting point for providing more detailed responses to the questionnaire.

Questionnaire Design

The questionnaire serves as a tool for gathering data related to the 2ZERO KPIs from the 2ZERO project coordinators, focusing on both current and target performance levels. By incorporating baseline timings and values, as well as target KPI values, the questionnaire ensures alignment with the Partnership's objectives and provides a structured framework for tracking progress. The design process for the questionnaire began with drafting open-ended questions to capture qualitative insights. These questions were refined via a thorough review process involving the majority of the *Le*Mesurier project partners, to enhance clarity, ensure balance between open and closed questions, and improve the overall feasibility for respondents. Trial runs were conducted with *Le*Mesurier partners who were also involved in 2ZERO projects, to ensure the questionnaire's functionality and relevance before its distribution. The questionnaire was designed to collect detailed information about project contributions to the various 2ZERO KPIs.

Interview Design

Some coordinator interviews were conducted online in February or March 2025 and were based on the responses the *Le*Mesurier team received from previously via the questionnaire. For the initial assessment, three projects were interviewed in a trial. The interviews were designed in a two-step approach: the WP1 partners led the interview participants through the questionnaire responses received and mainly asked for clarification about the project's use cases. The WP2 partners presented the analysis approach for the Compound KPIs, giving the project coordinators the opportunity to react to preliminary results.

Statistical Data
For some of the KPIs, data was extracted from 2ZERO projects' reporting data (to CINEA): this was provided in an aggregated format to the *Le*Mesurier consortium by the European Commission.

Design of Deep-Dive Project Analysis
Some of the projects were the subject of a more qualitative, deep-dive assessment. The results of this activity are also now supporting WP3 in relation to the Generic Objectives of the relevant cluster or the Horizon Europe framework programme and the overall recommendations from *Le*Mesurier, as given in WP4

The selection process for the projects to be more deeply assessed was structured in several phases, incorporating feedback from stakeholders and aligning with the 2ZERO Partnership's Objectives. Initial consultations with 2ZERO in June 2024 helped shape the criteria, while a workshop in October 2024 with both 2ZERO and CINEA refined the selection. The process involved five steps, outlined below.

- Step 1: Thematic Focus. Projects were initially clustered based on the categories defined in WP2 and then grouped according to the overarching 2ZERO pillars. This approach represents a simplified categorisation.
- Step 2: Project Maturity. The maturity of the individual projects was assessed by their current reporting period (RP). RP1 projects, which generally cover the first 18 months of the project life, are at an early stage of development and may not provide sufficient public results for a comprehensive assessment. For this reason, RP1 projects were deprioritized. In contrast, RP2 projects, which have completed initial reviews and published results, were prioritized for deeper analysis. Currently, no projects are available beyond RP2.
- Step 3: Information Availability and Involvement. *Le*Mesurier partner involvement is key for facilitating data sharing and enhancing analysis quality. Projects with varying levels of partner involvement were selected to offer insights into different involvement dynamics. Projects not included in the *Le*Mesurier WP2 assessment were also considered. In addition, the availability of public publications and results was reviewed.
- Step 4: Consultation with 2ZERO and CINEA. The project selection was validated with 2ZERO and CINEA. Initial feedback from 2ZERO (June 2024) emphasized the importance of focusing on heavy-duty vehicles, circular economy and components. Furthermore, a consultation with 2ZERO and CINEA, held on October 9th, 2024, provided specific feedback, which shaped the final selection.
- Step 5: Final Selection. After incorporating the feedback and the review of the four remaining component projects, the final project selection included ESCALATE, EBRT2023, EV4EU, HighScape and, additionally, GIANTS and ZEV-UP were identified for an exploratory analysis to test the method on projects currently in RP1.

Conclusion
The completed initial assessment of the Direct KPIs shows that all consulted 2ZERO projects have contributed to the achievement of the overarching 2ZERO Partnership Objectives. They have contributed on different levels and in different degrees of fragmentation, but (with few exceptions) almost all measured Direct KPIs have progressed towards their targets set out in the 2ZERO SRIA. The processing of high amounts of information and feedback for progress monitoring purposes requires high effort, which may indicate that thoughtful and precise use of an AI tool to support this process may be beneficial.

Next Steps
The findings from the work reported here are feeding into the other work packages of the *Le*Mesurier project. Attention within WP1 will now turn to the visualisation and dissemination of the findings (from WP1 and WP2) such that methods and measurements are understood and could be applied, in future, by 2ZERO and, possibly, a wide group of stakeholders.

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List of abbreviations and acronyms

Abbreviation	Meaning
2ZERO	Towards Zero Emission Road Transport Partnership
AC	Alternating Current
AI	Artificial Intelligence
AVERE	European Association for Electromobility
BEV	Battery Electric Vehicle
BEPA	Batteries Europe Partnership Association
BMS	Battery Management System
CCAM	Connected, Cooperative and Automated Mobility
CE	Circular Economy
CPO	Charge Point Operator
CSA	Coordination and Support Action
DC	Direct Current
DIN	Deutsches Institut für Normung (German Institute for Standardization)
DSO	Distribution System Operator
ECIRL	Urban EV Adoption Charging Infrastructure Readiness Level (ECIRL) Index: A Strategic Tool for Policymakers to Assess Public Charging Infrastructure
ECSEL	Electronic Components and Systems for European Leadership
ECU	Electronic Control Unit
EMS	Energy Management System
EPOSS	European Platform on Smart Systems Integration
ERTRAC	European Road Transport Research Advisory Council
ESVE	Electrical Vehicle Supply Equipment
EU	European Union
EUCAR	European Council for Automotive R&D
EV	Electric Vehicle
FCEV	Fuel Cell Electric Vehicle
FISITA	International Federation of Automotive Engineering Societies
H2020	Horizon 2020
HVAC	Heating, Ventilation and Air Conditioning
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronics Engineers
IoT	Internet of Things
ISO	International Organization for Standardization
KPIs	Key Performance Indicators (and measures of success)
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LFP	Lithium Iron Phosphate
MCS	Megawatt Charging System
MSP	Mission Suitability Profile
NMC	Nickel Manganese Cobalt
OCPP	Open Charge Point Protocol
OEM	Original Equipment Manufacturer
PV	Photovoltaic
RES	Renewable Energy Sources
RTO	Research and Technology Organisation
SAE	Society of Automotive Engineers
SOC	State of Charge
SRIA	Strategic Research and Innovation Agenda

SUMP	Sustainable Urban Mobility Plan
TCO	Total Cost of Ownership
TRL	Technology Readiness Level
TSO	Transmission System Operator
V2B	Vehicle-to-Building
V2G	Vehicle-to-Grid
V2H	Vehicle-to-Home
V2X	Vehicle-to-Everything
VPP	Virtual Power Plant
WP	Work Package

INTRODUCTION

1.1 *Le*Mesurier introduction

The 2ZERO Partnership KPIs are multiple and various, relating to the three-layer approach for the Objectives of 2ZERO, as expressed in its Strategic Research and Innovation Agenda (SRIA)[2]. The *Le*Mesurier Coordination and Support Action (CSA) is determining a common framework for monitoring these multiple and various Key Performance Indicators, KPIs (including their sources, methods and reporting formats). It generates values for the KPIs and their expected variation for the coming decade, based upon the results of the projects being conducted within the Partnership and the assessment of the impact of these projects' results.

The CSA supports the identification and quantification of the interactions, impacts and effectiveness of the Partnership within the road transport challenge. Furthermore, the CSA will provide recommendations for development and analysis of the means of measurement and evaluation of the Partnership within the road transport challenge. Finally, the CSA is disseminating and communicating its results to a wide range of stakeholders, throughout the road transport sector, but also across Member States and to the public in general, via a range of media and events.

The consortium undertaking *Le*Mesurier represents many sectors of the road transport community from multiple European countries: it is guided by a strong Advisory Board from a broad range of vehicle manufacturers, suppliers, RTOs, operators and infrastructure providers, as well as technology partnerships, joint undertakings and other representative organisations within Europe.

The *Le*Mesurier project has many work packages. Work Packages 1 and 2 work on the evaluation of the contribution of the 2ZERO Partnership and its projects towards achieving the Partnership's objectives, as set out in the SRIA. The Partnership's objectives have measures of success, which will be tracked using a set of KPIs.

Within *Le*Mesurier, the accounting of these KPIs is dependent on the characteristics of the KPIs themselves. Within the project the KPIs have been classified as two types, either Direct or Compound. Direct KPIs: many of the KPIs are "single count" parameters, i.e. data available from direct reference to single sources, which are suggested within the SRIA document. These parameters can be captured in documentation and demonstrations. However, some of these single counts are likely to be projections for the duration of 2ZERO given the timeframe of the measurement of the KPIs, that is between 2025 and 2035; whereupon multiple sources of such projections would be valuable, in order to determine a range within which the results of 2ZERO are likely to occur. Compound KPIs: some of the KPIs are "compound parameters", derived from multiple input data, to give an aggregate measure of some aspect of the road transport system and the effect that 2ZERO is likely to have upon it. Again, these parameters are also likely to be projections: hence, models which combine the effects of the multiple input data in order to derive these compound parameters will need to be used. WP1, this report, relates primarily to the Direct KPIs.

1.2 Scope of the Document and its Relation to the Work within *Le*Mesurier

This report describes the findings of the initial assessment done on the Direct KPIs analysed in WP1. It is the result of Tasks 1.2 and 1.4 and summarizes *Le*Mesurier's findings pertaining a) assessment methods and procedures, b) Direct KPI assessments including public data research, project consultation and reporting statistics, and c) lessons learned and recommendations from the assessment, completed by d) a deep-dive analysis into projects.

The initially envisioned submission date was February 28th, 2025. The submission of the deliverable was delayed due to some delayed project feedback and time intensive collection and visualization of the

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[2] See https://www.2zeroemission.eu/what-we-do/strategic-research-and-innovation-agenda-sria/

received information. However, further delays occurred since access to data from the project periodic reports needed to be approved within the EC. Once this data became available and could be analysed, this report was completed.

The majority of this deliverable's objectives were achieved in full. Some open points will be dealt with in the follow-up assessment, Deliverable D1.3. The roles of those involved in the creation of D1.2 is given in the table below.

Table 2: Roles and affiliations of those working on Deliverable 1.2

Role:	Who:
Schedule, timing, coordination	Verena Wagenhofer, AVL
Public data research	All WP1 partners
Questionnaire design	Vera-Marie Andrieu, UEMI Eleni Papaioannou, CERTH Verena Wagenhofer, AVL
Questionnaire trial runs and improvements	Vera-Marie Andrieu, UEMI Eleni Papaioannou, CERTH Verena Wagenhofer, AVL All *Le*Mesurier partners involved in 2ZERO projects
Collection and visualization of questionnaire feedback	Eleni Papaioannou, CERTH
Coordinator interviews	Verena Wagenhofer, AVL Simon Edwards, Ricardo Giannis Papadimitriou, emisia Marco Mammetti, Idiada
Project deep-dive analysis	Vera-Marie Andrieu, UEMI Oliver Lah, UEMI Shruti Raje, UEMI
Detailed assessment summary	Verena Wagenhofer, AVL

This deliverable report starts with a summary, which highlights the main findings and conclusions of the assessment, and continues with a description of the methods and procedures used to do the analyses. Each Direct KPI is assessed in a separate sub-chapter including the relevant 2ZERO calls, the baseline information, the projects' contributions and an assessment summary. This is followed by a chapter describing the detailed deep-dive analysis. The deliverable report concludes with a chapter about recommendations and provides snapshots and document examples in the Annex.

Direct references between described results and specific 2ZERO projects were removed and projects' contributions described in an aggregated way. Depending on the type of KPI and the sources used for the analysis the visual representation of the assessment may vary. Information retrieved from public sources has been supported by visuals and graphs, input received from the project consultation has been described in tables and sub-sections, and statistical data representing the status quo at the time of receipt has been described in shorter statements. The document includes some repeating information, so that every KPI assessment sub-chapter may be read and understood on its own. A secure application of an AI tool without web-access has been used with care to support the management and processing of the high amount of information and support the analysis of questionnaire feedback.

METHODS USED AND PROCEDURE

2.1 Timing and schedule

- April – June 2024: data available from public sources was researched and compiled in KPI Data Collection Sheets.
- June 2024: the Project Questionnaire was drafted.
- June – September 2024: the Project Questionnaire went through some trial runs, was further improved and clarified according to the feedback received.
- October 2024: the Questionnaire was officially distributed to all running 2ZERO projects.
- October 2024 – January 2025: the project feedback was collected and reminders were sent to projects and project clusters.
- February – March 2025: the Questionnaire feedback was summarized and visualized. Project coordinator interviews were conducted.
- March – June 2025: the data from the project periodic reports was made available, analysed and included in this report.

The following graph shows a snapshot of the working timetable the team used as a supporting document during the steps described (up to March 2025).

LeMesurier PROJECT CONSULTATION: QUESTIONNAIRE TIMETABLE

Steps	1 done	2	3	4	5			6
Task	1.2	1.2	1.2a	1.2a	1.2b	1.2b	1.4	1.2b
Description of step	**Design of questionnaire** D	**Questionnaire trial run A** D	**Questionnaire trial run B** D	**Questionnaire to all LeMesurier partners involved in 2Zero projects** D	**Questionnaire to project clusters** D	**Questionnaire to project coordinators, if the projects are not part of a cluster** D	**Deep-dive analysis** D	**Interviews with project coordinators** D
When will it take place?	CW 29 start (15/7)	CW 30, 31 start (22/7)	CW 31, 32, 33 start (29/7)	CW 34, 35, 36 start (19/8)	CW 37, 38, 39 start (9/9)	CW 37, 38, 39 start (9/9)	CW 37, 38, 39 start (9/9)	CW 40, 41, 42, 43 start (30/9)
Action items	**Action:** design a questionnaire as simple and as useful as possible, mirroring the 2ZERO SRIA KPI table (CERTH, UEMI, AVL) LEAD: CERTH DONE	**Action:** AVL, FEV, ERTICO and Fraunhofer receive the questionnaire to test it for the projects HighScape, ESCALATE, ZEV-UP and TranSensus LCA. They will work the questionnaire, discover flaws, gaps, uncertainties and provide feedback. They will fill out as much information for the three projects as they can. They will also record the time and effort it takes to fill out the questionnaire. LEAD: AVL DONE	**Action:** CERTH, UEMI and AVL will modify and improve the questionnaire based on the suggestions received. LEAD: UEMI DONE	**Action:** UEMI will collect all information for the projects received in step 3. They will also pre-fill the questionnaires for the projects as much as possible. LEAD: UEMI DONE	**Action:** CERTH and UEMI will gather all information received in steps 2, 3 and 4 and pre-fill the questionnaires where possible. LEAD: UEMI DONE	**Action:** CERTH will reach out to all project coordinators directly, if their projects are not part of any relevant cluster, provide them with pre-filled (or still empty for some projects) questionnaires and request feedback. LEAD: CERTH DONE	**Action:** UEMI will present suggestions for deep-dive analysis to Guido Sacchetto and Lucie Beaumel. Projects for the deep-dive analysis are selected. LEAD: UEMI DONE	**Action:** All partners involved in WP1, WP2 and WP3 get together in an online meeting to discuss the status of the project analysis. LEAD: AVL IN PROGRESS
	Action: Draft covering letters to be used as introduction for the questionnaire (Ricardo, CERTH) LEAD: RICARDO DONE	**Action:** Ricardo, E3M, EMISIA and IDIADA will review the questionnaire and provide suggestions for modifications, especially to cover WP2 specifics. They will use the XLConnect project as an example. They will also suggest a split between very project-specific questions and general questions suitable for every project. LEAD: IDIADA DONE	**Action:** LeMesurier partners (see full list below) very active in 2ZERO projects will be contacted and requested to fill in the questionnaire and provide as much information for every project as possible. They will also record the time and effort it takes to fill out the questionnaire. LEAD: UEMI DONE	**Action:** LeMesurier partners (see full list below) active in 2ZERO projects will be contacted and requested to fill in the questionnaire, provide as much information and possible and complement (or comment on) information that is already there. > Part 1: Word document by 06/09 > Part 2: Online by mid CW37 LEAD: UEMI DONE	**Action:** CERTH will reach out to all relevant project cluster administrations, provide them with pre-filled (or still empty for some projects) questionnaires and request feedback. LEAD: CERTH DONE	**Action:** CERTH will summarize, how many projects have been reached by our questionnaire and identify gaps and/or "tricky" projects. LEAD: CERTH IN PROGRESS	**Action:** UEMI will perform the deep-dive analysis. LEAD: UEMI IN PROGRESS	**Action:** All partners involved in WP1 and WP2 review the project feedback and determine open questions that will need to be asked directly to coordinators. LEAD: AVL IN PROGRESS
	Action: First review of questionnaire and preparation of trial run 1 (AVL, CERTH, UEMI, Ricardo, EMISIA) LEAD: CERTH DONE	**Action:** Second review of questionnaire and preparation of trial run 2 (AVL, CERTH, UEMI, Ricardo, EMISIA) LEAD: AVL DONE			**Action:** 2ZERO will review the questionnaire LEAD: RICARDO DONE	**Action:** AVL, CERTH, UEMI, Ricardo and EMISIA will review the "tricky" projects and come up with mitigation measures and strategy in order to avoid radio-silence from some projects. LEAD: AVL SLIGHTLY DELAYED		**Action:** CERTH will summarize the open questions for each project. LEAD: CERTH
						Action: UEMI will identify projects for deep-dive analysis. AVL, Ricardo and UEMI will arrange for a separate meeting with Guido from the EC. LEAD: UEMI SLIGHTLY DELAYED DONE		**Action:** CERTH will make a suggestion which of of the LeMesurier partners involved in WP1 and/or WP2 will interview which project representative. LEAD: CERTH
								Action: All assigned LeMesurier partners perform interviews with project representatives to clarify open questions. LEAD: CERTH

Figure 1: Timeline for the first measurements of the Direct KPIs

2.2 Data management

At the beginning of the *Le*Mesurier project, one of the leading partners e:misia created a shared working space in Microsoft Teams, which all other partners have used to jointly work on documents and gather the required information from public data sources and projects. This shared space was used for the preparation of documents and collection of data for WP1. The following folders were established to properly manage the large amount of information:

- "Individual KPI data collection": This folder includes one Word document per Direct 2ZERO KPI. The document is used to collect all information pertaining to each KPI in one place and make it easier for the involved partners to navigate.
- "WP1 working meetings": This folder includes the meeting protocols of each time the WP1 partners got together.
- "WP1 Deliverables in elaboration": This folder includes the deliverable reports that are currently being drafted. Once a deliverable is finalized for submission it is moved to another, general *Le*Mesurier Deliverables folder.
- "Deep Dive": This folder includes the drafts and supporting documents for the project deep-dive analysis done in T1.4.
- "WP1 analysis table": This Excel table visualizes the clustering of the assessed 2ZERO projects (e.g. V2X cluster or AEVETO cluster) and direct links to the "Individual KPI data collection" documents for each KPI.
- "KPIs & related projects": This Excel table visualizes the expected connection between the 2ZERO projects and the 2ZERO KPIs as well as an analysis of *Le*Mesurier partners involved in the 2ZERO projects.
- An overview of the 2ZERO calls and the funded 2ZERO projects in each call is given in two Word documents.

2.2.1 Project consultation

Since the consultation of the 2ZERO projects is relevant for both WP1 and WP2, a separate space was created on the Microsoft Teams page. It includes two main folders: a) Project interviews, and b) Project questionnaires:

- "Project interviews": This folder includes the interview protocols for coordinator interviews that were conducted after the receipt of project feedback via the questionnaire.
- "Project questionnaires": This folder includes a version history of the questionnaire that was drafted, developed and improved through some trial runs. It contains some pre-filled questionnaires that include information that could be gathered from projects before the questionnaire was officially sent out to each 2ZERO project. Partners can also find the official e-mails and reminders that were sent to coordinators, as well as a very comprehensive summary of the responses received.

2.3 Public data research

Before the consultation of the 2ZERO projects, all WP1 partners conducted desk research, to see how much of the information required for the KPI assessment could be obtained from public sources, such as open databases, dashboards or project webpages. This activity had two main objectives:

- The involved partners needed to get to know and to understand the Direct KPIs and what information was required for a comprehensive assessment.
- Information gathered beforehand could be included in the questionnaires before they were sent to project coordinators. This way, project coordinators had a starting point for providing more detailed responses to the questionnaire.

2.4 Questionnaire design

2.4.1 Objectives for questionnaire

The questionnaire serves as a tool for gathering data related to the 2ZERO KPIs from the 2ZERO project coordinators, focusing on both current and target performance levels. By incorporating baseline timings and values, as well as target values, the questionnaire ensures alignment with the Partnership's objectives and provides a structured framework for tracking progress.

The design process for the questionnaire began with drafting open-ended questions to capture qualitative insights. These questions were refined via a thorough review process, involving WPs 1, 2 and 3, to enhance the clarity, balance between open and closed questions, and improve the overall feasibility for respondents. Trial runs were conducted with *Le*Mesurier partners who were also involved in 2ZERO projects, to ensure the questionnaire's functionality and relevance before its final distribution. The questionnaire was designed to collect detailed information about project contributions to the various 2ZERO KPIs.

2.4.2 Word questionnaire basis

In an editable Word version of the questionnaire, respondents were asked whether their project contributed to achieving a particular KPI. If the answer was affirmative, they were required to describe how their project contributed, including an estimate of when relevant results were expected. The questionnaire also sought to determine whether the project introduced innovative methods or demonstrations and requested citations of any publications or results that supported the provided statements. In addition, respondents were encouraged to detail any specific issues or challenges they had encountered in their efforts to achieve the KPI, including any confidentiality issues they might have faced while answering the questionnaire. Whenever possible, responses were supported with corresponding values to ensure accuracy and clarity. At the end of the questionnaire, respondents were asked a broader question regarding Generic Objective parameters for road transport research, indicating which of these parameters were relevant to their project.

2.4.3 EU Survey questionnaire

To facilitate the process, the questionnaire was also designed in EU survey. The online questionnaire employed simplified formats, such as Likert scales, balanced the depth of questions, and utilized the EU Survey platform for its intuitive interface and robust capabilities.

2.4.4 Responses to questionnaire

Status of responses

In October 2024, the questionnaire was distributed to the 2ZERO project coordinators, with feedback collection extending through December 2024. To accommodate diverse project preferences, coordinators were provided with both the online version via the EU Survey platform and the editable Word version, allowing them to choose the format that best suited their needs. Responses to the questionnaire offered valuable insights into the extent to which projects addressed specific KPIs, revealed gaps in baseline definitions, and highlighted areas requiring follow-up interviews with coordinators to address data limitations and improve the overall assessment.

It is encouraging that all project coordinators have been highly responsive, demonstrating a strong willingness to engage with the KPI assessment process. However, a recurring challenge is that projects are often reluctant to share preliminary results, likely due to concerns over data accuracy or ongoing developments. To address this, the optimal timing for engaging projects in their KPI assessment appears to be within the last six months before project completion, when findings are more concrete and readily available.

After collecting all project responses to the *Le*Mesurier Questionnaire, partners from WP1 and WP2 undertook the post-analysis process. This involved gathering, categorizing and systematically organizing the information into separate files for each KPI. The data was then consolidated and transferred into clear, structured and meaningful tables, ensuring better readability and usability.

However, the post-analysis of project responses remains a time- and resource-intensive task, requiring significant effort from the *Le*Mesurier project teams, particularly those in WP1 and WP2.

2.4.5 White spots and open points

The post-analysis of project contributions to the Direct KPIs, reveals varying levels of alignment, offering valuable insights for refining project strategies and ensuring stronger connections between project ambitions and expected outcomes.
For instance, GO.KPI.3 and OO.KPI.1 exhibit the strongest alignment, indicating that most projects are successfully addressing these key objectives and integrating them into their activities. This suggests that these KPIs are well-defined and effectively embedded within project frameworks.
Conversely, weaker alignment is observed in OO.KPI.3, OO.KPI.5 and OO.KPI.9, where many projects face challenges in aligning their contributions effectively. This misalignment may stem from unclear expectations, resource constraints or difficulties in implementation, highlighting the need for additional support and targeted guidance to improve engagement with these KPIs.
Additionally, based on the questionnaire evaluation, the timeline for achieving measurable results across various KPIs varies among projects. However, most projects anticipate delivering tangible outcomes within the 2025-2026 timeframe, indicating a crucial period for assessment and impact measurement.
These insights provide a foundation for further refinement of project methods and evaluation processes, ensuring greater alignment and effectiveness in meeting strategic objectives.

2.4.6 Interview design

Some coordinator interviews were conducted online, in February or March 2025, and were based on the responses the *Le*Mesurier team received from them via the questionnaire. For the initial assessment, GIANTS, ZEV-UP and EV4EU were interviewed. The interviews were designed in a two-step approach: The WP1 partners led the interview participants through the questionnaire responses received and mainly asked for clarification about the project's use cases. The WP2 partners presented the analysis approach for the Compound KPIs, giving the project coordinators the opportunity to react to preliminary results.

2.5 Design of deep-dive project analysis

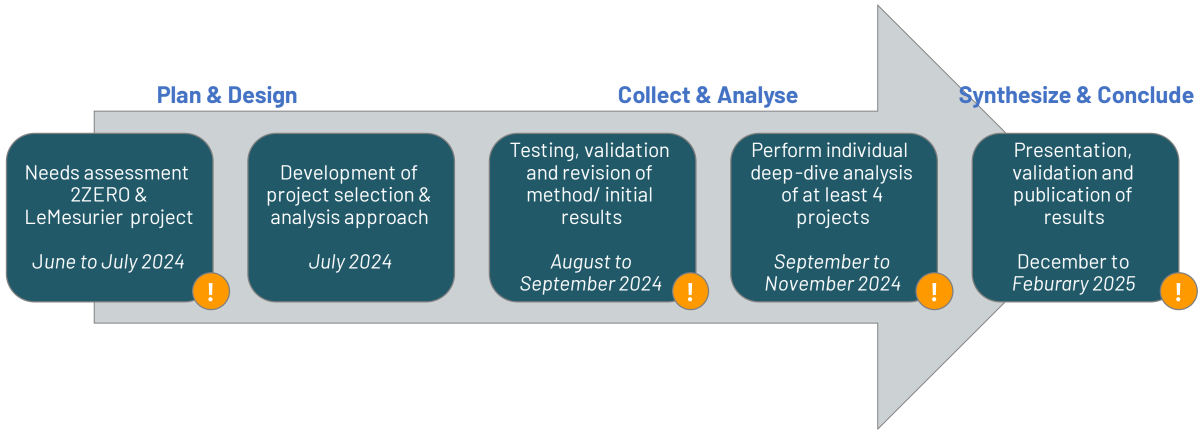


Figure 2: Time schedule for deep-dive analysis

Task 1.4 supported both the project and 2ZERO more generally (based on the Grant Agreement and initial project phase):

- Supports 2ZERO by exploring and describing causal pathways from project outputs to impacts toward achieving 2ZERO Objectives.
- Contributes to the *Le*Mesurier project objectives by providing complementary qualitative insights to the quantitative assessment of Direct KPIs, e.g. by focusing on hard-to-capture KPIs.

Task 1.4 is strongly intertwined with the other activities in WP1. Therefore, task partners closely follow and contribute to the work in Task 1.1. Task 1.4 is based on the analysis and desk research of the 2ZERO KPIs being conducted and is developed in close cooperation with the WP1 partners. Among other things, needs aligned between the tasks include streamlining stakeholder engagement, such as interviews and exchanges with project coordinators, *Le*Mesurier partners and the 2ZERO Partnership.

In June 2024 UEMI developed an initial concept and framework for the in-depth analysis, which was further developed jointly with WP1 partners. In addition, a consultation with 2ZERO, the T1.4 task partners, and AVL was done in July 2024. The purpose of this consultation was to present the concept to 2ZERO and carry out a needs assessment, e.g., regarding new relevant developments and 2ZERO's requirements.

2.5.1 Project selection approach

This section outlines the considerations for defining the selection criteria for the projects included in the deep-dive analysis. It is based on the objectives defined in the *Le*Mesurier DoA and initial discussions within the *Le*Mesurier consortium, particularly in WP1. The selection is guided by the review of available information for each KPI and project conducted in Task 1.2 (Review Matrix WP1).

Figure 3: Project selection steps

The deep-dive analysis was to include at least four projects. The selection criteria and the final selection of projects were defined together with the *Le*Mesurier partners in WP1 and 2ZERO. UEMI compiled a list of selection criteria, which can be found below.

Selection criteria

The criteria for selecting projects for the deep-dive analysis include thematic relevance, alignment with 2ZERO's strategic priorities, project maturity, information availability and stakeholder involvement. The selection process includes: (1) making a preselection, (2) presenting and validating this selection with 2ZERO and CINEA, and (3) incorporating feedback to refine the final project shortlist. Table 1 summarizes these criteria.

Table 3: Project selection criteria

Category	Criterion
Thematic Focus	• Projects must be currently active within the 2ZERO project portfolio. • Include projects classified as Innovation Actions (IA) or Research and Innovation Actions (RIA). • Include one project each with key focus on the 2ZERO Pillars 2 and 3, and two projects in vehicle/component development (Pillar 1). • Include at least one project per cluster (e-VOLVE, V2X, AEVETO).

Category	Criterion
Maturity	• Prioritize late and mid-stage projects, i.e. projects having completed more than 50% of the project lifetime. • Prioritize projects that have completed the first periodic reporting.
Information avail-ability	• Projects with adequate data availability (including objectives, expected outcomes, impact and deliverables). • Prioritize projects with *Le*Mesurier partner involvement.
Relevance for 2ZERO	• Project selection will be validated with 2ZERO. Project selection can be revised to prioritise projects most relevant for the 2ZERO Partnership governing bodies.

Project Selection Steps

The project selection process was structured in several key phases, incorporating feedback from stake-holders and aligning with the 2ZERO Partnership's objectives. Initial consultations with 2ZERO in June 2024 helped shape the criteria, while a workshop in October 2024 with both 2ZERO and CINEA refined the selection. The process involved five steps, outlined below.

Step 1: Thematic focus

Projects were initially clustered based on the categories defined in WP2 and then grouped according to the overarching 2ZERO pillars. This approach represents a simplified categorisation.
Figure 2 provides the legend used in the subsequent figures, detailing the colours and shapes applied. Projects are color-coded based on categories from their respective funding calls, while shapes denote the type of action. Figure 5 shows the thematic clustering of projects, illustrating how projects are distributed across different thematic pillars. Figure 6 shows the more granular clustering that followed into the categories "Vehicle technologies and propulsion solutions for BEV and FCEV", "Integration of BEV into the energy system and related charging infrastructure", "Innovative concepts, solutions and services for zero tailpipe emission mobility for people and goods" and "LCA and circular economy approaches for sustainable and innovative road mobility solutions".

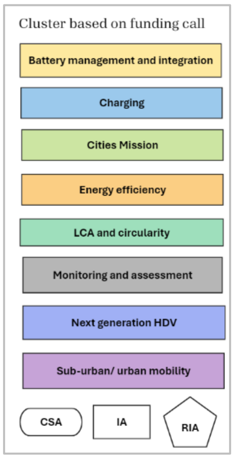


Figure 4: Clustering based on call topic

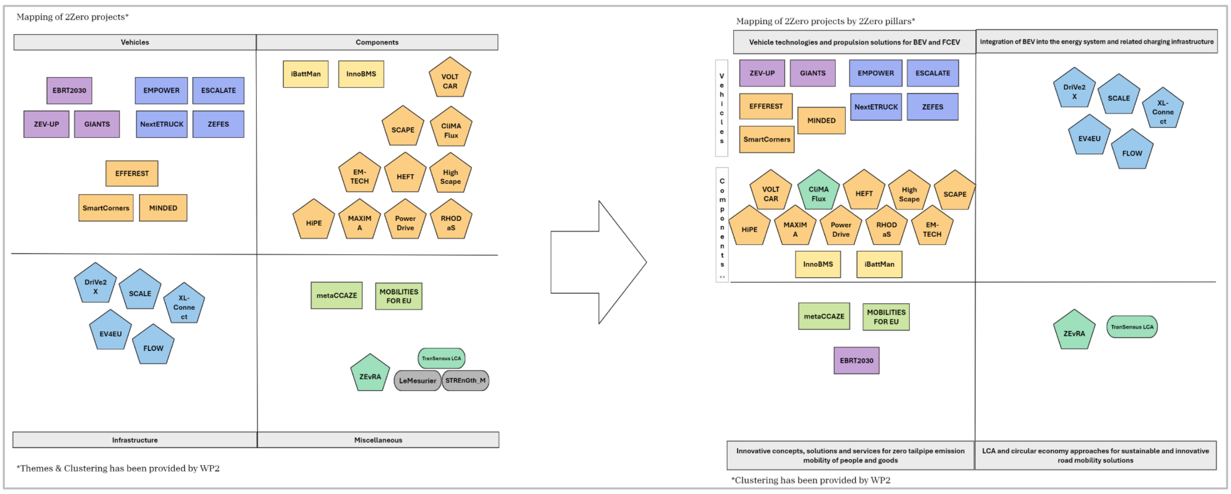


Figure 5: Clustering based on thematic focus

Step 2: Project Maturity

The maturity of the individual projects was assessed by their current reporting period (RP). RP1 projects, which generally cover the first 18 months of the project life, are at an early stage of development and may not provide sufficient public results for a comprehensive assessment. For this reason, RP1 projects were deprioritized. In contrast, RP2 projects, which have completed initial reviews and published results, were prioritized for deeper analysis. Currently, no projects are available beyond RP2. Figure 7 shows the clustering of projects based on maturity.

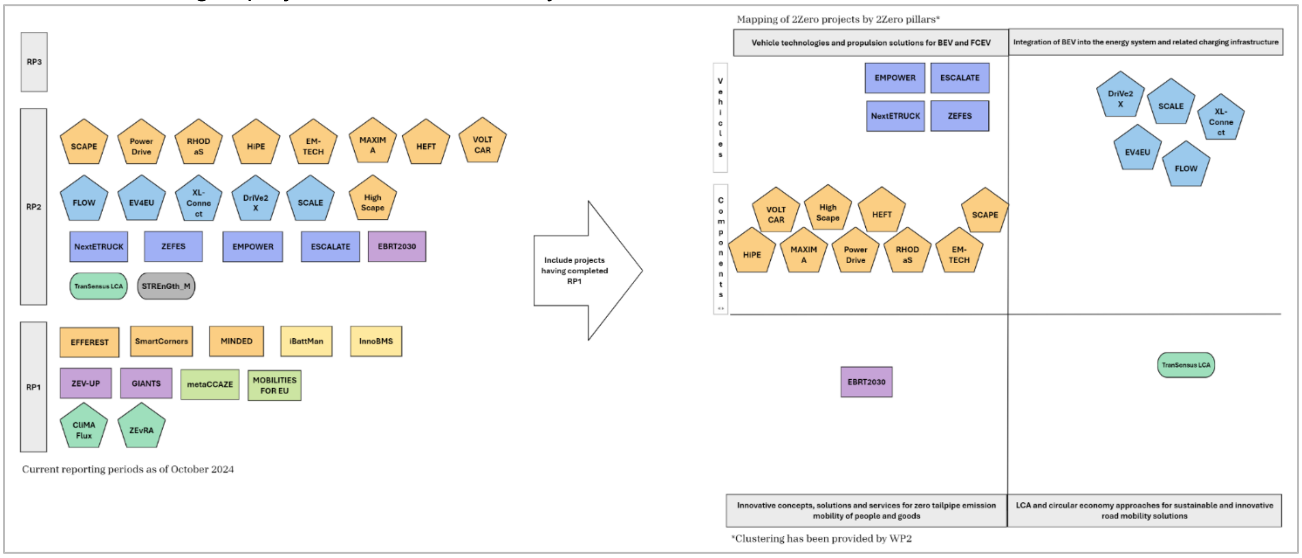


Figure 6: Clustering based on project maturity

Step 3: Information availability and involvement

*Le*Mesurier partner involvement is key for facilitating data sharing and enhancing analysis quality. Projects with varying levels of partner involvement were selected to offer insights into different involvement dynamics. Projects not included in the *Le*Mesurier WP2 assessment were also considered. In addition, the availability of public publications and results was reviewed. Figure 8 presents a categorisation of projects based on the involvement of *Le*Mesurier partners. Projects placed in grey boxes indicate those that were not included in the WP2 assessment.

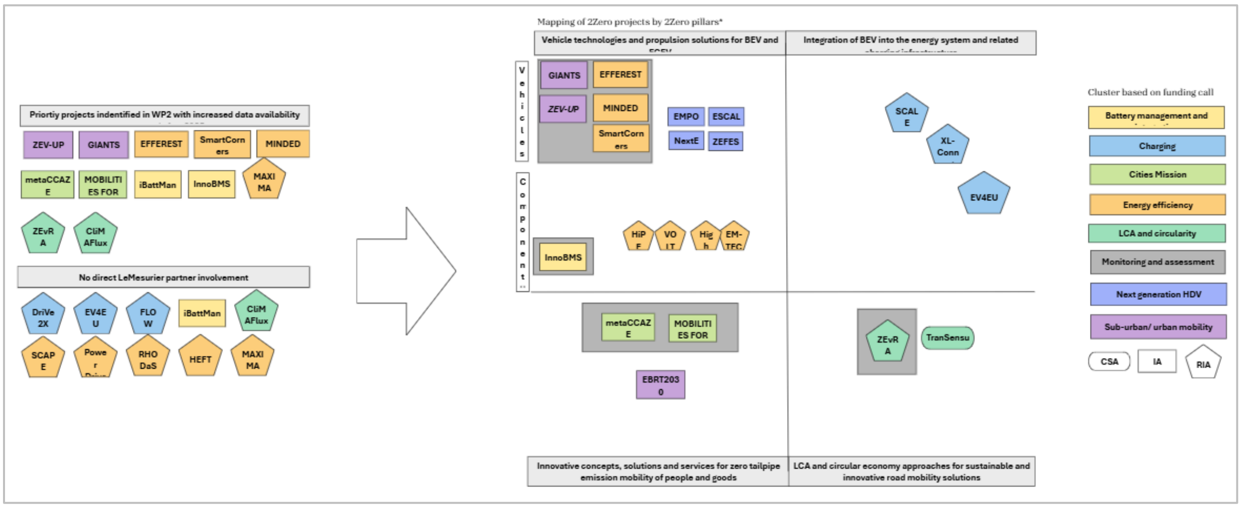


Figure 7: Categorisation based on involvement of LeMesurier partners

Step 4: Consultation with 2ZERO and CINEA

The project selection was validated with 2ZERO and CINEA. Initial feedback from 2ZERO (June 2024) emphasized the importance of focusing on heavy-duty vehicles, circular economy and components. Furthermore, a consultation with 2ZERO and CINEA, held on October 9th, 2024, provided specific feedback, which shaped the final selection.

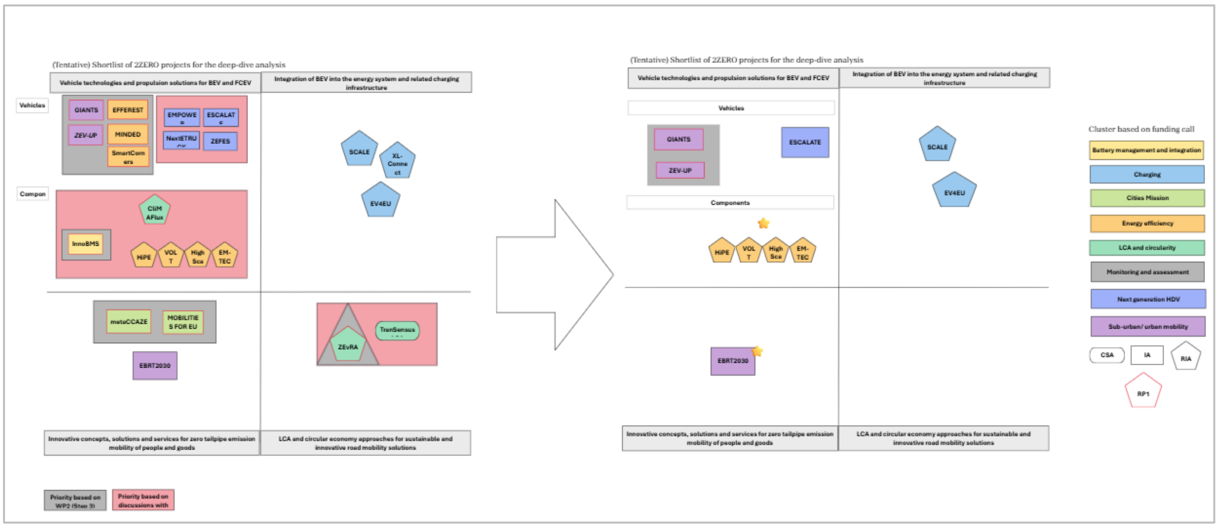


Figure 8: Stakeholder exchange with 2ZERO and CINEA

Step 5: Final selection

After incorporating the feedback and the review of the four remaining component projects, the final project selection includes ESCALATE, EBRT2023, EV4EU, HighScape and, additionally, GIANTS and ZEV-UP have been identified for an exploratory analysis to test the method on projects currently in RP1. Figure 7 presents the final shortlist of selected projects.

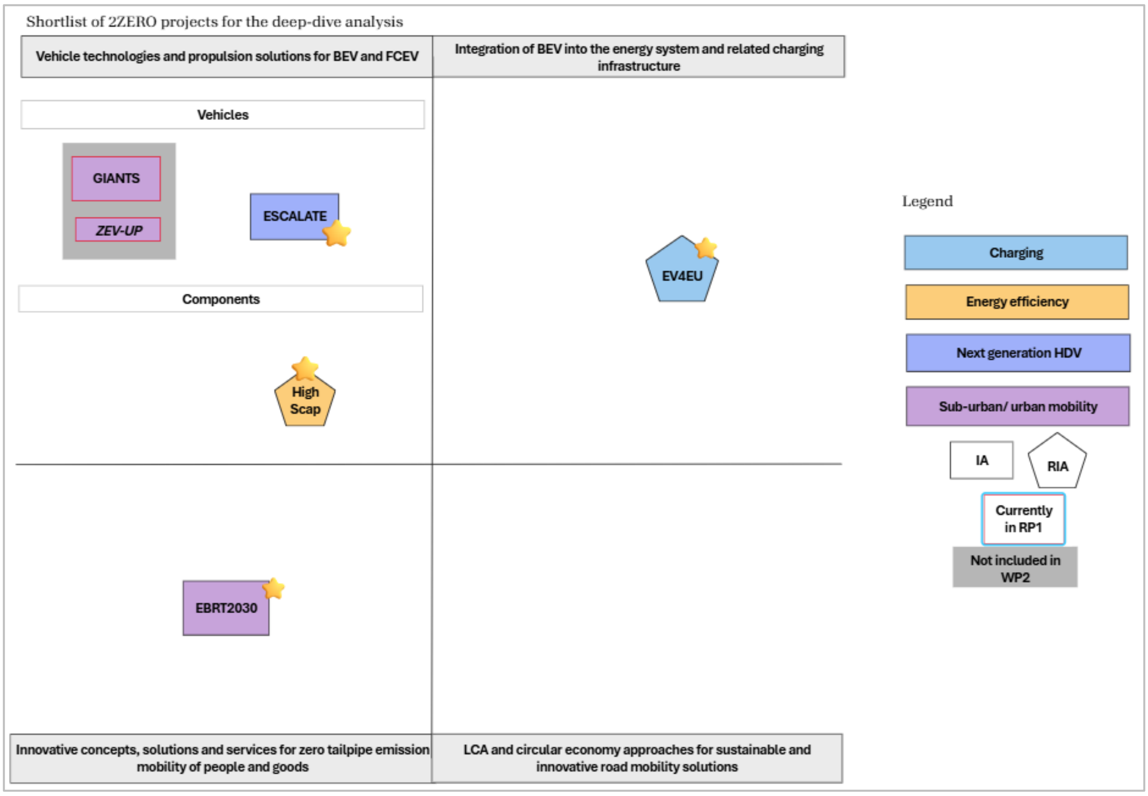


Figure 9: Final shortlist of selected 2ZERO projects for deep-dive analysis

2.6 Statistical data

A number of Direct KPIs were not assessed by direct interaction with 2ZERO projects but rather from excerpts taken from the Continuous and Periodic Reporting of the projects. The request for the extract was sent to the EC and CINEA and consolidated, aggregated data for statistics was provided by the EC in Excel format. Initially, there were confidentiality considerations that led to delays, but which could be solved by *Le*Mesurier receiving and using aggregated project reporting data only.

2.7 Main learnings from the methods and procedure

2.7.1 Timing

Generally, the team was able to keep the proposed deadlines for the schedule, the necessary steps for analysis were completed with minor delay only. A finding would be that the design and improvement of the questionnaire took a significant amount of time, which was not anticipated right from the beginning and would have to factor in for future similar activities.

2.7.2 Data management

The data management made on the e:misia Microsoft Teams page worked reasonably well for the project partners involved. The platform has provided enough flexibility for multiple people to work on the same documents and the same time and for each for the Work Packages to design their workspace and folder structure. Access rights to the shared workspace were granted specifically, which makes the solution secure, as well.

2.7.3 Public data research

WP1 partners started off their work for the KPI assessment by doing desk research on information that has been publicly available. This exercise helped colleagues involved revisit and better understand the 2ZERO KPIs, as listed in the Partnership's SRIA, determine which of the KPIs would absolutely require detailed consultation of 2ZERO projects and which would be assessed by using other means, and gather project specific information in advance to the distribution of the questionnaires, and the conducting of interviews to be better prepared.

2.7.4 Questionnaire

A key observation is that some 2ZERO calls may lack sufficient reference to the 2ZERO SRIA Objectives, success measures or targets. To enhance alignment and coherence, a systematic mapping and integration process is recommended, ensuring these critical elements are explicitly embedded in project planning and execution from the outset. Another challenge identified is a lack of awareness regarding the 2ZERO Partnership (SRIA) Objectives and requirements at the project level later on, which seems to be a direct result of such misalignment. Many projects may not fully understand how their work aligns with the broader strategic framework, which can lead to inconsistent reporting and missed evaluation opportunities. Increased communication, training and documentation could help bridge this gap.
During project consultation, it became apparent that the 2ZERO SRIA KPI/measures of success table in the SRIA has been found to be too complex for many project coordinators, who were not involved in the co-creation process. This required some additional explanation and interpretation at times. If feasible, it would be recommended to simplify this table and maybe enable training sessions or workshops at the start of funded projects to clarify open questions.

2.7.5 Interviews

In order to prepare an interview properly, the interviewer needs to prepare by revisiting the collected public data, the project webpages in general and the more detailed questionnaire feedback. In addition, setting-up a coordinator interview requires a lot of time and effort, so the *Le*Mesurier partners focused on a handful of interviews absolutely required for this initial assessment. While an interview builds a good basis of communication with project coordinators, it is recommended to complement the other described approaches with interviews only if more detailed understanding is required and it is, therefore, deemed necessary.

DIRECT KPI ASSESSMENT

The following pages include details about the initial assessment of the Direct KPIs, as done in WP1. Each assessment includes information about related Horizon Europe/2ZERO calls, baseline definition where appropriate, projects' responses to questionnaires and interviews, which subsequently leads to the measurement of these KPIs.

3.1 GO.KPI.1: Proportion of climate related spending in Horizon Europe spending

3.1.1 Related Horizon Europe/2ZERO calls for submissions

Due to the scope of GO.KPI.1, it is expected that all 2ZERO calls for submissions are relevant.

3.1.2 Assessment summary

Table 4: Assessment summary for GO.KPI.1

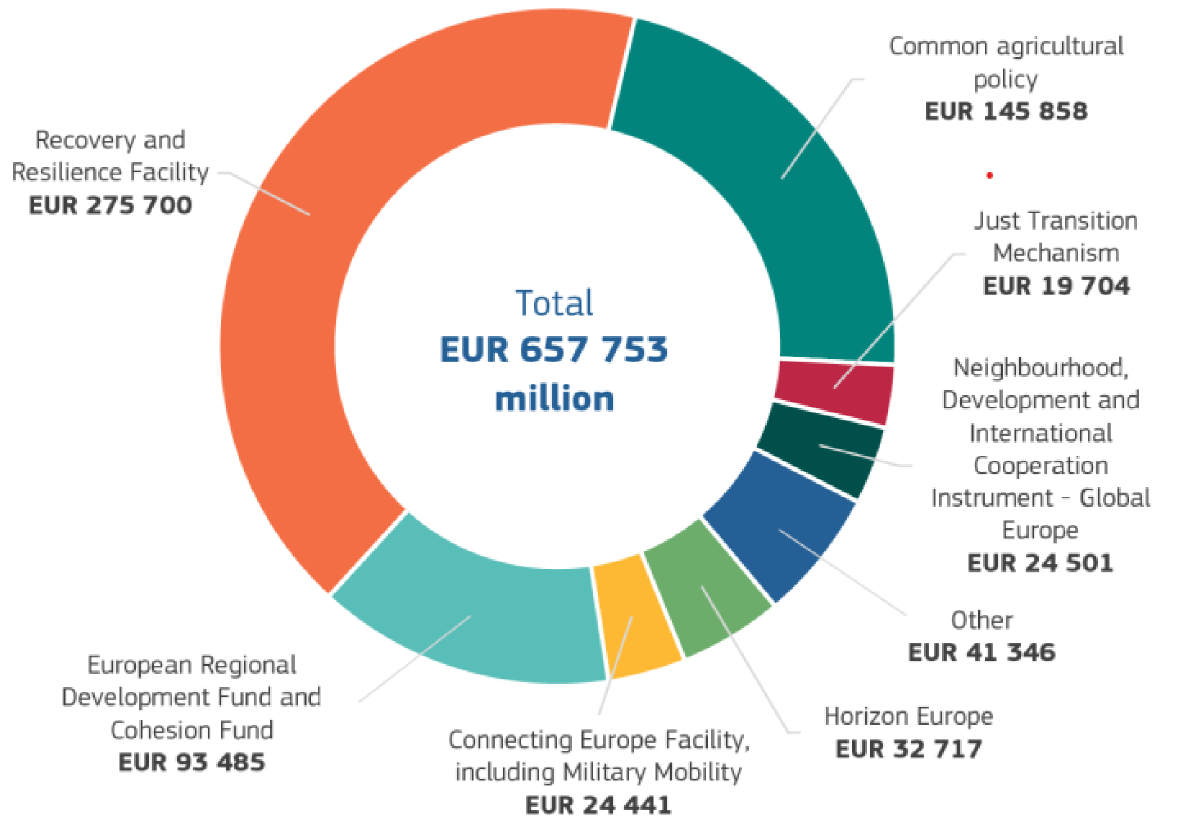
GO.KPI.1	Contribute to Europe having the first carbon neutral road transport system by 2050. Technology leadership supporting economic growth and job creation all over Europe. Ensure European competitiveness thanks to solutions for an integrated carbon neutral road transport ecosystem; Improve the quality of life of EU citizens and ensure mobility for people and goods.
The following targets were defined in the 2ZERO SRIA.	○ N/A
Information was obtained by referring to the following information sources.	○ Public data research
Progress had been made towards Europe having the first carbon neutral road transport system by 2050.	Yes. From 2021 to 2024 21% of the Horizon Europe budget has been linked to climate-related spending. ✓✓

3.1.3 Assessment in detail

The European Commission has been actively working on climate mainstreaming[3], which involves integrating climate considerations into all policy areas and funding programmes. One of the major initiatives is the European Green Deal, which aims to make the EU climate-neutral by 2050. This comprehensive strategy includes measures to reduce greenhouse gas emissions, promote sustainable mobility, and enhance energy efficiency. Another significant initiative is the Sustainable and Smart Mobility Strategy, which aims to achieve a 90% reduction in transport-related greenhouse gas emissions by 2050. The primary goal of climate mainstreaming is to ensure that all EU policies contribute to the climate objectives. This includes making all transport modes more sustainable, providing sustainable alternatives, and integrating digitalization and automation to further reduce emissions. Within the Climate Mainstreaming Architecture, an overall target was set of at least 30% of the budget envelope for climate-relevant expenditure.

[3] European Commission : Climate Mainstreaming Architecture in the 2021-2027 Multiannual Financial Framework, 2022, https://commission.europa.eu/system/files/2022-06/swd_2022_225_climate_mainstreaming_architecture_2021-2027.pdf (31.03.2025)

All 2ZERO projects fall under climate-related spending.



Climate contribution in 2021 to 2027 (million EUR).

Source: European Commission.

Figure 10: Climate contribution in 2021 to 2027 in million EUR (source: EC)

3.1.3.1 Online information

As part of the 2021-2027 climate mainstreaming framework, the 30% target has been divided into specific targets for individual programmes, with Horizon Europe expected to contribute 35% of its budget.

3.1.3.2 Progress towards targets

According to the Climate overview 2024[4], the EU budget for 2021-2027 has been projected to contribute EUR 658 billion to climate spending, representing 34.3% of the budget envelope, surpassing the initial overall target of 30%. The budget commitment made by Horizon Europe is (in million EUR) 4602.6 in 2021, 4926.2 in 2022, 5206.2 in 2023, 4604 in 2024, 4302.6 in 2025, 4392.5 in 2026 and 4682.5 in 2027, resulting in 32716.7, which amounts to 36% of the programmes envelope. From 2021 to 2024 this was (in million EUR) 19.339, which amounts to 21%.

[4] European Commission : Climate overview 2024 (Budget contribution – climate / commitments ; million EUR), 2024, https://commission.europa.eu/document/download/91afaff1-2948-436e-b415-59cbbe0ab08d_en?filename=Budget%20contribution%20-%20climate.pdf (31.03.2025)

3.2 **GO.KPI.2**: FTE jobs supported in entities involved in Horizon Europe projects addressing the European Green Deal

4570 permanent jobs have been supported by 2ZERO projects, so far. This number was retrieved from the Periodic and Continuous Reports of all assessed 2ZERO projects. While useful for the assessment, the information does not match the exact requirements for the status of the full-time equivalents.

3.3 GO.KPI.4: Number of new vehicle registrations of zero tailpipe emission vehicles in Europe in 2030 (passenger cars, light duty vehicles, commercial vehicles)

3.3.1 Related Horizon Europe/2ZERO calls for submissions

Due to the scope of GO.KPI.4 it is expected that all 2ZERO calls for submissions are relevant.

3.3.2 Assessment summary

Table 5: Assessment summary for GO.KPI.4

GO.KPI.4	Contribute to Europe having the first carbon neutral road transport system by 2050. Technology leadership supporting economic growth and job creation all over Europe. Ensure European competitiveness thanks to solutions for an integrated carbon neutral road transport ecosystem; Improve the quality of life of EU citizens and ensure mobility for people and goods.
The following targets were defined in the 2ZERO SRIA.	○ N/A
Information was obtained by referring to the following information sources.	○ Public data research
Progress has been made in increasing the number of new registrations for zero emission vehicles in Europe.	Yes. Both market share and number of new vehicle registrations have increased significantly over the last few years. ✓✓✓

3.3.3 Assessment in detail

3.3.3.1 Information from Eurostat

The overall trend indicates a substantial increase in the number of zero-emission vehicles registered in the EU. From 2021 to 2023, there has been a consistent upward trajectory in registration of new zero emission vehicles, reflecting the EU's commitment to reducing greenhouse gas emissions and promoting sustainable mobility. The data shows that passenger cars have seen the most growth, followed by goods road motor vehicles and lorries.

Table 6: Extract from Eurostat for zero-emission vehicle registrations

Data extracted on 03/04/2025 12:24:57 from [ESTAT]

Dataset:	**New zero-emission vehicles by type of vehicle and type of motor energy [road_eqr_zev__custom_16106387]**
Last updated:	19/12/2024 23:00

Time frequency
Motor energy
Unit of measure
Geopolitical entity (reporting)

TIME	2021	2022	2023
VEHICLE (Labels)			
Lorries > 3.5 tonnes	1 126	1 694	4 037
Road tractors	51	161	899

Goods road motor vehicles <= 3.5 tonnes	40 389	59 348	100 817
Passenger cars	886 164	1 130 992	1 548 417
Buses, motor coaches and trolley buses	3 011	3 549	5 262

3.3.3.2 Information from ACEA (pocket guide 2024/2025)

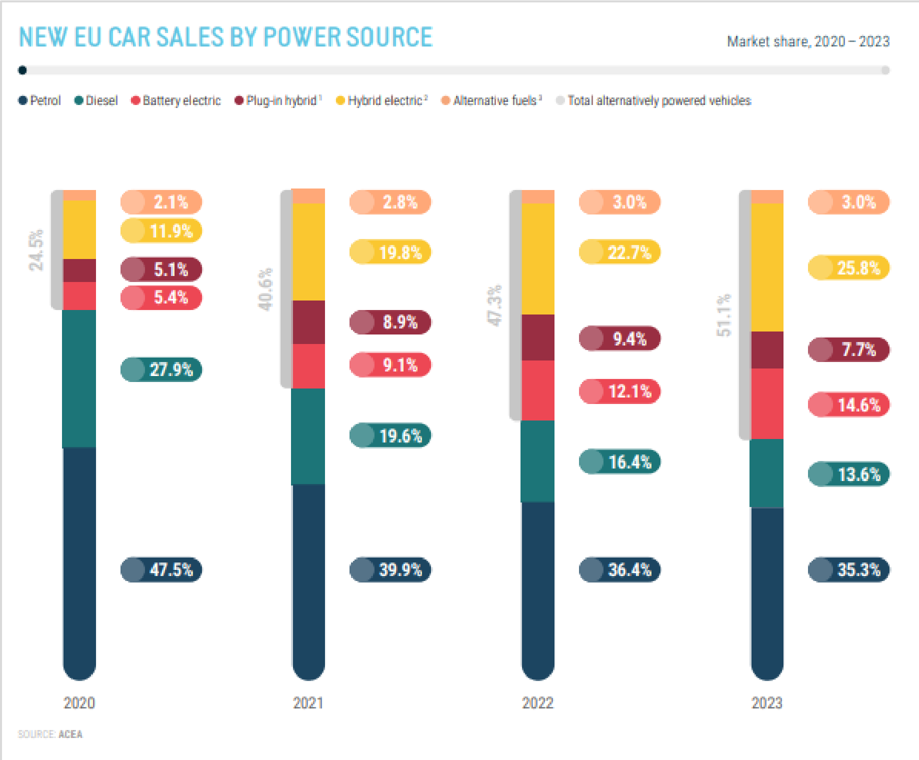


Figure 11: Extract from ACEA pocket guide 2024/2025: car sales by power source

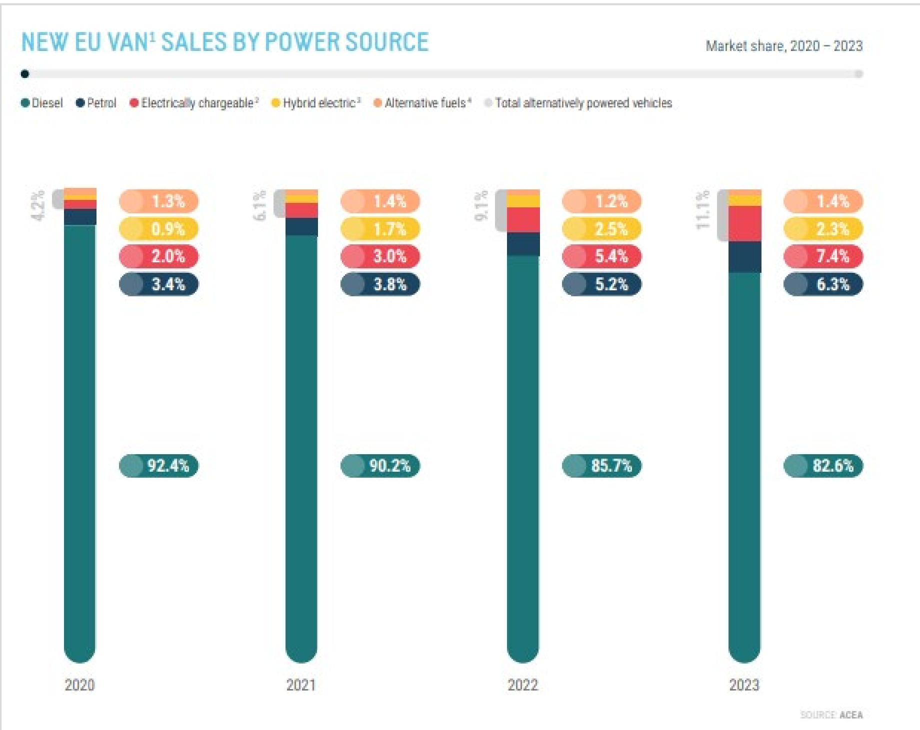


Figure 12: Extract from ACEA pocket guide 2024/2025: van sales by power source

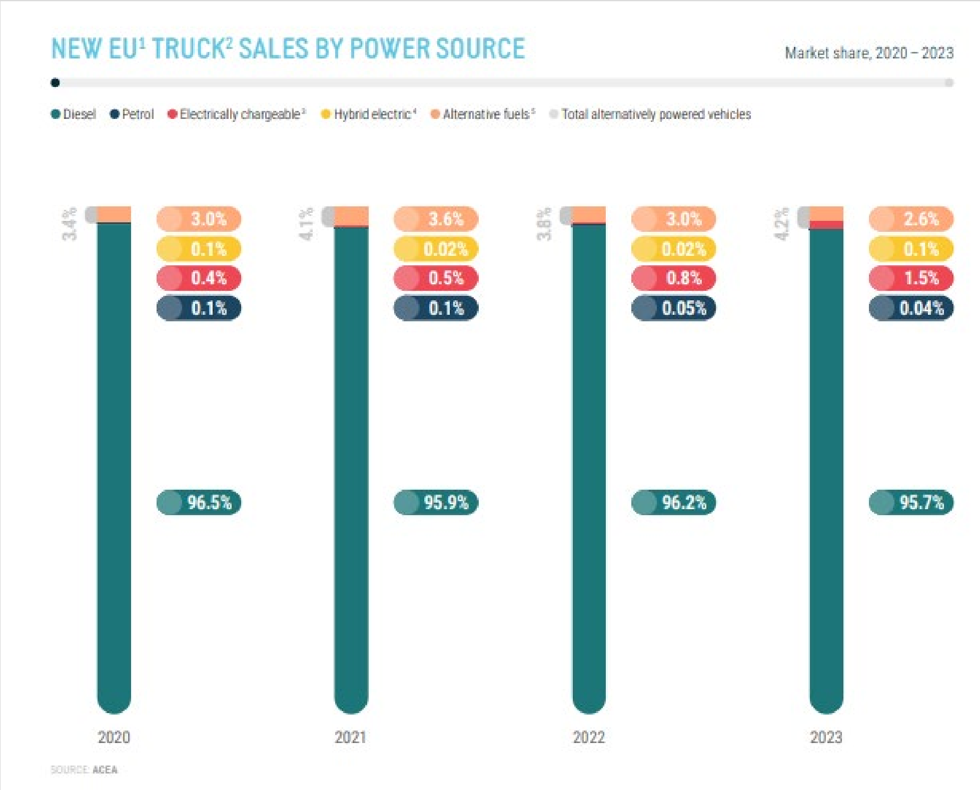


Figure 13: Extract from ACEA pocket guide 2024/2025: truck sales by power source

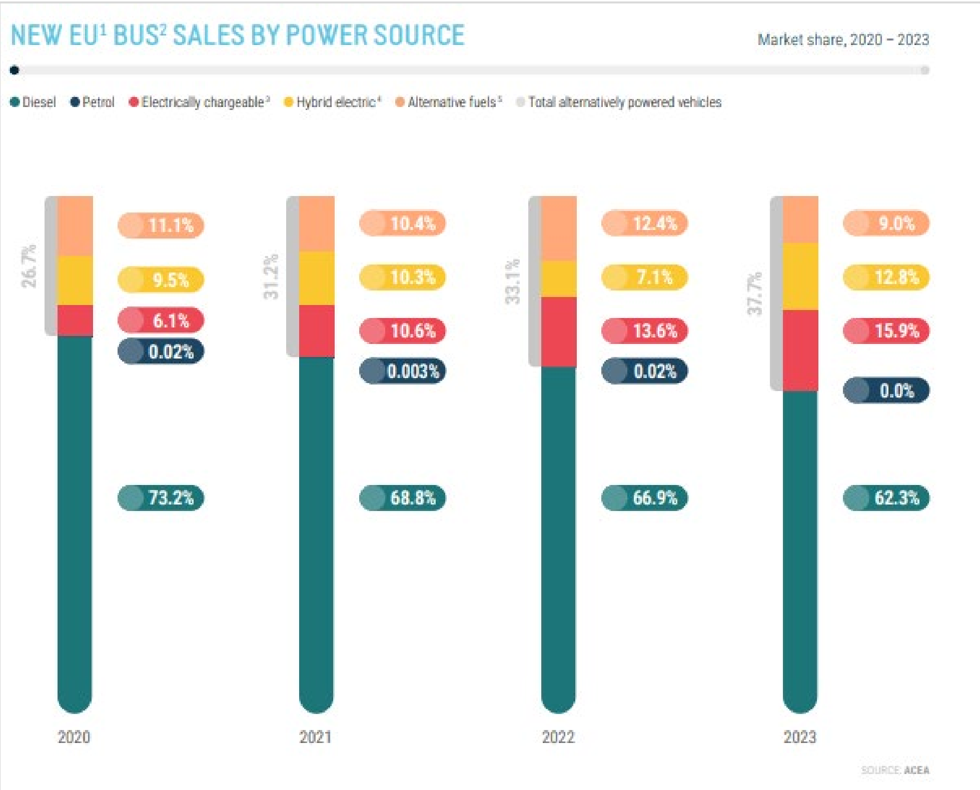


Figure 14: Extract from ACEA pocket guide 2024/2025: bus sales by power source

3.3.3.3 Progress towards targets

According to Eurostat, all zero-emission vehicle types have experienced a significant increase of registrations over the last years. This information is supported by the additional data provided by ACEA in their pocket guide.

3.4 GO.KPI.5: Increased affordability of zero tailpipe emission vehicles

3.4.1 Related Horizon Europe/2ZERO calls for submissions

Due to the scope of GO.KPI.5 it is expected that all 2ZERO calls for submissions are relevant.

3.4.2 Assessment summary

Table 7: Assessment summary for GO.KPI.5

GO.KPI.5	Contribute to Europe having the first carbon neutral road transport system by 2050; Technology leadership supporting economic growth and job creation all over Europe. Ensure European competitiveness thanks to solutions for an integrated carbon neutral road transport ecosystem; Improve the quality of life of EU citizens and ensure mobility for people and goods.
The following targets were defined in the 2ZERO SRIA.	○ N/A
Information was obtained by referring to the following information sources.	○ Public data research
Progress had been made towards the increased affordability of zero tailpipe emission vehicles	Yes. Progress toward increasing the affordability of zero tailpipe emission vehicles, particularly electric vehicles (EVs), has been achieved by involving reductions in manufacturing costs, offering government incentives narrowing price gaps with internal combustion engine (ICE) vehicles, and the emergence of robust second-hand markets. ✓

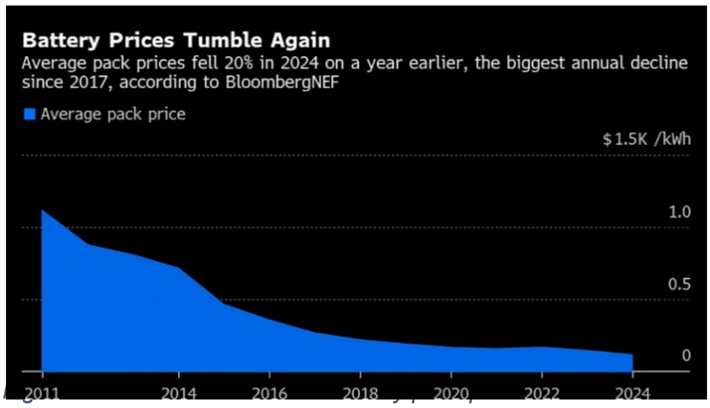
3.4.3 Assessment in detail

3.4.3.1 Information from other sources

Information from European Alternative Fuels Observatory

Decline in Battery Costs:[5]

In 2024, the average price of lithium-ion battery packs fell by 20%, reaching $115 per kilowatt-hour (kW.h). This significant reduction is a key factor in lowering overall EV production costs, bringing them closer to price parity with internal combustion engine vehicles.



[5] https://alternative-fuels-observatory.ec.europa.eu/general-information/news/electric-vehicle-battery-packs-experience-record-price-drop-2024?utm

Several factors contributed to this reduction in battery costs:
Overcapacity in Cell Production: The global production capacity for EV battery cells, primarily led by China, has surged. In 2024 alone, China is expected to produce enough cells to meet 92% of global demand, creating downward pressure on prices.
Cheaper Materials: A decline in the costs of metals and components, coupled with the adoption of more affordable lithium iron phosphate (LFP) batteries, has further driven the price drop.
Competitive Dynamics: Smaller battery manufacturers are being forced to lower their prices and margins to compete with larger players, intensifying the downward pricing trend.

National Incentives and Legislation:[6]
Member States have introduced various incentives to promote EV adoption.

Netherlands:
Road Tax Benefits: Fully electric cars were exempt from road tax until 2024. In 2025, they are subject to 25% of the standard rate, with full taxation resuming in 2026. European Alternative Fuels Observatory
Purchase Subsidies: As of 2023, private individuals could receive €2,950 for new electric passenger cars and €2,000 for used ones, subject to specific conditions.

France:
Eco-Bonus Adjustments: The environmental bonus for EVs is set to decrease from a maximum of €7,000 to €4,000. The total budget for EV subsidies will reduce from €1.5 billion in 2024 to €1 billion in 2025, with the eco-bonus becoming income-dependent and linked to CO_2 emissions from vehicle and battery production.

Spain:
MOVES III Plan: Extended until July 31st, 2024, this plan offers subsidies up to €7,000 for battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), especially when an old internal combustion engine vehicle is scrapped.
Tax Incentives: Individuals can claim a 15% income tax deduction when purchasing an electric car, with savings up to €20,000 per vehicle, available until December 31st, 2025.

Italy:
Ecobonus Program: For e-cars priced up to €35,000, incentives range from €6,000 to €13,750, depending on factors like scrapping old vehicles and the buyer's income.

Austria:
Purchase Subsidies: In 2024, private buyers can receive €5,000 for BEVs and €2,500 for PHEVs, with specific conditions on list prices and battery range.

Finland:
Tax Benefits: BEVs are exempt from the annual vehicle tax. Additionally, a tax deduction of €170 per month from taxable income is available for BEVs from 2021 to 2025.

Denmark:
Tax Deductions: A phased reduction in battery deductions is in place, with €67/kW.h in 2024 and set to be €0/kW.h in 2025, up to a maximum of 45 kW.h.

Slovenia:
Purchase Incentives: Up to €7,200 is available for new electric vehicles with zero CO_2 emissions priced up to €35,000.

Lithuania:

[6] https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road

Purchase Bonuses: In 2024, individuals could receive €2,500 for a used M1 electric vehicle registered after April 2016, with additional incentives for scrapping old diesel or petrol vehicles.

Information from European Climate Action[7]

Already in 2023, battery electric vehicles (BEVs) were the most popular alternative to petrol and diesel cars, representing more than 14.6% of all new cars sold in the EU. Plug-in hybrid electric cars represented another 7.7%. So, over 1 in 5 new cars sold in Europe can now be charged electrically.

Battery electric cars are cheaper to run than equivalent conventional cars. When comparing costs, it is worthwhile to note that electric cars consume less energy and have lower maintenance needs than conventional cars. As a result, the total cost of an electric car is lower than an equivalent conventional car over the lifetime of the vehicle.

According to Bloomberg NEF, battery electric vehicles are expected to become more affordable to purchase than comparable conventional cars in Europe between 2025 and 2028, depending on the type of vehicle. Decreases in battery prices, new affordable car models, and a growing mid-range and second-hand market are all factors expected to drive down prices.

Several EU Member States have put in place purchase incentives to support buyers, and the EU Recovery and Resilience Plan is helping to fund some of these schemes.

[7] https://climate.ec.europa.eu/news-your-voice/news/5-things-you-should-know-about-electric-cars-2024-05-14_en?utm_source=chatgpt.com

3.5 GO.KPI.6: Number of publicly available electric recharging and hydrogen refuelling stations available in the EU in 2030

3.5.1 Related Horizon Europe/2ZERO calls for submissions

Due to the scope of GO.KPI.6 it is expected that all 2ZERO calls for submissions are relevant.

3.5.2 Assessment summary

Table 8: Assessment summary for GO.KPI.6

GO.KPI.6	**Contribute to Europe having the first carbon neutral road transport system by 2050. Technology leadership supporting economic growth and job creation all over Europe. Ensure European competitiveness thanks to solutions for an integrated carbon neutral road transport ecosystem; Improve the quality of life of EU citizens and ensure mobility for people and goods.**
The following targets were defined in the 2ZERO SRIA.	○ N/A
Information was obtained by referring to the following information sources.	○ Public data research
Progress has been made towards the increase of number of refuelling/recharging stations.	Yes. The numbers of hydrogen refuelling stations and electric charging points have increased significantly over the last years. ✓✓✓

3.5.3 Assessment in detail

3.5.3.1 Information from EAFO

Currently EAFO has mapped[8] a total of 187 hydrogen refuelling stations across the EU and a total of 939,581 electric recharging points in Europe.

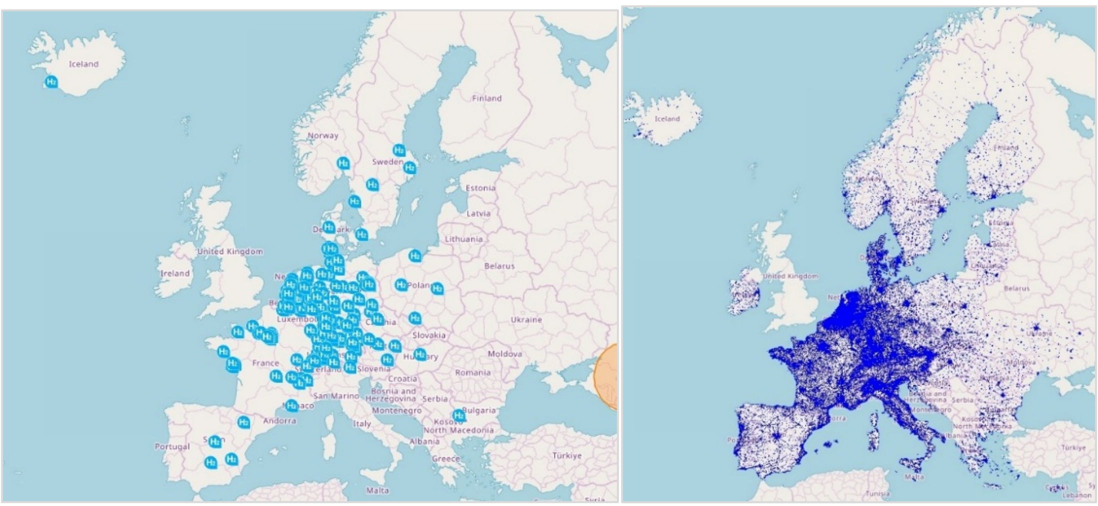


Figure 16: Map from EAFO showing location of hydrogen refuelling stations and electric recharging points in Europe

[8] EAFO interactive map https://webgate.ec.europa.eu/tentec-maps/web/public/screen/home (03.04.2025)

3.5.3.2 Progress towards targets

ACEA reported in April 2024 that at the end of 2023 there were 632,426 public charging points available across Europe[9]. According to EAFO this number has increased significantly, to 939,581 during 2024. Referring to the European Hydrogen Observatory[10], one can see that the number of hydrogen refuelling stations has increased from two in 2006, to eight in 2010, to 91 in 2017, to 155 in 2021 and finally to 187 in 2024.

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[9] ACEA : Charging ahead : accelerating the roll-out of EU electric vehicle infrastructure in Automotive Insights https://alternative-fuels-observatory.ec.europa.eu/sites/default/files/document-files/2024-05/Charging_ahead_Accelerating_the_roll-out_of_EU_electric_vehicle_charging_infrastructure.pdf (09.04.2025)

[10] https://observatory.clean-hydrogen.europa.eu/hydrogen-landscape/distribution-and-storage/hydrogen-refuelling-stations#:~:text=Since%202015%2C%20the%20total%20number,of%20cars%20at%20700%20bar. (09.04.2025)

3.6 SO.KPI.3: Reduction of development time and effort

3.6.1 Related H2020 or Horizon Europe/2ZERO calls for submissions

Table 9: Horizon Europe/2ZERO calls relating to SO.KPI.3

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2021-D5-01-01 horizon-cl5-2021-d5-01-01	Nextgen vehicles: Innovative zero emission BEV architectures for regional medium freight haulage (2ZERO)	NextETRUCK	Vehicle
HORIZON-CL5-2022-D5-01-08 horizon-cl5-2022-d5-01-08	Modular multi-powertrain zero-emission systems for HDV (BEV and FCEV) for efficient and economic operation (2ZERO)	EMPOWER	Vehicle
HORIZON-CL5-2023-D5-01-01 horizon-cl5-2023-d5-01-01	User-centric design and operation of EV for optimized energy efficiency (2ZERO Partnership)	EFFEREST MINDED SmartCorners	Vehicle
HORIZON-CL5-2023-D5-01-03 horizon-cl5-2023-d5-01-03	Frugal zero-emission vehicles concepts for the urban passenger challenge (2ZERO Partnership)	ZEV-UP	Vehicle
HORIZON-CL5-2021-D5-01-02 horizon-cl5-2021-d5-01-02	Nextgen EV components: Integration of advanced power electronics and associated controls (2ZERO)	HighScape	Compo-nent
HORIZON-CL5-2022-D5-01-09 horizon-cl5-2022-d5-01-09	Nextgen EV components: High efficiency and low-cost electric motors for circularity and low use of rare resources (2ZERO)	EM-TECH VOLTCAR	Compo-nent
HORIZON-CL5-2023-D5-01-02 horizon-cl5-2023-d5-01-02	Innovative battery management systems for next generation vehicles (2ZERO & Batt4EU Partnership)	InnoBMS	Compo-nent

3.6.2 Assessment summary

Table 10: Assessment summary for SO.KPI.3

SO.KPI.3	Reduction of development time and effort
The following targets were defined in the 2ZERO SRIA.	○ 20% reduction of development time and effort
The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: 2017 Suggested baseline value: 5.5 years (66 months)

Information was obtained by referring to the following information sources.	○ Public data research ○ Project questionnaires ○ Other: Internal information of FEV and Ricardo
The following more mature projects have provided input to the assessment of this particular KPI.	○ MINDED ○ ZEV-UP ○ InnoBMS ○ NextETruck ○ EFFEREST ○ EMPOWER ○ SmartCorners ○ VOLTCAR
Progress has been made in the reduction of development time and effort.	Partially. ○ 20% reduction of development time and effort ×

3.6.3 Assessment in detail

According to the replies of the projects in relation to this KPI, there is a strong impact of virtual frontloading either expected or experienced. The projects mention integrated simulation toolchains, digital twins, AI supported design and controls development as well as big data. Moreover, connected test facilities in experimental work and cross-experts and cross-institution collaboration in virtual development are mentioned in individual cases.
The expected reduction of development time and effort ranges, depending on the project's focus, between 5-10% and 30%.
Most of the projects responding to this KPI expect to contribute at least partially to Carbon Neutrality (9), Air Pollution and Health Effects (7), European Competitiveness (9), Technology Leadership (9), Economic Growth (6) and Circular Economy (5).

3.6.3.1 Baseline definition

Published information about development times varied significantly between e.g., three years in 2017[11] and 54 months in 2023[12]. Even before, in 2016, the TRIMIS STRIA on Vehicle design and manufacturing[13] reported that car models would be produced, then, only for four years instead of eight in the past, and development times of new models had already shrunk from former 48 months to 25 and were expected to fall further to only 20 months until 2018!

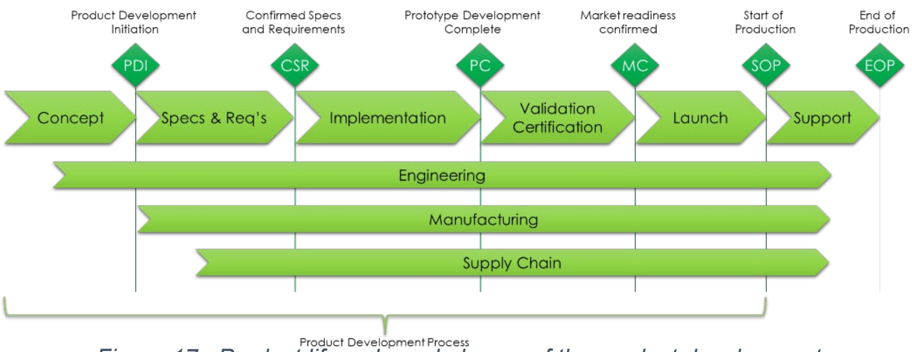

Figure 17: Product lifecycle and phases of the product development

These three references alone represent the significant heterogeneity of information about the state of the art before and at the start of the 2ZERO Partnership in 2021.The major difficulty about evaluating published timeframes lies in the different span width of phases of the entire development process included in the statements. For example, the development times referred to in the TRIMIS STRIA are

[11] N.N., Center for Automotive Research, "Automotive Product Development Cycles and the Need for Balance with the Regulatory Environment ", 2017-09-20, Ann Arbor, MI, USA,, https://www.cargroup.org/automotive-product-development-cycles-and-the-need-for-balance-with-the-regulatory-environment/, reviewed last: 2025-01-23
[12] Webb, Marc, "Volkswagen Reducing Development Time To 36 Months While Boosting Quality", in: Motor1 News, 2023-09-06, New York, NY, USA, https://www.motor1.com/news/685484/volkswagen-reducing-development-time-boosting-quality/, reviewed last : 2025-01-23
[13] Peter Malkin et al., STRIA roadmap on "Vehicle Design & Manufacturing", 2016-09-20, Joint Research Centre, Ispra, Italy, 2016 reviewed last: 2025-01-23.

related to facelifts in the middle of the 2010s, probably, but surely not to any development from clean sheet. That is, if included at all, the effort spent on concept phase, specification and requirements and project implementation is very much reduced over the effort to develop a brand-new vehicle from scratch. Moreover, it is unclear whether the published information is based on recently concluded developments or if it refers to ongoing development projects that still have to prove their completion in the stated timeframe.

In a discussion between Ricardo and FEV, it was decided, therefore, to rely on internal information, as the two companies, like AVL and IDIADA, through their involvement with automotive customers have a closer insight into the development process. This turned out to retrieving (partly) publishable information adjusting the above published information.

A study performed by FEV Consulting GmbH in 2018 including vehicle development programmes from very early phases until start of production resulted in development times of seven to eight years in total. Assuming that the developments concluded in 2017/2018, such development times would refer to projects started between 2010 and 2011.

A second study of FEV Consulting GmbH and FEV Consulting China Ltd in 2023 shows development times of European OEMs of 36-60+ months, which supports the assumption that the projects started in about 2017-2019.

Based on this data, the *Le*Mesurier team considered it appropriate to define a baseline of average development time of 5.5 years for projects starting in 2017.

3.6.3.2 Project's responses

Depending on the start and planned duration of the projects, they apply different years as baseline, 2020, 2022 or 2023, and envisage availability of results and, hence, a final assessment of how much development tasks are accelerated between 2025 and 2027. Most projects could not give an indication about the achieved acceleration at the time of the poll, one project estimated an achieved reduction of the effort by 20%, another project estimated to have realised 30% time savings. As final expected achievement the answers of the project range between 5-10% to 30% acceleration and up to 30% savings on investment. However, the majority of projects did not provide any answer or replied that they were not able or entitled yet to provide such information. It must be noted that no project was able to cover the whole development process as shown in the figure above, but only a limited subset of tasks and/or components or systems of the zero-emission vehicle.

3.6.3.3 Information from other sources

A recent example of a vehicle platform development is the BMW "Neue Klasse" that was announced in public by BMW's former CEO Oliver Zipse in March 2021[14]. Though, the decision was taken before, as his speech indicates when presenting the quarterly results of Q3 2020[15]. During the presentation of the annual report 2024 on 14th March 2025, Oliver Zipse confirmed the presentation of the first model, the new iX3 to take place at the IAA Mobility 2025 (9-14th September 2025) in Munich[16]. In this example, the timeframe from the first announcement until the first model release is in the range of 54-58 months. It is deemed appropriate to assume that the decision to go for the NCAR development was preceded by a concept phase of several single to dozen months, which underpins the abovementioned assumption of a timeframe for developments starting at the onset of Horizon Europe and, hence, the 2ZERO Partnership of 5.5 years (and maybe more).

3.6.3.4 Progress towards targets

The project results contribute to accelerate certain phases or tasks of the development and indicate a time gain between 5-10% and 30% of the tasks in focus, some of which already achieved today, some

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[14] Lang, P., Stegmaier, G.: "Neue Zellen für die Neue Klasse ab 2025", auto motor sport, 20 April 2021, https://www.auto-motor-und-sport.de/verkehr/bmw-neue-klasse-2025-feststoffbatterie-zellentwicklung/, last visited: 2025-03-24

[15] Hiltscher, B.: "CLAR 2025: Zipse kündigt neue BMW Cluster-Architektur an", BimmerToday.de, 4 November 2020, https://www.bimmertoday.de/2020/11/04/clar-2025-zipse-kundigt-neue-bmw-cluster-architektur-an/, last visited: 2024-03-24

[16] Hiltscher, B.: "Neue Klasse: IAA-Debüt & Name des BMW iX3 offiziell bestätigt ", BimmerToday.de, 17 March 2025, https://www.bimmertoday.de/2025/03/17/neue-klasse-iaa-debut-name-des-bmw-ix3-offiziell-bestatigt/, last visited: 2025-03-24

of which expected by the end of the project. Some projects reported not being able to provide any information yet, be it due to confidentiality reasons or lack of project progress.

None of the projects obviously covered the entire development process. Therefore, the tasks addressed and the related accelerations represent a mosaic with missing pieces that challenge a forecast of how much all 2ZERO projects have or will have contributed to savings of development time and effort of the whole development process after completion.

While several tools and methods can be employed throughout several phases of the development cycle, their individual impact on the process efficiency is limited. But the combination of tools of their kind will leverage the efficiencies provided by the individual tools on their tasks to the benefit of the entire development time and cost.

Beyond the aspects considered by the projects, the time span and efficiency of the development process is influenced by the quality of management and management decisions as well as by necessary but delaying reactions to changes in policy, regulations and supply chain, which may cause iterations and reiterations of parts of the process.

The tools and methods developed by projects in the 2ZERO Partnership will help accelerating also these loops and improve the competitiveness of the European vehicle industry. This being said, there will be need to further improve the toolkit to foster European Competitiveness by emphasising data-driven and physical-based development, and, beyond the classical playground of EGCI, EGVI and 2Zero, potentially also tools to accelerate managerial processes.

3.7 SO.KPI.4: Improvement of the integration of Electric Vehicles into the grid

3.7.1 Related Horizon Europe/2ZERO calls for submissions

Table 11: Horizon Europe/2ZERO calls relating to SO.KPI.4

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2022-D5-01-08 horizon-cl5-2022-d5-01-08	Modular multi-powertrain zero-emission systems for HDV (BEV and FCEV) for efficient and economic operation (2ZERO)	ESCALATE	Vehicle
HORIZON-CL5-2022-D5-01-10 horizon-cl5-2022-d5-01-10	New generation of full electric urban and peri-urban Bus Rapid Transit systems to strengthen climate-friendly mass transport (2ZERO)	EBRT2030	Vehicle
HORIZON-CL5-2023-D5-01-03 horizon-cl5-2023-d5-01-03	Frugal zero-emission vehicles concepts for the urban passenger challenge (2ZERO)	ZEV-UP	Vehicle
HORIZON-CL5-2021-D5-01-02 horizon-cl5-2021-d5-01-02	Nextgen EV components: Integration of advanced power electronics and associated controls (2ZERO)	PowerDrive	Component
HORIZON-CL5-2023-D5-01-02 horizon-cl5-2023-d5-01-02	Innovative battery management systems for next generation vehicles (2ZERO & Batt4EU)	InnoBMS iBattMan	Component
HORIZON-CL5-2021-D5-01-03 horizon-cl5-2021-d5-01-03	System approach to achieve optimised Smart EV Charging and V2G flexibility in mass-deployment conditions (2ZERO)	EV4EU DriVe2X FLOW SCALE XL-CONNECT	Infrastructure
HORIZON-MISS-2023-CIT-01-01 horizon-miss-2023-cit-01-01	Co-designed smart systems and services for user-centred shared zero-emission mobility of people and freight in urban areas (2ZERO, CCAM & Cities Mission)	MOBILITIES FOR EU	Miscellaneous

3.7.2 Assessment summary

Table 12: Assessment summary for SO.KPI.4

SO.KPI.4	Improvement of the integration of Electric Vehicles into the grid (and related improvement on the load curve management and integration of Renewable Energy Sources).
The following targets were defined in the 2ZERO SRIA.	○ Commonly agreed charging protocols enabling V2G options for BEV by 2030. ○ 100% of new BEV and infrastructure offering smart charging possibilities by 2030.

The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2019 Suggested baseline value: 3 charging protocols, 50% of BEV and infrastructure
Information was obtained by referring to the following information sources.	○ Public data research ○ Project questionnaires ○ Coordinator interviews
The following more mature projects have provided input to the assessment of this particular KPI.	○ EV4EU ○ FLOW ○ iBattMan ○ SCALE ○ ESCALATE ○ XLConnect ○ ZEV-UP ○ EBRT2030 ○ InnoBMS ○ MOBILITIES FOR EU ○ PowerDrive ○ DriVe2X
Progress had been made towards the improvement of the integration of Electric Vehicles into the grid.	Yes. ○ Improvement of the integration of Electric Vehicles into the grid ✓✓ ○ Commonly agreed charging protocols enabling V2G options for BEV by 2030 ✓✓✓ ○ 100% of new BEV and infrastructure offering smart charging possibilities by 2030 ×

3.7.3 Assessment in detail

Projects working on the improvement of the integration of electric vehicles (EVs) into the grid encompass a variety of innovative activities. One key area involves quantifying the flexibility that EVs can provide and developing models to incorporate this flexibility into distribution grid planning. Platforms are being created to enable distribution system operators (DSOs) to activate this flexibility effectively. Smart charging and vehicle-to-everything (V2X) solutions are being developed and tested to facilitate the mass integration of EVs. These solutions are designed to address grid issues such as reinforcement needs and congestion, while also promoting the penetration of renewable energy sources (RES). This comprehensive approach includes harmonization, user-centric technology design, interoperability and advanced smart charging solutions. In the realm of charging infrastructure, efforts are focused on identifying key requirements and standards for e-mobility applications. This includes defining interfaces for fast and wireless bidirectional charging and designing optimal charging profiles. Standardization of communication protocols and data collection is also being promoted to ensure seamless integration. Advanced battery management systems (BMS) are being developed with real-time monitoring capabilities to ensure optimal and safe operation. These systems are being tested and validated on multiple battery platforms, with a roadmap for scalability. Collaborative research between academia and industry is being encouraged to drive innovation across the EU supply chain. The mass deployment of smart charging is another critical focus area. By sharing knowledge and developing new techniques, both participating and non-participating countries can benefit from proven innovations. Grid-friendly charging solutions and protocols are being developed, including prototypes for pilot testing. Integration technologies such as smart charging, vehicle-to-home, vehicle-to-building and vehicle-to-grid are being investigated and tested, to enhance EV integration. High-efficiency charging systems and optimization strategies are being developed to ease the impact on the grid, incorporating solutions such as battery swapping and photovoltaic panels. Smart charging management systems are being integrated to address electric load challenges, reduce energy requirements and optimize charging strategies. These systems aim to reduce charging time at depots, terminals and bus stops compared to conventional methods. Innovative BMS development is focused on achieving advanced systems with user-friendly technology that offers optimal charging and vehicle-grid interactions. Finally, integrated energy systems are being implemented, combining photovoltaic plants, batteries and digital twins to manage energy production and demand in real-time, along with bi-directional charging capabilities.

3.7.3.1 Projects' responses

The consulted projects are actively incorporating V2G capabilities:

- One project is testing V2G with BEVs using ISO15118-20 for bidirectional charging equipment. They are working with OEMs to get production vehicles that support bidirectional CCS charging with the standard ISO 5118-20 for seamless interoperability. Additionally, they are developing a bidirectional DC charger that operates on a DC microgrid, using ISO15118-20 for vehicle-to-charger communication and OCPP for charger-to-central management system communication.
- Another project uses charging protocols ISO15118-2 and ISO15118-20, as well as OCPP1.6 and 2.0.1, and DIN70121 for V2G capabilities.
- Several other projects also support V2G options, although specific protocols have not been mentioned during the consultation.
- As of today, projects estimate that ~5% of battery electric vehicles currently support V2G capabilities.
- Projects estimate that ~20% of battery electric vehicles will support V2G capabilities by 2030.

The consulted projects are actively working on smart charging possibilities for battery electric vehicles:

- One project is focused on technical advances and delivering use cases with smart and bidirectional charging within demonstrations and testbeds.
- Another project is working on maximizing battery utilization under fast charge conditions and optimizing charging time.
- Additionally, some other projects are developing smart charging solutions and integrating them into electric vehicle supply equipment (EVSE), with estimates suggesting that a significant portion of EVSE and BEVs will support smart charging by 2030.
- The reference years for measuring the percentage of BEVs and smart charging infrastructure vary, with some projects using 2020 or 2021 as their baseline.
- Projects' estimates indicate that the availability of smart charging infrastructure is still in its early stages, with approximately 10% of chargers offering bidirectional capabilities. However, this is expected to grow significantly by 2030 (with 2025 expected to be a turning point), with projections indicating that more than 90% of chargers will offer unidirectional smart charging, and about 50% of chargers will support V2X capabilities.

3.7.3.2 Timing of expected future results

- 2025: Results from SCALE, ESCALATE (mid-year), XL CONNECT (Q3/Q4), EBRT2030 (end of year), and initial algorithms from InnoBMS (mid-year) with further testing by end of year.
- 2026: Completed results from DriVe2X, FLOW, and POWERDRIVE.
- 2027: Final results from iBattMan (June), ZEV-UP (end of year), and vehicle testing for InnoBMS (mid-year).
- 2028: Evaluation of impacts for MOBILITIES FOR EU.

3.7.3.3 Information from other sources

A project focuses on validating and quantifying the benefits associated with EV flexibility, interoperability of charging infrastructure, and fostering mobility and energy decarbonization. Another project is implementing user-centric V2X management strategies, coordinating between electric vehicles and renewable energy sources, reducing greenhouse gas emissions and decarbonizing road transport.
Integration planning for smart charging and V2X services is a key focus of another initiative, which includes analysing hardware and software requirements and defining IT use-cases for V2X services. Additionally, the impact assessment of V1G, V2G and V2X technologies is being conducted to understand their broader implications.

The development of bi-directional smart charging technologies is another critical area of focus, with efforts to raise widespread awareness of V2X and create affordable, user-friendly solutions suitable for mass EV deployment. Mapping flexible and abundant charging/refuelling points and demonstrating novel charging concepts are also being undertaken to enhance the infrastructure for EVs.

Vehicle development with a focus on connected grid-friendly multi-energy fast charging concepts and solutions is another significant contribution. This includes the development and demonstration of such concepts to ensure efficient and sustainable charging options. System architecture and total cost of ownership optimization, along with infrastructure, charging and management systems, are also being addressed to improve the overall efficiency and effectiveness of EV operations.

Innovations in electric bus rapid transit (BRT) charging infrastructure are being demonstrated, including modular charging systems for bus-to-grid services. Several pilots are being conducted across various locations, although specific results are not yet available. Theoretical contributions include defining key vehicle-grid integration terms, identifying factors that influence integration, and outlining barriers and services related to vehicle-grid integration.

Demonstrations are being conducted in multiple locations to showcase the feasibility and benefits of V2X technologies in different scenarios across Europe. These efforts aim to provide practical insights and validate the effectiveness of these technologies. Additionally, use cases are being monitored over an extended period to gather comprehensive data and insights.

3.7.3.4 Progress towards targets

- Seven consulted 2ZERO projects have reported to work on charging protocols enabling V2G options for BEVs and eight consulted 2ZERO projects have reported to work on smart charging possibilities for BEVs.
- The commonly agreed charging protocols mentioned are ISO15118-20, 15118-2, OCPP1.6, OCPP2.0.1 and DIN70121.
- It is estimated that ~5% of battery electric vehicles currently support V2G capabilities.
- It is estimated that ~20% of battery electric vehicles will support V2G capabilities by 2030.

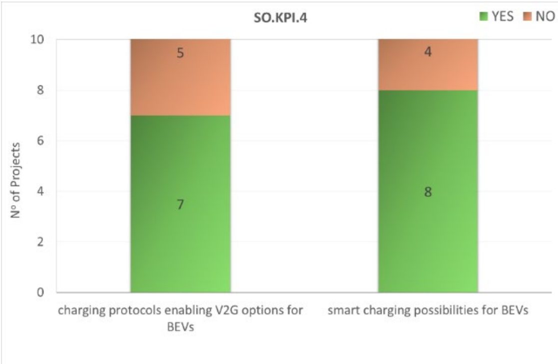

Figure 18: Project feedback for SO.KPI.4

3.8 SO.KPI.5: Improvement of charging efficiency demonstrated for slow, fast and ultra-fast charging

3.8.1 Related Horizon Europe/2ZERO calls for submissions

Table 13: Horizon Europe/2ZERO call relating to SO.KPI.5

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2022-D5-01-08 horizon-cl5-2022-d5-01-08	Modular multi-powertrain zero-emission systems for HDV (BEV and FCEV) for efficient and economic operation (2ZERO)	ZEFES ESCALATE	Vehicle
HORIZON-CL5-2022-D5-01-10 horizon-cl5-2022-d5-01-10	New generation of full electric urban and peri-urban Bus Rapid Transit systems to strengthen climate-friendly mass transport (2ZERO)	EBRT2030	Vehicle
HORIZON-CL5-2023-D5-01-03 horizon-cl5-2023-d5-01-03	Frugal zero-emission vehicles concepts for the urban passenger challenge (2ZERO)	ZEV-UP	Vehicle
HORIZON-CL5-2021-D5-01-02 horizon-cl5-2021-d5-01-02	Nextgen EV components: Integration of advanced power electronics and associated controls (2ZERO)	SCAPE PowerDrive	Component
HORIZON-CL5-2023-D5-01-02 horizon-cl5-2023-d5-01-02	Innovative battery management systems for next generation vehicles (2ZERO & Batt4EU)	InnoBMS iBattMan	Component
HORIZON-CL5-2021-D5-01-03 horizon-cl5-2021-d5-01-03	System approach to achieve optimised Smart EV Charging and V2G flexibility in mass-deployment conditions (2ZERO)	DriVe2X FLOW XL-CONNECT	Infrastructure
HORIZON-MISS-2023-CIT-01-01 horizon-miss-2023-cit-01-01	Co-designed smart systems and services for user-centred shared zero-emission mobility of people and freight in urban areas (2ZERO, CCAM & Cities Mission)	metaCCAZE	Miscellaneous

3.8.2 Assessment summary

Table 14: Assessment summary for SO.KPI.5

SO.KPI.5	Develop affordable, user-friendly charging infrastructure concepts and technologies that include vehicle and grid interaction
The following target was defined in the 2ZERO SRIA.	○ At least 25% reduction of energy losses during charging (considering both charger and vehicle) for all types of chargers by 2030
The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2019 Suggested baseline value: 10 – 25% energy lost

Information was obtained by referring to the following information sources.	○ Public data research ○ Project questionnaires ○ Coordinator interviews
The following more mature projects have provided input to the assessment of this particular KPI.	○ FLOW ○ iBattMann ○ SCAPE ○ ESCALATE ○ XLConnect ○ ZEV-UP ○ EBRT2030 ○ InnoBMS ○ ZEFES ○ metaCCAZE ○ DriVe2X ○ PowerDrive
Progress had been made towards the reduction of energy losses.	Yes. ○ Projects have stated they are working on the reduction of energy losses in the range of ~5% and ~20%. ✓✓

3.8.3 Assessment in detail

Efforts to enhance the integration of electric vehicles (EVs) into the grid involve various innovative projects and activities. One such initiative focuses on developing a modular DC bidirectional charging system to improve the efficiency and flexibility of future charging and energy management systems. Another project aims to design a universal modular battery management system (BMS) architecture that is technologically agnostic, catering to a wide range of applications from electro-mobility to vehicle-to-grid and second-life use cases for current and next-generation battery technologies. This includes identifying and characterizing advanced sensors, developing miniaturized multi-sensing units and creating virtual sensors for increased prediction accuracy.

Additionally, efforts are being made to improve charging efficiency in slow charging through the development of a fully integrated inverter charger that requires only one power conversion stage. This system employs low-loss semiconductor devices and advanced implementation techniques to further reduce losses. Another project is working on the development of megawatt charging systems, which include prototypes capable of reaching 90% state of charge (SOC) in 45 minutes with an efficiency of 80%.

Cost-effective bidirectional DC charging equipment is also being developed for massive deployment in home and tertiary applications. In parallel, projects are focusing on developing vehicles with efficient charging capabilities, including low-power home charging and battery swap-ability, particularly for regions with limited EV charging infrastructure.

Innovations are also underway to improve the charging efficiency of electric buses, including the development of hybrid battery concepts, advanced charging solutions and vehicle energy management systems. These efforts aim to optimize the efficiency and sustainability of electric bus operations. Another project is developing a cutting-edge BMS solution to maximize battery efficiency and longevity while ensuring safety.

Furthermore, projects are working on improving the charging efficiency and power range for ultra-fast charging of heavy-duty vehicles. This involves developing efficient and interoperable megawatt charging systems with high overall efficiency and fast-charging capabilities. The introduction of recent semiconductor technologies and new control systems will enable a range recovery of 400 km in 45 minutes.

Automated and rapid charging concepts are also being developed, including inductive and robot-based charging systems for depots and on-route locations. These concepts are being tested in living labs across different cities to optimize charging schedules and infrastructure.

3.8.3.1 Project's responses

Consulted projects have worked on different aspects of charging power range for low-power, high-power, and ultra-high power charging infrastructure:

- For low-power charging infrastructure, some projects are working on developing cost-effective solutions. One project reported a 20% increase in charging power range since 2022, with an expected 30% increase by 2030 across the whole charging profile. Another project used 2021 as a reference year but did not provide current estimates.
- Regarding high-power charging infrastructure, a few projects are actively working on this area. One project is working to achieve a reduction in charging time by 10% by 2030. Another project is targeting the end of 2025 for significant advancements but has not yet provided specific estimates for 2030.
- For ultra-high power charging infrastructure, some projects are making notable progress. One project reported that existing designs in 2022 provided power up to 1 MW, with the potential to connect an MCS type plug in one power charger. Within the project, the multiple outputs MCS is expected to reach a power of up to 2 MW. By 2030, the power range of ultra-high power charging infrastructure is anticipated to further increase to 3 MW. However, advancements in battery technology will be necessary to support higher voltages and reduce charging current.

Some projects have provided estimates of energy lost during charging:

- One project considered efficiency values for 2020-2021 of 93-95% for single-phase smaller power and higher power range chargers, with a target efficiency of 98%, corresponding to a 3-5% energy loss reduction. However, they aim to assess charger efficiency in a more nuanced way, considering it as a variable parameter.
- Another project tackles efficiency over the charging profile, with a peak efficiency of 97%, although this does not mean that only 3% of losses occur during the charging session.
- A third project aims for a peak load reduction of 20% and energy savings from charging up to 15% of kW.h used for a BEV per year.
- As of today, some projects have not yet implemented chargers, making it difficult to assess the percentage of energy lost per charging session.
- One project expects to achieve less than 1% energy loss per charging session by 2030, while others find it challenging to provide general estimates at this moment in time.
- Regarding high-power charging infrastructure, one project reported a port efficiency of 97% between two ports, while another project aims for an overall charging efficiency greater than 80% during the battery state of charge window of 15%-85%. However, specific estimates for 2030 are not yet available.
- For ultra-high power charging infrastructure, one project reported that existing systems in 2022 provide an efficiency of approximately 80%. They aim to enable an overall charging efficiency greater than 80% during the battery state of charge window of 15%-85%.
- Overall projects have stated expected reduction of energy losses in the rather wide range of ~5% and ~20%.

3.8.3.2 Timing of expected results

- 2025: Results from SCALE, ESCALATE (mid-year), XL CONNECT (Q3/Q4), EBRT2030 (end of year), and initial algorithms from InnoBMS (mid-year) with further testing by end of year.
- 2026: Completed results from DriVe2X, FLOW, and POWERDRIVE.
- 2027: Final results from iBattMan (June), ZEV-UP (end of year), and vehicle testing for InnoBMS (mid-year).
- 2028: Evaluation of impacts for MOBILITIES FOR EU

3.8.3.3 Information from other sources

Several initiatives are focused on developing smart charging strategies and control mechanisms that maximize EV driver's satisfaction and the efficiency of the entire energy system. These efforts aim to increase the use of renewable electricity sources by harnessing unused EV storage capacity. Additionally, some projects are demonstrating charge efficiency of at least 80%, ensuring that the charging process is both effective and sustainable. Some projects are developing managerial tools and fast charging concepts to overcome payload and range limitations, while others are working on efficient, safe and secure flexible bus transport solutions. These solutions are designed to meet future user demands for convenience in both urban and peri-urban environments, offering a key opportunity to reduce the carbon footprint of the transport sector.

Other initiatives are ensuring ease of use in targeted urban and suburban areas, accounting for traffic and parking conditions as well as battery charging and swapping points availability. These projects conduct systematic and thorough analyses of user-centric needs, considering the future evolution of urban areas and the required infrastructure development. Validation with real electric vehicles and related battery solutions is also being carried out to demonstrate the developed functions, particularly the capabilities of the proposed architecture in terms of payload, charging requirements and vehicle efficiency to optimize range and battery sizing.

Furthermore, some projects are taking into consideration future development pathways for urban public, semi-public and private charging infrastructure, especially in developing countries where such infrastructure is currently non-existent. These efforts aim to adapt future urban vehicle concepts to the specific needs of these regions.

Grid integration, charging infrastructure, vehicle connectivity, automation, smart fleet management, road traffic and energy management, and the safety of vulnerable road users are also key areas of focus. These projects build upon relevant experiences of cities and partnerships to co-design implementation plans for local and regional transport authorities. The goal is to roll out innovative smart mobility solutions and related infrastructure, particularly for charging and connectivity, and to lower energy demand.

3.8.3.4 Progress towards targets

The project consultation revealed an expected reduction of energy losses in the range of ~5% and ~20%, which shows progress towards the target defined in the SRIA.

3.9 SO.KPI.6: Development of well-established decision-making tools and stakeholder engagement practices to implement integrated deployment strategies for boosting e-mobility as project follow-ups

3.9.1 Related Horizon Europe/2ZERO calls for submissions

Table 15: Horizon Europe/2ZERO calls relating to SO.KPI.6

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2022-D5-01-08 horizon-cl5-2022-d5-01-08	Modular multi-powertrain zero-emission systems for HDV (BEV and FCEV) for efficient and economic operation (2ZERO)	ZEFES ESCALATE	Vehicle
HORIZON-CL5-2023-D5-01-03 horizon-cl5-2023-d5-01-03	Frugal zero-emission vehicles concepts for the urban passenger challenge (2ZERO)	ZEV-UP	Vehicle
HORIZON-CL5-2021-D5-01-03 horizon-cl5-2021-d5-01-03	System approach to achieve optimised Smart EV Charging and V2G flexibility in mass-deployment conditions (2ZERO)	EV4EU DriVe2X FLOW	Infrastructure
HORIZON-MISS-2023-CIT-01-01 horizon-miss-2023-cit-01-01	Co-designed smart systems and services for user-centred shared zero-emission mobility of people and freight in urban areas (2Zero, CCAM and Cities' Mission)	MOBILITIES FOR EU metaCCAZE	Miscellaneous
HORIZON-CL5-2023-D5-01-04 horizon-cl5-2023-d5-01-04	Circular economy approaches for zero emission vehicles (2ZERO)	ZEvRA	Miscellaneous

3.9.2 Assessment summary

Table 16: Assessment summary for SO.KPI.6

SO.KPI.6	Demonstrate innovative use cases for the integration of zero tailpipe emission vehicles and infrastructure concepts for the road mobility of people and goods
The following target was defined in the 2ZERO SRIA.	○ Decision-making tools and stakeholder engagement practices developed in funded projects are part of the SUMP guidelines and are implemented by at least 30 cities, also taking into account the mission "100 Climate Neutral Cities"
The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2019 Suggested baseline value: 0
Information was obtained by referring to the following information sources.	○ Public data research ○ Project questionnaires

	○ Coordinator interviews
The following more mature projects have provided input to the assessment of this particular KPI.	○ EV4EU ○ FLOW ○ ESCALATE ○ ZEV-UP ○ ZEFES ○ metaCCAZE ○ MOBILITIES FOR EU ○ ZEvRA ○ DriVe2X
Progress has been made in demonstrating innovative use cases for the integration of zero tailpipe emission vehicles and infrastructure concepts for the road mobility of people and goods.	Yes. ○ Demonstrate innovative use cases for the integration of zero tailpipe emission vehicles and infra-structure concepts for the road mobility of people and goods ✓✓✓ ○ Decision-making tools and stakeholder engagement practices developed in funded projects are part of the SUMP guidelines and are implemented by at least 30 cities, also taking into account the mission "100 Climate Neutral Cities" ✓✓✓

3.9.3 Assessment in detail

One project is proposing tools for users, charging point operators (CPOs), virtual power plants (VPPs), and distribution system operators (DSOs). Another project is focusing on improving user experience for smart charging, developing user requirements and acceptance strategies, harmonizing services, and creating a blockchain-based energy data space connector. They are also working on specifications for software development and integration and developing various tools and platforms for electric vehicle (EV) flexibility management and grid impact assessment.

Additionally, several use cases are being implemented in testbeds and demonstrations across different cities, including Copenhagen, Menorca and Rome. These demonstrations are exploring various smart charging and flexibility services, such as peak shaving, cost-based smart charging, and integration with transmission system operators (TSOs) and DSOs.

Another project is developing fleet management and predictive maintenance tools, supported by digital twin approaches and AI-enabled dynamic routing solutions. These tools aim to optimize zero-emission vehicle (ZEV) fleet management and ensure mission guarantee through predictive maintenance.

Further contributions include the development and demonstration of use cases for passenger and goods transportation, with active stakeholder engagement and vehicle showcases in multiple cities. Web-based tools are being created to assist logistics operators in transitioning from diesel heavy goods vehicles (HGVs) to ZEVs, focusing on total cost of ownership (TCO), CO_2 reduction and operational impacts.

Moreover, co-design activities with stakeholders are being conducted to analyse and understand the status quo of living labs, prototype use cases, and verify governance and business models. This involves multiple rounds of meta-design activities and regular stakeholder meetings.

Lastly, a methodology is being developed to create action plans that boost e-mobility solutions demonstrated in the projects. This methodology will help cities prioritize solutions that fit their needs, define financial plans, and apply the best business models. Urban transport laboratories will be established to engage key stakeholders and citizens in decision-making processes, ensuring the successful implementation of these plans.

3.9.3.1 Projects' responses

The consulted projects have been developing and utilizing decision-making tools and stakeholder engagement practices following a comprehensive and systematic approach to ensure effective implementation and widespread adoption:

- The actions typically begin with the identification of key stakeholders, including users from various sectors such as households, buildings, companies, charge point operators (CPOs), virtual power plants (VPPs) and distribution system operators (DSOs). Understanding the motivations, demands and drivers of these stakeholders is crucial for tailoring the tools and strategies to meet their specific needs.
- One of the primary objectives is to devise future scenarios and roll-out plans that support decision-making in smart cities. This involves creating tools that provide a georeferenced, visual overview of possible deployment possibilities for charging stations, optimizing choices based on criteria such as grid congestion constraints.
- Additionally, projects often adopt a systemic approach to technology diffusion and market structuration, establishing reference policy frameworks that consider technological, market and social dimensions. These frameworks are used to advise city planners on how to best engage with e-mobility infrastructure, taking into account the collective behaviour of users.
- Improving user experience for smart charging is another key focus. Projects work on developing user requirements and acceptance strategies, harmonizing services, and creating blockchain-based energy data space connectors. Specifications for software development and integration are established, along with portfolios of electric vehicle supply equipment (EVSE) and components. Platforms for modular V2X-equipped DC microgrids and energy management systems (EMS) for EV flexibility management are also developed. Cooperation tools for charging hotspots with multiple V2X-capable clusters, scenario development and grid impact assessment tools, open-source investment planning tools, and multi-criteria assessment models are created to support these efforts.
- To facilitate flexibility provision from EVs, aggregation cloud-based platforms and crowd balancing functionalities are developed. Technical platforms for distribution system operators (DSOs) are also established, providing advice on regulations, policy, and standardization. Demonstration use cases are implemented in various locations, showcasing centralized smart charging, peak shaving, bidirectional charging and cost-based smart charging solutions.
- Fleet management and predictive maintenance tools are developed to support zero-emission vehicles (ZEVs). These tools include flexible fleet management solutions supported by digital twin approaches and route optimization techniques. Detailed cost and lifecycle inventories, energy consumption modelling, and operating emissions analysis are conducted in coordination with operational dynamics. Predictive maintenance tools utilize hybrid AI algorithms to detect and isolate operating condition faults during dynamic operation.
- Stakeholder engagement is a critical component of these projects. Engagement practices involve cross-project liaison, exchange of best practices and vehicle showcases in multiple cities. Web-based tools with user interfaces are developed to help logistics operators transition from diesel heavy goods vehicles (HGVs) to ZEVs, providing supporting information on purchase, operation, and maintenance, with a focus on total cost of ownership (TCO), CO_2 reduction, and operational impacts.
- Co-design activities with stakeholders are conducted to analyse and understand the status quo of living labs, prototyping use cases and scenarios, and verifying governance and business models during demonstrations. Methodologies are developed to create action plans that boost solutions demonstrated in the project, helping cities prioritize and implement solutions that fit their needs. Financial plans and business models are defined, and urban transport labs are established to engage key stakeholders and citizens in decision-making processes.
- Training platforms are created to educate young talent, science and industry, disseminating knowledge about the circular economy in the field of mobility. These comprehensive efforts ensure that the developed tools and stakeholder engagement practices are effective, scalable and replicable, contributing to the successful implementation and adoption of innovative solutions in smart cities and beyond.

Some projects are actively engaging cities to adopt and use the tools developed:

- One of the consulted projects is improving communications and security of EV chargers, facilitate data sharing, and optimize smart and bidirectional charging.
- Currently, five cities are using the tools, and it is estimated that a similar number of additional cities will adopt these tools by the project's end. The largest growth is expected to occur post-project, driven by companies deploying the tools at more locations or groups using the open-source tools.
- Another project aims for two cities to use the tools by 2026. Specifically, the modelling methodology for mass V2X deployment futures will be validated in two cities, and the V2X reference policy framework will be validated in at least one city.
- Another project expects at least ten cities to use the tools, including five cities directly involved in the project and five observer cities.
- A fourth project involves seven cities that will adopt the tools developed.
- In total, these projects aim to have their tools adopted by at least 24 cities by the end of their respective timelines.
- Developed tools are, for example, tested in Prague, Dublin, Rome, Menorca, Copenhagen, Madrid or Dresden.

Two of the consulted projects confirm they are integrating the developed tools into SUMP guidelines:
- The first project expects to integrate several tools into recommendations for Sustainable Urban Mobility Plans (SUMPs). These tools include a supply-demand matching platform for on-demand shared zero-emission services, e-vehicle fleet management and scheduling, optimal enroute charging, e-charging infrastructure, and optimization of hubs with electric fleets.
- The second project aims to develop guidelines for cities on how to integrate neutrality targets into Sustainable Urban Mobility Plans (SUMP) and Sustainable Urban Logistics Plans (SULP). These guidelines will be based on various aspects of the project, requiring an analysis of whether the potential tools developed will contribute to the creation of such guidelines.

This is an extract of the tools, platforms and practices mentioned during consultation:
- Georeferenced Visual Overview Tool: For optimizing charging station deployment based on grid congestion constraints.
- Reference Policy Framework: For V2X market structuration, considering technological, market and social dimensions.
- User Experience (UX) Improvement Tools: For smart charging.
- Blockchain-Based Energy Data Space Connector: For secure data management.
- Specifications for Software Development and Integration.
- EVSE Platform: For modular V2X-equipped DC microgrids.
- Energy Management System (EMS): For EV flexibility management.
- Cooperation Tool: For charging hotspots with multiple V2X-capable clusters.
- EV Scenario Development and Grid Impact Assessment Tool.
- Open-Source Investment Planning Tool.
- Multi-Criteria Assessment Model.
- Aggregation Cloud-Based Platform: For flexibility provision from EVs.
- Crowd Balancing Platform Functionalities.
- DSO Technical Platform.
- Fleet Management Tool: ZEV-specific, supported by digital twin and route optimization techniques.
- Predictive Maintenance Tools: For detecting and isolating operating condition faults using hybrid AI algorithms.
- Web-Based Tools: For logistics operators transitioning to ZEVs, focusing on TCO, CO_2 reduction, and operational impacts.
- Co-Design Activities Tools: For analysing and understanding the status quo of living labs.
- Action Plan Development Tools: For prioritizing and implementing solutions in cities.
- Training Platform: For educating young talent, science and industry about the circular economy in mobility.

3.9.3.2 Timing of expected results

- 2025: Results from FLOW, ESCALATE (mid-year), and initial validation for ZEFES starting in Spring. metaCCAZE deliverables are also expected mid-year.
- 2026: Completed results from DriVe2X, FLOW, and ZEvRA.
- 2027: Final results from ZEV-UP (end of year).

3.9.3.3 Information from other sources

A stakeholder map is created to illustrate the power and service flows, providing a visual representation of the relationships and influences within the system. Following this, a service catalogue is developed to cater to various market conditions. This catalogue serves as a comprehensive guide to the services available, tailored to meet the diverse needs of the stakeholders. Concurrently, a stakeholder engagement strategy is formulated. This strategy outlines the methods and approaches for engaging stakeholders, ensuring their active participation and collaboration throughout the project. Scalability and replicability actions are planned to commence in the later stages of the projects.

Innovation strategies and exploitation plans are also made in this process. The plans provide a roadmap for leveraging new technologies and innovations, ensuring their effective implementation and widespread adoption. High-level designs of management platforms are created, with updates expected periodically to keep pace with technological advancements. Additionally, apps and tools are developed to promote the adoption of new technologies, facilitating their integration into existing systems.

Co-simulation platforms and high-level management strategies are established to support decision-making processes. These platforms enable the simulation of various scenarios, providing valuable insights and aiding in the development of robust strategies. Decision support tools are also developed, offering stakeholders the necessary resources to make informed decisions.

Capacity-building activities and training materials are created to enhance the skills and knowledge of stakeholders. These activities are designed to build the capacity of stakeholders, enabling them to effectively utilize the developed tools and practices. ROI calculations, system models, and guidelines are also developed, providing a framework for evaluating the return on investment and guiding the implementation process. Standards and protocols are analysed to ensure compliance and consistency across the project.

Predictive tools and digital twins are developed to optimize charging and control strategies. These tools leverage real-time data to create accurate predictions, enhancing the efficiency and effectiveness of the system. Digital twin and fleet management tools are also integrated, providing a comprehensive solution for managing fleets and optimizing operations.

Efforts to raise public awareness and understanding of new concepts are undertaken, ensuring that the broader community is informed and engaged. Support for research activities and market scale-up is provided through open-access tools, models and data, facilitating the dissemination of knowledge and fostering innovation.

Human vehicle interfaces with communication and routing capabilities are developed to enhance the interaction between vehicles and users. Fleet management systems are created to ensure the seamless integration of zero-emission heavy-duty vehicles, promoting sustainability and reducing environmental impact. Life cycle assessments and total cost of ownership assessments are conducted to evaluate the overall impact and cost-effectiveness of the project.

AI managerial tools and predictive algorithms are developed to support service and maintenance activities. These tools utilize advanced algorithms to predict energy management needs and assess the aging of powertrains, ensuring optimal performance and longevity. Flexible managerial tools specific to zero-emission vehicles are also designed, providing tailored solutions for managing these vehicles.

New business models are developed to increase end-user acceptance and market uptake. These models are designed to address the needs and preferences of end-users, promoting the adoption of new technologies. Dissemination strategies are published to share knowledge and insights, facilitating the spread of information and encouraging collaboration.

Finally, tools to support bus rapid transit innovation are planned, with the development of a comprehensive interactive tool illustrating the state of bus rapid transit systems globally. A user group is established to engage future bus rapid transit cities, fostering collaboration and knowledge sharing.

3.9.3.4 Progress towards targets

The consulted projects have been actively working on demonstrating innovative use cases for the integration of zero tailpipe emission vehicles and infrastructure concepts for the road mobility of people and goods. While all of them work on decision-making tools and stakeholder engagement practices, only three have confirmed they are engaging cities to adopt and use the developed tools, and only two are currently working on integrating the developed tools into SUMP guidelines. A total of 20 tools and engagement practices have been confirmed by 2ZERO projects. They are being tested, validated or implemented in at least 24 cities.

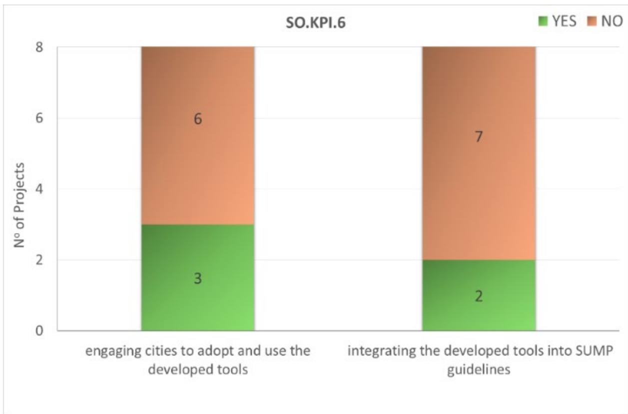

Figure 19: Project feedback for SO.KPI.6

3.10 SO.KPI.7: Well established fleet managerial tools to smoothly incorporate zero tailpipe emission vehicles in transportation fleets

3.10.1 Related Horizon Europe/2ZERO calls for submissions

Table 17: Horizon Europe/2ZERO calls relating SO.KPI.7

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2022-D5-01-08 horizon-cl5-2022-d5-01-08	Modular multi-powertrain zero-emission systems for HDV (BEV and FCEV) for efficient and economic operation (2ZERO)	ZEFES ESCALATE	Vehicle
HORIZON-CL5-2022-D5-01-10 horizon-cl5-2022-d5-01-10	New generation of full electric urban and peri-urban Bus Rapid Transit systems to strengthen climate-friendly mass transport (2ZERO)	EBRT2030	Vehicle
HORIZON-CL5-2023-D5-01-03 horizon-cl5-2023-d5-01-03	Frugal zero-emission vehicles concepts for the urban passenger challenge (2ZERO)	GIANTS	Vehicle
HORIZON-CL5-2021-D5-01-03 horizon-cl5-2021-d5-01-03	System approach to achieve optimised Smart EV Charging and V2G flexibility in mass-deployment conditions (2ZERO)	EV4EU	Infrastructure

3.10.2 Assessment summary

Table 18: Assessment summary for SO.KPI.7

SO.KPI.7	Demonstrate innovative use cases for the integration of zero tailpipe emission vehicles and infrastructure concepts for the road mobility of people and goods
The following target was defined in the 2ZERO SRIA.	○ Successful demonstration of cities with emissions-free logistics by 2030 (>150,000 inhabitants)
The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2019 Suggested baseline value: 0
Information was obtained by referring to the following information sources.	○ Public data research ○ Project questionnaires ○ Coordinator interviews
The following more mature projects have provided input to the assessment of this particular KPI.	○ EV4EU ○ ESCALATE ○ EBRT2030 ○ ZEFES ○ GIANTS
Progress has been made towards successful demonstration of cities with emissions-free logistics.	Yes. A demonstration has been confirmed for one large city.✓

3.10.3 Assessment in detail

Efforts to enhance the integration of electric vehicles (EVs) into the grid include the development of various tools and platforms aimed at improving efficiency and management. One initiative focuses on creating tools for users, charge point operators (CPOs) and virtual power plants (VPPs) to facilitate better energy management in houses and buildings.
Another project is developing decision-making tools for fleet managers, comparing the total cost of ownership (TCO) of fuel cell heavy-duty vehicles (HDVs), electric HDVs and range-extended HDVs against diesel HDVs. These tools also include predictive maintenance and life cycle assessment (LCA) to support informed decision-making.
Fleet management optimization is a key focus, with tools being developed to integrate real-time data for control centres and drivers. Internet of Things (IoT) devices are deployed on electric buses to monitor real-time data, enhancing energy efficiency and charging processes.
A comprehensive platform is being created to serve various use cases, incorporating different application programming interfaces (APIs) and workflows to enable fleet management tools. Additionally, a low-cost IoT tool is being developed to be implemented in vehicles, allowing for the transmission of vehicle information to a data cloud. This data helps optimize eco-driving and battery management based on the specific missions of individual vehicles, thereby increasing energy efficiency.

3.10.3.1 Projects’ responses

All of the consulted projects have confirmed they have worked on the emissions-free logistics topics. However, only two of them stated they have engaged with cities to validate and implement the developed solutions. One of the projects has confirmed the demonstration of use cases with emissions-free logistics in currently one city but plans to increase the number of cities to three by the end of the project.

3.10.3.2 Timing of expected future results

- 2025: Results from ESCALATE (mid-year) and EBRT2030.
- 2027: Final versions of ZEFES tools and results from GIANTS (June)

3.10.3.3 Progress towards targets

Progress has been made in the successful demonstration of cities with emissions-free logistics by 2030. The demonstration of one such use case has been confirmed.

3.11 SO.KPI.8a: Number of transport operators implementing zero tailpipe business models and use cases for freight transport and people mobility

3.11.1 Related Horizon Europe/2ZERO calls for submissions

Table 19: Horizon Europe/2ZERO relating to SO.KPI.8a

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2022-D5-01-08 horizon-cl5-2022-d5-01-08	Modular multi-powertrain zero-emission systems for HDV (BEV and FCEV) for efficient and economic operation (2ZERO)	ZEFES ESCALATE	Vehicle
HORIZON-CL5-2022-D5-01-10 horizon-cl5-2022-d5-01-10	New generation of full electric urban and peri-urban Bus Rapid Transit systems to strengthen climate-friendly mass transport (2ZERO)	EBRT2030	Vehicle
HORIZON-CL5-2023-D5-01-01 horizon-cl5-2023-d5-01-01	User-centric design and operation of EV for optimized energy efficiency (2ZERO)	SmartCorners	Vehicle
HORIZON-CL5-2023-D5-01-03 horizon-cl5-2023-d5-01-03	Frugal zero-emission vehicles concepts for the urban passenger challenge (2ZERO)	ZEV-UP GIANTS	Vehicle
HORIZON-CL5-2022-D5-01-09 horizon-cl5-2022-d5-01-09	Nextgen EV components: High efficiency and low-cost electric motors for circularity and low use of rare resources (2ZERO)	MAXIMA	Component
HORIZON-MISS-2023-CIT-01-01 horizon-miss-2023-cit-01-01	Co-designed smart systems and services for user-centred shared zero-emission mobility of people and freight in urban areas (2ZERO, CCAM and Cities' Mission)	MOBILITIES FOR EU	Miscellaneous

3.11.2 Assessment summary

Table 20: Assessment summary for SO.KPI.8a

SO.KPI.8a	Demonstrate innovative use cases for the integration of zero tailpipe emission vehicles and infrastructure concepts for the road mobility of people and goods
The following targets were defined in the 2ZERO SRIA.	○ 30 companies involved in the demonstration of innovative use cases over the lifetime of the Partnership demonstrating the zero tailpipe emission vehicles

	○ 30 passenger transport and freight transport and logistics use cases demonstrated in projects over the lifetime of the Partnership ○ 70-80 % of the volume of the current use cases/freight transport needs are addressed in projects
The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2019 Suggested baseline value: 0
Information was obtained by referring to the following information sources.	○ Public data research ○ Project questionnaires ○ Coordinator interviews ○ Other: Description
The following more mature projects have provided input to the assessment of this particular KPI.	○ MAXIMA ○ ESCALATE ○ ZEV-UP ○ EBRT2030 ○ ZEFES ○ GIANTS ○ MOBILITIES FOR EU ○ SmartCorners
Progress has been made towards the demonstration of innovative use cases for the integration of zero tailpipe emission vehicles and infrastructure concepts for the road mobility of people and goods.	Yes. ○ 30 companies involved in the demonstration of innovative use cases over the lifetime of the Partnership demonstrating the zero tailpipe emission vehicles. ✓✓ ○ 30 passenger transport and freight transport and logistics use cases demonstrated in projects over the lifetime of the Partnership ✓✓✓ ○ 70-80 % of the volume of the current use cases/freight transport needs are addressed in project ✗

3.11.3 Assessment in detail

One project is focused on developing an electric motor for electric vehicles (EVs), which is crucial for transitioning from traditional combustion engines to fully electric vehicles, thereby reducing emissions in the transport sector. This includes the creation of a demonstrator motor to be tested in a representative automotive environment, supporting the broader adoption of zero-emissions vehicles in commercial and public passenger transport.

Efficient powertrain design for fuel cell heavy-duty vehicles (HDVs), electric HDVs and range-extended HDVs is another key area of innovation. These designs aim for higher efficiencies and the ability to handle up to 40 tonnes GVW with a single charge, ensuring zero tailpipe emissions in heavy-duty transport.

The development of frugal zero-emission vehicles for passenger use is also being pursued, promoting a shift from single-use cars in urban areas to more sustainable transportation options. Additionally, new business models for electric bus rapid transit (BRT) are being implemented both in Europe and internationally, with feasibility studies in cities outside Europe, focusing on building business models for the exploitation of project results.

A comprehensive approach is being taken to address the entire value chain from vehicle production to buying, operations, including charging/refuelling, maintenance and reporting. This ensures a seamless transition to zero-emission vehicles.
Validation of demonstration vehicles in real-world use cases across emerging and advanced environments is another critical area of focus. This includes assessing scalability, modularity, interoperability, manufacturability, vehicle operation, user acceptability, environmental benefits, social and economic benefits, business viability, and replicability. The aim is to reduce development and production costs by 20% compared to using individual components.
Zero-emission vehicles are being deployed with associated business models to make them affordable. Initial business models are being refined in collaboration with local innovation ecosystems to deploy demonstrative solutions and mid-term investment plans, facilitating the upscaling of these solutions in participating cities.
Finally, the development of new commercial vehicles is being simplified through a skateboard design for all vehicle platforms. This design increases space for larger battery packs, passenger areas or freight, enhancing the versatility and efficiency of new vehicle models.

3.11.3.1 Projects' responses

One of the consulted projects is dedicated to commercial/public passenger transport, specifically targeting the development of an electric motor for EVs. It creates a motor that aligns with the core market of automotive applications, thereby facilitating the transition to electric mobility. However, this project does not involve any specific transport operators.
Another one focuses on freight long-haul, zero-emission transport. This initiative includes four physical use cases and one virtual use case, each demonstrating different configurations of heavy-duty trucks (HDTs). These configurations include hybrid battery/fuel cell HDTs for long-haul, fuel cell HDTs for long-haul, battery electric vehicle (BEV) HDTs for regional transport, solar BEV HDTs for regional transport, and fuel cell HDTs for long-haul. The project involves four transport operators dedicated to freight transport.
Another action is concerned with passenger transport, developing modular, frugal and zero-emission vehicles for urban use. The use cases for this project encompass various scenarios, such as urban commuting, shopping, peri-urban or regional use, and car sharing. Additionally, there are cargo use cases focused on last-mile missions, urban deliveries, and company service vehicles. However, no transport operators have yet implemented these use cases, as the vehicle development is still in progress.
Another initiative targets passenger transport through seven demonstration sites. These sites include cities such as Barcelona, Amsterdam, Athens, Prague, Rimini, Eindhoven and Bogotá. Each site involves multiple stakeholders, including public transport operators and various companies, to test and validate innovative solutions for bus rapid transit systems. Currently, six transport operators are involved, with many more companies participating.
Focusing on freight transport, another project demonstrates nine different long-haul truck configurations, including both BEVs and fuel cell electric vehicles (FCEVs). These demonstrations cover important TEN-T corridors in Europe, with plans to implement about 14 freight use cases by the end of the project. Approximately 15 transport operators are involved in this initiative.
A project that addresses both freight and passenger transport provides scalable and modular solutions through five living labs implemented in different countries. These use cases focus on various aspects such as scalability, modularity, interoperability, manufacturability, vehicle operation, user acceptability, environmental benefits, social and economic benefits, business viability, and replicability. Five transport operators are involved in this project.
Furthermore, one of the projects looks at both passenger and freight transport, with demonstrations in two lead cities and five replication cities. The project plans to implement three freight transport use cases and six passenger transport use cases by the end of the project. While the exact number of transport operators involved is currently unknown, three operators have been confirmed, with others pending.
Lastly, a project aims to develop scalable and flexible smart corner systems adaptable for all kinds of EVs, targeting both passenger cars and freight transport. This initiative does not involve any specific transport operators.

3.11.3.2 Timing of expected future results

- 2025: Results from EBRT2030 and initial demonstrations for MOBILITIES FOR EU in lead cities.
- 2026: Completed results from MAXIMA, ESCALATE (mid-year) and EBRT2030.
- 2027: Final results from ZEV-UP (end of year) and GIANTS (June). All results from ZEFES will also be available by the end of the project.
- 2028: Replicator cities' results for MOBILITIES FOR EU.

3.11.3.3 Progress towards targets

130 private-for profit companies have been involved in the relevant 2ZERO projects[17]. Overall, the projects have demonstrated at least 49 use cases for passenger and/or freight transport and confirmed the involvement of at least 29 transport operators in their efforts.

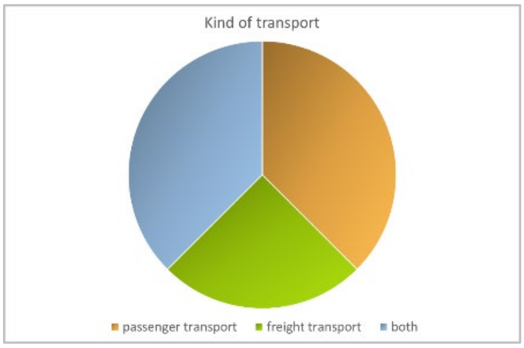

Figure 20: Split of project focus according to project feedback for SO.KPI.8a

[17] Information based on CORDIS analysis/CORDIS booklet of the relevant projects (08.04.2025)

3.12 SO.KPI.8b: Demonstrated innovative use cases using zero tailpipe emission trucks for regional, medium and long-haul, addressing payload from 7.5 tn to 40+ tn by 2025-2027

3.12.1 Related Horizon Europe/2ZERO calls for submissions

Table 21: Horizon Europe/2ZERO calls relating to SO.KPI.8b

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2021-D5-01-01 [horizon-cl5-2021-d5-01-01]	Nextgen vehicles: Innovative zero emission BEV architectures for regional medium freight haulage (2ZERO)	NextETRUCK	Vehicle
HORIZON-CL5-2022-D5-01-08 [horizon-cl5-2022-d5-01-08]	Modular multi-powertrain zero-emission systems for HDV (BEV and FCEV) for efficient and economic operation (2ZERO)	ZEFES ESCALATE	Vehicle
HORIZON-CL5-2023-D5-01-01 [horizon-cl5-2023-d5-01-01]	User-centric design and operation of EV for optimized energy efficiency (2ZERO Partnership)	SmartCorners	Vehicle

3.12.2 Assessment summary

Table 22: Assessment summary for SO.KPI.8b

SO.KPI.8b	Demonstrate innovative use cases for the integration of zero tailpipe emission vehicles and infrastructure concepts for the road mobility of people and goods
The following targets were defined in the 2ZERO SRIA.	○ 30 companies involved in the demonstration of innovative use cases over the lifetime of the partnership demonstrating the zero tailpipe emission vehicles ○ 30 passenger transport and freight transport and logistics use cases demonstrated in projects over the lifetime of the partnership ✓ ○ 70-80 % of the volume of the current use cases/freight transport needs are addressed in projects (i.e. use cases should reflect mainstream operations and how the majority of the freight is being transported)
The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2019 Suggested baseline value: 0
Information was obtained by referring to the following information sources.	○ Public data research ○ Project questionnaires
The following more mature projects have provided input to the assessment of this particular KPI.	○ ESCALATE ○ NextETruck ○ ZEFES ○ SmartCorners

Progress had been made towards the improvement of the integration of Electric Vehicles into the grid.	Partially. ○ 30 companies involved in the demonstration of innovative use cases over the lifetime of the partnership demonstrating the zero tailpipe emission vehicles ✓ ○ 30 passenger transport and freight transport and logistics use cases demonstrated in projects over the lifetime of the partnership ✓ ○ 70-80 % of the volume of the current use cases/freight transport needs are addressed in projects (i.e. use cases should reflect mainstream operations and how the majority of the freight is being transported) ×

3.12.3 Assessment in detail

Efforts to advance long-haul, zero-emission transport are focusing on innovative powertrain designs for heavy-duty vehicles (HDVs). These designs aim to achieve higher efficiencies and the capability to handle up to 40 tonnes with a single charge, addressing the needs of long-distance transport.

Innovations in zero-emission truck technologies are being validated in real-life scenarios through strategic use case demonstrators. In one metropolitan context, goods distribution trucks are operating between large consumer goods production facilities and retailers. Another scenario focuses on refuse trucks operating in zero-urban zones, with a pilot truck integrated into a waste collection fleet for an extended period. Additionally, a demonstrator for back-to-base logistics is translating innovations into flexible solutions for customers, particularly in express transport where efficient mission planning and last-mile monitoring are crucial.

Implementation of various sites for different use cases in diverse setups showcases the versatility and applicability of zero-emission solutions across different environments.

New vehicle designs are being enabled to cater to different transport needs. These adaptable and efficient vehicle platforms can accommodate various requirements, enhancing the overall functionality and sustainability of transport solutions.

3.12.3.1 Projects' responses

For commercial/public passenger transport, projects focus on creating electric motors for EVs, modular zero-emission vehicles for urban use and testing bus rapid transit systems across multiple European cities. These initiatives involve multiple stakeholders, including public transport operators and companies, to validate innovative solutions.

For freight transport, projects demonstrate different configurations of heavy-duty trucks (HDTs), including hybrid battery/fuel cell HDTs, fuel cell HDTs, battery electric vehicle (BEV) HDTs, and solar BEV HDTs. These demonstrations cover important TEN-T corridors in Europe and involve numerous transport operators dedicated to freight transport.

Additionally, some projects address both passenger and freight transport, providing scalable and modular solutions through living labs implemented in different countries. These use cases focus on various aspects such as scalability, modularity, interoperability, manufacturability, vehicle operation, user acceptability, environmental benefits, social and economic benefits, business viability, and replicability.

Another initiative focuses on both passenger and freight transport, with demonstrations in two lead cities and five replication cities. The project plans to implement three freight transport use cases and six passenger transport use cases by the end of the project. While the exact number of transport operators involved is currently unknown, three operators have been confirmed, with others pending.

Lastly, a project aims to develop scalable and flexible smart corner systems adaptable for all kinds of EVs, targeting both passenger cars and freight transport. This initiative does not involve any specific transport operators.

3.12.3.2 Timing of expected future results

- 2025: Results from NextETruck (end of year) and SmartCorners (second half of the year).
- 2026: Completed results from ESCALATE (mid-year), final results from ZEFES (end of project).

3.12.3.3 Progress towards targets

Overall, projects have reported 18 demonstrated passenger transport, freight transport and logistics use cases using zero tailpipe emission trucks for regional, medium and long-haul, addressing payload from 7.5 tn to 40+ tn with just as many companies involved in them. However, it could not be confirmed that 70-80 % of the volume of the current use cases/freight transport needs have been addressed in the projects.

3.13 SO.KPI.9: Commonly accepted LCA approach

3.13.1 Related Horizon Europe/2ZERO calls for submissions

Table 23: Horizon Europe/2ZERO calls relating to SO.KPI.9

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2022-D5-01-08 horizon-cl5-2022-d5-01-08	Modular multi-powertrain zero-emission systems for HDV (BEV and FCEV) for efficient and economic operation (2ZERO)	ESCALATE	Vehicle
HORIZON-CL5-2022-D5-01-10 horizon-cl5-2022-d5-01-10	New generation of full electric urban and peri-urban Bus Rapid Transit systems to strengthen climate-friendly mass transport (2ZERO)	EBRT2030	Vehicle
HORIZON-CL5-2023-D5-01-01 horizon-cl5-2023-d5-01-01	User-centric design and operation of EV for optimized energy efficiency (2ZERO)	SmartCorners	Vehicle
HORIZON-CL5-2023-D5-01-03 horizon-cl5-2023-d5-01-03	Frugal zero-emission vehicles concepts for the urban passenger challenge (2ZERO)	ZEV-UP	Vehicle
HORIZON-CL5-2021-D5-01-02 horizon-cl5-2021-d5-01-02	Nextgen EV components: Integration of advanced power electronics and associated controls (2ZERO)	RHODaS	Component
HORIZON-CL5-2022-D5-01-09 horizon-cl5-2022-d5-01-09	Nextgen EV components: High efficiency and low-cost electric motors for circularity and low use of rare resources (2ZERO)	EM-TECH MAXIMA HEFT VOLTCAR CLIMAFlux	Component
HORIZON-CL5-2023-D5-01-02 horizon-cl5-2023-d5-01-02	Innovative battery management systems for next generation vehicles (2ZERO & Batt4EU)	InnoBMS	Component
HORIZON-CL5-2021-D5-01-03 horizon-cl5-2021-d5-01-03	System approach to achieve optimised Smart EV Charging and V2G flexibility in mass-deployment conditions (2ZERO)	XL-CONNECT	Infrastructure
HORIZON-MISS-2023-CIT-01-01 horizon-miss-2023-cit-01-01	Co-designed smart systems and services for user-centred shared zero-emission mobility of people and freight in urban areas (2Zero, CCAM & Cities' Mission)	MOBILITIES FOR EU	Miscellaneous
HORIZON-CL5-2023-D5-01-04 horizon-cl5-2023-d5-01-04	Circular economy approaches for zero emission vehicles (2ZERO)	ZEvRA	Miscellaneous
HORIZON-CL5-2021-D5-01-04 horizon-cl5-2021-d5-01-04	LCA and design for sustainable circularity - holistic approach for zero-emission	TranSensus LCA	Miscellaneous

	mobility solutions and related battery value chain (2ZERO & Batt4EU)		

3.13.2 Assessment summary

Table 24: Assessment summary for SO.KPI.9

SO.KPI.9	Support the development of life-cycle analysis tools and skills for the effective design, assessment and deployment of innovative concepts in products/services in a circular economy context.
The following target was defined in the 2ZERO SRIA.	○ Reliable and consistent tools and methodologies available with reduced uncertainties supporting the applicability of LCA/Circular Economy (CE) strategies
The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2020 Suggested baseline value: 0
Information was obtained by referring to the following information sources.	○ Project questionnaires ○ Exchange with projects
The following more mature projects have provided input to the assessment of this particular KPI.	○ CliMAFlux ○ HEFT ○ MAXIMA ○ RHODas ○ TranSensus LCA ○ ESCALATE ○ XLConnect ○ ZEV-UP ○ EBRT2030 ○ InnoBMS ○ EM-TECH ○ MOBILITIES FOR EU ○ SmartCorners ○ VOLTCAR ○ ZEvRA
Progress had been made towards a commonly accepted LCA approach.	Partially. The CSA TranSensus LCA published its proposal for a harmonised, transport specific LCA approach recently. ✓✓

3.13.3 Assessment in detail

In total, 15 projects have been assessed addressing LCA in their project objectives. In most cases LCA is considered as part of the design process to ensure a minimal environmental impact (reduction of materials, optimised energy consumption etc.) of the considered components (e.g. e-motor, power electronics or BMS) or vehicle (LDV, HDV or Frugal BEV). The LCA consideration in the analysed projects is often linked also to circular economy strategies. As part of the LCA considerations dedicate frameworks, platforms and tools are being developed applying digital twins to calculate and assess CO_2 emissions, energy consumption or air pollution reductions. Details on the LCA approach are partly available e. g. following ISO14040) or provision of software tools used such as SimaPro or Ecoinvent. A Social-LCA is only considered in TranSensus LCA. In developing those frameworks, platform and tools the projects are partially contributing to the development of a commonly accepted LCA approach, e. g.

through case studies, outlining potential approaches for a harmonised LCA approach. However, direct efforts towards harmonisation and defining a commonly accepted LCA approach can only be found in the CSA TranSensus LCA. Only a limited number of the analysed projects such as ESCALATE or ZEvRA are harmonizing with TranSensus LCA (in case of ZEvRA it is defined in their objectives). For instance, the ESCALATE project initiated an exchange with the 2ZERO projects ZEFES, EMPOWER and TranSensus LCA to compare the different LCA approaches aiming to agree upon a common approach (ideally taking the TranSensus LCA approach). One reason might be the different timeline of the projects or that a harmonisation of the LCA is not the main focus of the considered projects. Nevertheless, activities towards a common accepted LCA approach can also be found beyond the 2ZERO Partnership particular in the battery partnership. BEPA projects such as RESPECT, RELIEF, Free4Lib and others are discussing with the 2ZERO project TranSensus LCA towards a harmonisation of the LCA approach.

3.13.3.1 Projects' responses

Efforts to develop a commonly accepted Life Cycle Assessment (LCA) approach are embedding sustainability, circularity and recyclability into the design and production of next-generation electric motors. This aims to set new standards for LCA in the electric vehicle sector, optimizing environmental impact throughout the lifecycle — from material selection to manufacturing, use and end-of-life phases. Integrating LCA early in the design process guides material choices and production methods, aiming to reduce rare earth material use by 60%, while maintaining motor performance and efficiency. Emphasizing circularity, the goal is to achieve over 70% recyclability, with motors designed for easy disassembly and recycling, using reversible mechanisms to extract critical materials such as magnets and copper without adhesives.

The use of digital twins enables real-time LCA optimization by simulating and monitoring environmental impact throughout the motor's operational life. This dynamic feedback ensures continuous improvement in performance, efficiency and sustainability. A holistic digital twin-based toolchain assesses factors such as energy consumption, material sourcing and production efficiency, supporting smarter, greener designs.

Studies are evaluating the reduction of rare earth elements in magnets, energy consumption, supply chain risks, and cost-effective recycling and reusing strategies, while ensuring high technical capabilities. Standardized methodologies and protocols are being established to extract useful data from system components, creating databases and libraries to support LCA for green design and manufacturing purposes.

Specific logistics issues are being considered to ensure positive business models for operators through effective interpretation of LCA, LCCA and/or S-LCA of pilot demonstrations. This involves creating an overall framework and platform for detailed environmental and socioeconomic impact analysis, producing accurate information and input data for overall impact analysis on life cycle effects, generating detailed input data and framework for assessing total cost of ownership (TCO) and strategic outlook for its reduction, and proposing how LCA energy and CO_2 could be included in the homologation process.

Key performance indicators (KPIs) include achieving 60% common parts usage across vehicle versions due to modular platform and body, reducing component weight by 10% through additive manufacturing methods, and using additive manufacturing for 5% of non-safety parts for spare part usage. Tools are being developed to calculate the tank-to-wheel (TTW) CO_2 emission reduction and air pollution reduction caused by the shift to electric buses from diesel buses.

Existing LCA/LCC methodologies are being applied to identify the baseline of state-of-the-art e-motors and evaluate new in-wheel-motor and on-board motor technologies, leading to a technological-based LCA/LCC comparison. A harmonized method for the evaluation and optimization of vehicle components with a focus on circularity is being developed, integrating LCA results into the development process for circular components.

3.13.3.2 Progress towards targets

In the course of elaborating this deliverable, the CSA TranSensus LCA published its proposal for a harmonised, transport specific LCA approach (T-LCA). The T-LCA represents the minimum consensus of all relevant stakeholders along the BEV value chain on how to conduct a LCA. Although TranSensus

LCA is in discussion with 2ZERO and BEPA projects, the widespread uptake of the T-LCA still needs to be realised to realise a commonly accepted LCA approach.

3.13.3.3 Open points, next steps and recommendations

In order to accelerate the uptake of the T-LCA towards a commonly accepted LCA approach, the uptake of that approach should become mandatory for all subsequent 2ZERO projects (with the support of the TranSenus LCA consortium).

3.14 **SO.KPI.10**: Implementation of a LCI database

3.14.1 Related Horizon Europe/2ZERO calls for submissions

Table 25: Horizon Europe/2ZERO calls relating to SO.KPI.10

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2022-D5-01-08 horizon-cl5-2022-d5-01-08	Modular multi-powertrain zero-emission systems for HDV (BEV and FCEV) for efficient and economic operation (2ZERO)	ZEFES ESCALATE	Vehicle
HORIZON-CL5-2021-D5-01-02 horizon-cl5-2021-d5-01-02	Nextgen EV components: Integration of advanced power electronics and associated controls (2ZERO)	RHODaS	Component
HORIZON-CL5-2022-D5-01-09 horizon-cl5-2022-d5-01-09	Nextgen EV components: High efficiency and low-cost electric motors for circularity and low use of rare resources (2ZERO)	MAXIMA CLIMAFlux	Component
HORIZON-CL5-2023-D5-01-02 horizon-cl5-2023-d5-01-02	Innovative battery management systems for next generation vehicles (2ZERO & Batt4EU)	InnoBMS	Component
HORIZON-CL5-2021-D5-01-04 horizon-cl5-2021-d5-01-04	LCA and design for sustainable circularity - holistic approach for zero-emission mobility solutions and related battery value chain (2ZERO & Batt4EU)	TranSensus LCA	Miscellaneous

3.14.2 Assessment summary

Table 26: Assessment summary for SO.KPI.10

SO.KPI.10	**Support the development of life-cycle analysis tools and skills for the effective design, assessment and deployment of innovative concepts in products/services in a circular economy context.**
The following target was defined in the 2ZERO SRIA.	○ Reliable and consistent tools and methodologies available with reduced uncertainties supporting the applicability of LCA / CE strategies.
The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2020 Suggested baseline value: 0
Information was obtained by referring to the following information sources.	○ Project questionnaires ○ Exchange with projects
The following more mature projects have provided input to the assessment of this particular KPI.	○ CliMAFlux ○ MAXIMA ○ RHODas ○ TranSensus LCA

	○ ESCALATE ○ InnoBMS ○ ZEFES
Progress has been made towards the implementation of a LCI database.	No. Projects collecting LCI data cannot provide them due to confidentiality concerns. ×

3.14.3 Assessment in detail

In comparison to the SO.KPI.9, fewer projects have been identified contributing to the implementation of a LCI database although the Life Cycle Inventory is an essential building block of a LCA. The main reason seems to be that real-life data are considered as sensitive and confidential, and as such cannot be reported openly. As a consequence, most projects are applying commercial (MCL former GABI) or open access (Ecoinvent, GREET) databases complemented with confidential data from project partners and secondary data obtained through simulations. However, the aim of both SO.KPI.9 and 10 is to implement a commonly accepted LCA approach with a reliable and comparable LCI data. This cannot be provided by individual projects. Within the TranSensus LCA, an ontology for such a LCI database and requirements on data quality are proposed, allowing either to compare LCI databases or to initiate a common, European-wide LCI database.

3.14.3.1 Projects' responses

Efforts to implement a Life Cycle Inventory (LCI) database are focused on continuously updating data on materials, processes, energy use and costs throughout the development process. This approach relies on primary data from participants to ensure the relevance and accuracy of environmental and economic assessments. The data is stored and managed using standardized repositories and shared within the consortium through secure platforms.
A digital twin-based toolchain enables the collection of comprehensive LCI data across the motor lifecycle, supporting the creation of a robust database for evaluating environmental impacts and costs in alignment with best practices in Life Cycle Assessment (LCA) and LCI. The integration of software such as Ecoinvent, GaBI-SPHERA or SIMAPRO ensures that data models are consistent and up-to-date, contributing to the creation of a reliable LCI database for electric vehicle components.
Efforts are also being made to provide an LCI database for new electrical machines, including novel recycling processes for permanent magnets. Life Cycle Impact Assessment (LCIA) and LCA of power inverters and electric motors of propulsion systems are performed in accordance with ISO14040/14044 standards.
A comprehensive LCA framework includes ontology and data management for the LCI database, contributing to the building of life cycle inventories for environmental and socio-economic assessments. This framework supports the development of scenarios via the quantification of potential life cycle environmental and socio-economic impacts.
LCI databases are applied within vehicle LCA models to assess the CO_2 impact of vehicle technologies over specific use cases.

3.14.3.2 Progress towards targets

All projects a collecting LCI data but can only provide them openly if not marked as confidential. It is reasonable to assume that the data used do not follow a common framework and, as such, not necessarily suitable for comparison. To overcome this, a commonly accepted LCA approach must be implemented (see SO.KPI.9).

3.15 SO.KPI.11: Feasibility of advanced circular economy strategies in zero emission mobility solutions demonstrated by performed used cases

3.15.1 Related Horizon Europe/2ZERO calls for submissions

Table 27: Horizon Europe/2ZERO calls relating to SO.KPI.11

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2022-D5-01-08 horizon-cl5-2022-d5-01-08	Modular multi-powertrain zero-emission systems for HDV (BEV and FCEV) for efficient and economic operation (2ZERO)	ZEFES ESCALATE	Vehicle
HORIZON-CL5-2023-D5-01-03 horizon-cl5-2023-d5-01-03	Frugal zero-emission vehicles concepts for the urban passenger challenge (2ZERO)	ZEV-UP	Vehicle
HORIZON-CL5-2022-D5-01-09 horizon-cl5-2022-d5-01-09	Nextgen EV components: High efficiency and low-cost electric motors for circularity and low use of rare resources (2ZERO)	MAXIMA HEFT VOLTCAR CLIMAFlux	Component
HORIZON-CL5-2023-D5-01-02 horizon-cl5-2023-d5-01-02	Innovative battery management systems for next generation vehicles (2ZERO & Batt4EU)	InnoBMS	Component
HORIZON-CL5-2023-D5-01-04 horizon-cl5-2023-d5-01-04	Circular economy approaches for zero emission vehicles (2ZERO)	ZEvRA	Miscellaneous

3.15.2 Assessment summary

Table 28: Assessment summary for SO.KPI.11

SO.KPI.11	**Support the development of life-cycle analysis tools and skills for the effective design, assessment and deployment of innovative concepts in products/services in a circular economy context.**
The following target was defined in the 2ZERO SRIA.	○ 20% of the vehicle mass is linked to CE-based product design demonstrated at project level
The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2020 Suggested baseline value: 25% of the vehicle mass
Information was obtained by referring to the following information sources.	○ Public data research ○ Project questionnaires
The following more mature projects have provided input to the assessment of this particular KPI.	○ CliMAFlux ○ HEFT ○ MAXIMA ○ ESCALATE ○ ZEV-UP ○ InnoBMS ○ ZEFES

	○ VOLTCAR ○ ZEvRA
Progress had been made towards the improvement of the integration of Electric Vehicles into the grid.	Partially. ✓

3.15.3 Assessment in detail

Most of the projects considered are only addressing circular economy strategies on single components, such as e-motor or the battery focussing on substitution of critical raw materials or design for recyclability. In those cases, no objectives or achievements in terms of how much of the vehicle mass is linked to CE-based design is provided (or cannot be provided). Only two projects are addressing circular economy strategies on vehicle, allowing them to specify a circularity rate on vehicle level. However, only one defines targets, such as 84% of the automotive material mix is substituted by secondary materials and demonstrated in 8 prototypical components. One can assume that this target translates into more than 20% of the vehicle mass is realised by CE principles. The other project is addressing lightweight and sustainable materials, reduced material usage and the 2nd life of batteries contributing to the overall CE design of L7e vehicles. Nevertheless, specific targets are not provided.
Furthermore, projects addressing circularity can also be found beyond the 2ZERO Partnership, such as FlexCrash. FlexCrash is utilising green aluminium in crash-relevant structures but again is not able to provide an evaluation how much green aluminium is used related to the overall vehicle mass. In general, it seems difficult for the projects to specify the KPI as define in the 2ZERO SRIA.

3.15.3.1 Projects' responses

Projects are demonstrating several circular economy strategies through innovative design and manufacturing practices for next-generation electric motors. One approach aims to achieve over 70% recyclability for motor components by designing parts that can be disassembled easily at the end of their life. This includes using reversible mechanisms for critical materials such as magnets and windings, allowing these parts to be removed without adhesives or complex processing.
Reducing reliance on rare earth elements is another key strategy, with a targeted 60% reduction. This supports resource conservation by using alternative materials and optimized motor designs to ensure high performance without excessive dependency on rare resources. Digital twins are employed to evaluate environmental impact in real time, optimizing resource efficiency and design improvements for prolonged motor lifecycles. This dynamic, data-driven approach helps minimize waste and material usage.
A smart marking system is integrated to facilitate easy identification of components during disassembly and recycling. This system supports circularity by ensuring materials can be efficiently reclaimed and repurposed. Efforts are also focused on recycling or reusing the magnets of motors, which are not typically reused today.
Circular economy strategies are being employed by designing electric motors that incorporate recycled permanent magnets, reducing the need for virgin materials. At the end of the motor's life cycle, the extraction and recycling of these permanent magnets are facilitated. Additionally, developing efficient routes for recycling permanent magnets minimizes material waste and improves resource efficiency in manufacturing electric motors for zero-emission vehicles.
Battery system development and demonstrations for heavy-duty vehicles (HDVs) with fast-charging capabilities are being pursued to fit within a sustainable and circular economy. Lightweight, affordable and sustainable battery electric vehicles (BEVs) are being created by developing modular, scalable platforms and user-centric designs, incorporating alternative manufacturing methods to maximize energy efficiency and minimize vehicle weight.
Demonstrations are focused on meeting real-time conditions and requirements from a logistics perspective, learning from outcomes to address challenges and barriers for scaling the implementation of zero-emission HDVs in long-haul freight transport. Circularity assessments are conducted on electrical motors, particularly focusing on critical raw materials used.

Efforts are also aimed at developing vehicle concepts and use cases that minimize the use of new materials. Recyclable solutions for aluminium, plastic and composite components are employed, with a focus on repurposing strategies for steel.

3.15.3.2 Progress towards targets

All projects considered are addressing circular economy strategies but with a rather limited focus. With the exception of one project, which runs until 2027, an assessment on the progress towards the target is not possible.

3.15.3.3 Open points, next steps and recommendations

Up to now, it is not mandatory for most of the assessed projects to define targets contributing to the 2ZERO SO.KPI.11. In upcoming calls, addressing circularity at least partially, it should be considered to request such a target. However, it should also be considered to specify this KPI further following the circularity indicators proposed in WP 3 of *Le*Mesurier.

3.16 OO.KPI.1: Demonstration of technologies, components, systems and their integration in vehicles enabling affordability, high efficiency and fast charging capabilities

3.16.1 Related Horizon Europe/2ZERO calls for submissions

Table 29: Horizon Europe/2ZERO calls relating to OO.KPI.1

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2021-D5-01-01 horizon-cl5-2021-d5-01-01	Nextgen vehicles: Innovative zero emission BEV architectures for regional medium freight haulage (2ZERO)	NextETRUCK	Vehicle
HORIZON-CL5-2022-D5-01-08 horizon-cl5-2022-d5-01-08	Modular multi-powertrain zero-emission systems for HDV (BEV and FCEV) for efficient and economic operation (2ZERO)	ZEFES EMPOWER ESCALATE	Vehicle
HORIZON-CL5-2022-D5-01-10 horizon-cl5-2022-d5-01-10	New generation of full electric urban and peri-urban Bus Rapid Transit systems to strengthen climate-friendly mass transport (2ZERO)	EBRT2030	Vehicle
HORIZON-CL5-2023-D5-01-01 horizon-cl5-2023-d5-01-01	User-centric design and operation of EV for optimized energy efficiency (2ZERO)	EFFEREST SmartCorners	Vehicle
HORIZON-CL5-2023-D5-01-03 horizon-cl5-2023-d5-01-03	Frugal zero-emission vehicles concepts for the urban passenger challenge (2ZERO)	ZEV-UP GIANTS	Vehicle
HORIZON-CL5-2021-D5-01-02 horizon-cl5-2021-d5-01-02	Nextgen EV components: Integration of advanced power electronics and associated controls (2ZERO)	RHODaS SCAPE HIPE	Component
HORIZON-CL5-2022-D5-01-09 horizon-cl5-2022-d5-01-09	Nextgen EV components: High efficiency and low-cost electric motors for circularity and low use of rare resources (2ZERO)	EM-TECH MAXIMA VOLTCAR CLIMAFlux	Component
HORIZON-CL5-2023-D5-01-02 horizon-cl5-2023-d5-01-02	Innovative battery management systems for next generation vehicles (2ZERO & Batt4EU)	InnoBMS iBattMan	Component
HORIZON-CL5-2021-D5-01-03 horizon-cl5-2021-d5-01-03	System approach to achieve optimised Smart EV Charging and V2G flexibility in mass-deployment conditions (2ZERO)	XL-CONNECT	Infrastructure
HORIZON-MISS-2023-CIT-01-01 horizon-miss-2023-cit-01-01	Co-designed smart systems and services for user-centred shared zero-emission mobility	MOBILITIES FOR EU	Miscellaneous

	of people and freight in urban areas (2Zero, CCAM & Cities' Mission)		
HORIZON-CL5-2023-D5-01-04 horizon-cl5-2023-d5-01-04	Circular economy approaches for zero emission vehicles (2ZERO)	ZEvRA	Miscellaneous

3.16.2 Assessment summary

Table 30: Assessment summary for OO.KPI.1

OO.KPI.1	Development of affordable innovative Battery Electric Vehicles (BEV) and Fuel Cells Electric Vehicles (FCEV) concepts and technologies
The following targets were defined in the 2ZERO SRIA.	Technologies and mass market vehicle achieving ○ Worldwide Harmonized Light-Duty Vehicles Test Procedure (WLTP) Vehicle consumption 12 kW.h/t/100km ○ Charging time per 100 km, 8 minutes with minimal impact on battery degradation
The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2019 Suggested baseline value: Vehicle consumption of 15 – 20 kW.h/100 km & 20 – 25 minutes of charging time per 100 km
Information was obtained by referring to the following information sources.	○ Public data research ○ Project questionnaires ○ Coordinator interviews
The following more mature projects have provided input to the assessment of this particular KPI.	○ CliMAFlux ○ iBattMan ○ MAXIMA ○ RHODas ○ SCAPE ○ ESCALATE ○ XLConnect ○ ZEV-UP ○ EBRT2030 ○ InnoBMS ○ NextETruck ○ ZEFES ○ EFFEREST ○ EMPOWER ○ EM-TECH ○ GIANTS ○ HiPE ○ MOBILITIES FOR EU ○ SmartCorners ○ VOLTCAR ○ ZEvRA
Progress had been made towards the development of affordable innovative Battery Electric Vehicles (BEV) and Fuel Cells Electric Vehicles (FCEV) concepts and technologies.	Partially. ○ Worldwide Harmonized Light-Duty Vehicles Test Procedure (WLTP) Vehicle consumption 12 kW.h/t/100km ✗

	○ Charging time per 100 km, 8 minutes with minimal impact on battery degradation ✗ ○ Reduction of vehicle consumption from 27kW.h/100km to 22kW.h/100km ✓ ○ Baseline charging time reduced by at least 10% ✓

Efforts to integrate advanced electric motor technologies, components and systems are enabling high efficiency, affordability and fast charging capability in electric vehicles. This includes the development of highly efficient axial flux motors with reduced energy loss and high-power density, integrating advanced materials and cooling systems to enhance performance and reduce manufacturing costs. Modular power electronics, based on silicon carbide and gallium nitride technologies, support high voltage operations, fast and ultra-fast charging, improved energy efficiency and operational flexibility.
Digital twin technology is employed for real-time monitoring and optimization, supporting precise motor control, efficient energy use and predictive maintenance. AI-based controllers manage the entire drive system, further enhancing energy efficiency and extending the motor's lifespan. Components, such as the motor, power electronics and single-speed transmission, are integrated into a compact, modular assembly designed for easy scalability and flexible configurations.
A simplified, efficient and connected battery management system (BMS) is being developed to reduce parts and costs across a range of battery types. Advanced firmware design incorporates innovative functionalities, cybersecurity, over-the-air updates and self-testing capabilities for first and second life applications. Accelerated battery characterization supports cost-effective transitions to second life applications and embedded BMS functionality facilitates faster battery recyclability.
Efforts are also focused on providing light, performant and affordable electric motors for automotive applications with small environmental impacts. Using digital twins for control, electricity consumption of the motor is reduced, and losses are minimized compared to reference motors. The efficiency of integrated electrical motor drive (IMD) powertrains for multiple wheel drive architectures is being improved, with a focus on reducing size and cost through novel semiconductor materials, optimal thermal management strategies and disruptive power converter topologies.
A novel modular and scalable approach for the design of all power converters in electric vehicles is being proposed, incorporating multilevel conversion technology to reduce losses and distortion. This approach will be demonstrated in main power conversion systems within electric vehicles, including integrated inverter-chargers and battery interfacing converters.
Technologies in the zero-emission heavy-duty vehicle (zHDV) sector are promoting the development of powertrain components and related software for various HDV applications. This includes battery design and production, innovative refuelling and grid- and user-friendly charging solutions, and fast charging requirements. Propulsion system component sizes, hybrid configurations and system control strategies are defined to fulfil long-haul target distances.
Efforts to create frugal battery electric vehicles (BEVs) focus on affordability, targeting price reductions through lightweight innovations and battery ownership models. Light-weighting of vehicle components is achieved using topological optimization combined with generative design and additive manufacturing technologies.
Technological solutions are being integrated into demonstration sites, applying innovations at the vehicle, charging infrastructure and IoT connectivity systems levels. Fast-charging infrastructure is being developed with optimized topologies to attain flexibility, high efficiency and business readiness, incorporating features such as high conversion efficiency, centralized power converters, multiple outputs for scalability, and smart adaptive control systems.
Battery electric vehicle (BEV) technologies, components and systems are being further developed to improve efficiency in several engineering areas, including thermal management, propulsion and retardation systems, and energy management for predictive charge, route and range planning. Fuel cell electric vehicle (FCEV) technologies are also being developed, focusing on integrating hydrogen tank systems and fuel cell systems, with special attention to thermal and electrical systems.
Demonstration and evaluation of innovations are conducted through physical and virtual testing, validating initial results obtained through various tools. Integration of modular low-voltage architectures,

high-reliability fuel cell systems, efficient e-axles, optimized thermal and energy management systems, and innovative human-vehicle interfaces are being demonstrated in real-world operations.
Next-generation EV traction motors are being developed with reduced energy loss, rare earth content usage, temperature hotspots and costs, while increasing power density and continuous torque density.
Unified EV architectures with key components such as swappable batteries and solar rooves are being developed, showcasing usability in multiple vehicles.
Scalable and modular families of wide bandgap (WBG)-based traction inverters and bidirectional on-board chargers are being developed, enabling significant size and weight reductions. These components are integrated into electric drives and high-voltage ancillaries, targeting passenger cars and commercial vehicles.
Technologies and components are being integrated to achieve more efficient and affordable vehicles and charging stations. Solution packages include fully electrified bus depots, energy grids based on photovoltaic systems, bidirectional charging systems, and hydrogen refuelling stations.
Accelerated design and testing methodologies for adaptable, efficient and user-centric smart corner systems based on in-wheel powertrains are being developed, reducing vehicle weight and increasing energy recovery and efficiency. Electric traction motors are being developed with a focus on circular economy compatibility, demonstrating feasibility through selected use cases and integrated demonstrator vehicles.

3.16.3 Assessment in detail

3.16.3.1 Projects' responses

The projects aimed at improving WLTP vehicle consumption employ a variety of innovative approaches:

- Some focus on developing advanced electric traction machines to enhance the performance and cost-effectiveness of electric vehicles (EVs). By optimizing the efficiency of electric motors, these projects directly impact vehicle consumption and WLTP results. Others, concentrate on improving battery management systems, which play a crucial role in maximizing battery utilization and performance, thereby reducing vehicle consumption.
- Another approach involves the development of low-cost, highly compact and environmentally friendly electrical machines for automotive applications. These machines are designed to reduce energy consumption on driving cycles, leading to increased vehicle range and reduced battery pack mass and cost. Additionally, some projects focus on innovative power converters using new semiconductor materials and digital technologies to improve the efficiency, power density and sustainability of EVs.
- The progress of the projects varies, with some already demonstrating significant advancements in vehicle consumption. For instance, projects working on electric traction motors have reported improvements in energy efficiency, indirectly leading to increased WLTP driving range or decreased energy consumption. However, specific values for these improvements are often not yet available, as many projects are still in the development or early implementation stages.
- Challenges faced by these projects include the difficulty of assessing improvements in a general way, as the impact of new technologies can vary widely depending on the specific vehicle and driving conditions. Additionally, some projects have not yet disclosed specific information regarding their progress, citing the need for further development and testing.
- Looking ahead, the consulted projects aim to achieve substantial improvements in WLTP vehicle consumption by the end of their respective timelines. Goals include significant reductions in energy consumption per 100 kilometres, increased vehicle range, decreased battery pack mass and cost. For example, one project targets a reduction in baseline consumption from 27 kW.h/100km to 22 kW.h/100km at 0°C.

Several projects have undertaken the challenge of improving charging times:

- One of the projects has set a reference point for measuring the improvement of charging time by the end of 2025. However, as of now, this project has not defined a specific achieved charging time, nor has it established an estimated achieved charging time by the end of the project.
- Another initiative, although uncertain about the reference value used in its proposal, aims to reduce the charging time by 10% compared to the suggested baseline.

- Another has made significant strides in improving charging times already. Initially, it used a reference value of up to 350 kW, resulting in a charging time of 22 minutes per 100 km for a battery electric vehicle (BEV) with a gross combination weight (GCW) of 40 tons and an energy use of 1.27 kW.h/km. Currently, the project's vehicle charging systems can realize a direct current (DC) charging power of about 700 kW, resulting in a charging time of 10 minutes per 100 km for a BEV with the same specifications but with an improved energy use of 1.17 kW.h/km.

3.16.3.2 Timing of expected future results

- 2025: Results from RHODAS (end of year), ESCALATE (mid-year), ZEV-UP (vehicle prototype in December), NextETRUCK (end of year), ZEFES (vehicles and technologies available for testing end of year), EM-TECH (second half of the year), HIPE (components available in the first half of the year), and SMART CORNERS (end of year).
- 2026: Completed results from MAXIMA, POWERDRIVE, EBRT2030, ZEFES (after demonstration phase), EFFEREST, EMPOWER, VOLTCAR, ZEvRA, and initial results from SCAPE (beginning of the year).
- 2027: Final results from iBattMan (June) and GIANTS (summer).
- 2028: Evaluation of impacts for MOBILITIES FOR EU

3.16.3.3 Information from other sources

Public information from project webpages and available deliverable reports confirm significant advancements in electric vehicle technology and infrastructure:

- One project is developing disruptive power converter topologies using new semiconductor materials and digital technologies to enhance efficiency, power density, reliability, cost and sustainability. The validation of these solutions targets electric drivetrains for heavy-duty vehicles, corresponding to USA Class 7-8 vehicles.
- Another project is creating highly energy-efficient, cost-effective, modular and compact wide bandgap power electronics solutions for battery electric vehicles. Outputs include scalable and modular traction inverters, DC/DC converters, integrated on-board chargers and fault-tolerant power electronics for high-voltage ancillaries.
- Another focuses on BEV architectures with distributed multiple wheel drives, specifically in-wheel powertrains. It explores the feasibility of highly efficient power electronics components and systems, including integrated traction inverters, on-board chargers, DC/DC converters and electric drives for auxiliaries and actuators, assessed on test rigs and BEV prototypes.
- The enhancement of the performance and cost of axial flux synchronous machines by optimizing design and manufacturing processes while minimizing environmental impact is a further focus topic of the project. It provides high TRL5 prototypes and validated methodologies to accelerate design and new technologies such as electric motor digital twins.
- Real-world demonstrations of long-haul BEVs and FCEVs across Europe are executed, aiming to make these vehicles more affordable, reliable and energy-efficient, with longer ranges per charge and reduced charging times. It maps flexible and abundant charging/fuelling points and novel charging concepts, and develops tools for fleet management.
- One action delivers two flexible, modular and scalable zero-emission heavy-duty vehicles, one powered by a fuel cell system with a 750 km range and the other by a battery-electric powertrain with a 400 km range.
- And one of the consulted projects also focuses on standardized, cost-effective modular and scalable multi-powertrain components, fast fuelling and grid-friendly charging solutions, and digital twin and AI-based management tools. It aims to develop modular building blocks for various types of zero-emission heavy-duty vehicles.
- Some projects work on a minimum 10% increase in energy efficiency compared to existing battery electric vehicle trucks, demonstrating next-generation e-mobility concepts for medium freight haulage.
- One initiative creates advanced full electric, urban and peri-urban European Bus Rapid Transit systems with novel automation and connectivity functionalities to support sustainable urban transport by reducing costs, emissions and traffic congestion.

- Lastly, a project aims to develop better-performing EV vehicles, cost-efficient production chains in power converter development, validated through models, simulations, digital twins and prototypes.

3.16.3.4 Progress towards targets

While many of the 2ZERO projects consulted confirm they are actively working towards the reduction of vehicles' energy consumption and charging time, only some were able to refer to results and specific values. Projects confirm they have been able to reduce the consumption from 27kW.h/100km to 22kW.h/100km and the suggested baseline charging time by at least 10%.

3.17 OO.KPI.2 and OO.KPI.3: Demonstrator vehicles and concepts realized in 2ZERO with an optimized cost vs. benefit and an expected positive impact on cost drivers

3.17.1 Related Horizon Europe/2ZERO calls for submissions for OO.KPI.2

Table 31: Horizon Europe/2ZERO calls relating to OO.KPI.2

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2023-D5-01-01 horizon-cl5-2023-d5-01-01	User-centric design and operation of EV for optimized energy efficiency (2ZERO Partnership)	SmartCorners	Vehicle
HORIZON-CL5-2021-D5-01-02 horizon-cl5-2021-d5-01-02	Nextgen EV components: Integration of advanced power electronics and associated controls (2ZERO)	SCAPE	Component
HORIZON-CL5-2022-D5-01-09 horizon-cl5-2022-d5-01-09	Nextgen EV components: High efficiency and low-cost electric motors for circularity and low use of rare resources (2ZERO)	EM-TECH MAXIMA HEFT	Component
HORIZON-CL5-2023-D5-01-02 horizon-cl5-2023-d5-01-02	Innovative battery management systems for next generation vehicles (2ZERO & Batt4EU Partnership)	InnoBMS	Component
HORIZON-CL5-2023-D5-01-04 horizon-cl5-2023-d5-01-04	Circular economy approaches for zero emission vehicles (2ZERO Partnership)	ZEvRA	Miscellaneous

3.17.2 Assessment summary OO.KPI.2

Table 32: Assessment summary for OO.KPI.2

OO.KPI.2	Demonstration of zero-emission Light Duty Vehicles (LDV), passenger cars and commercial use, to reduce total cost of ownership compared to conventional vehicles by 20% for the widest usages
The following target was defined in the 2ZERO SRIA.	○ Successful demonstration of zero-emission Light Duty Vehicles (LDV) in representative use cases by 2ZERO projects with an expected outcome of 20% cost reduction in 2030 compared to the 2020 baseline
The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2019 Suggested baseline value: for an average zero-emission LDV ~ EUR 40k purchase costs + ~ EUR 10k operating costs for 5 years
Information was obtained by referring to the following information sources.	○ Public data research ○ Project questionnaires

The following more mature projects have provided input to the assessment of this particular KPI.	○ HEFT ○ MAXIMA ○ SCAPE ○ InnoBMS ○ EM-TECH ○ SmartCorners ○ ZEvRA ○ Only partial contributions by all projects.
Progress had been made towards the improvement of the integration of Electric Vehicles into the grid.	Partially. ○ Successful demonstration of zero-emission Light Duty Vehicles (LDV) in representative use cases by 2ZERO projects with an expected outcome of 20% cost reduction in 2030 compared to the 2020 baseline. × ○ Reduction of total costs of ownership of up to EUR 5,000. ✓

Projects developing lower-cost, higher-efficiency and higher-power-density electric motors for mass-produced cars and vans are focusing on advanced configurations and materials. These include silicon carbide inverters, advanced cooling systems, electrical insulation and innovative rotor topologies. The use of advanced materials such as Grain Boundary Diffusion magnets and new composite materials for motor housing aims to enhance performance and reduce costs.

Optimizing the cost versus benefit of axial flux electric motors is another key focus. By significantly reducing manufacturing costs, these highly efficient motors can become competitive in mass-market applications, making zero-emission light-duty vehicles (LDVs) more affordable without compromising performance.

Modular and scalable technology for electric vehicle (EV) power electronics components is being developed to reduce costs through economies of scale. Improvements in the efficiency of these power conversion systems also contribute to decreased energy consumption during use.

Efforts to improve battery utilization aim to extend the state of charge (SoC) and lifetime, potentially reducing the need for larger batteries or increasing range. This could lead to significant cost reductions for passenger cars and light-duty vehicles, with demonstrations planned for specific vehicle models.

Novel functionalities and innovative motor designs are being tested and demonstrated in interconnected testing facilities. This approach, combined with digital twinning, allows real-time verification and validation, accelerating product development cycles and reducing time-to-market.

Accelerated design and testing methodologies for adaptable, efficient, and user-centric smart corner systems based on in-wheel powertrains are being developed. These designs facilitate easier exchangeability of powertrain components, leading to a more competitive market and lower prices for customers. Reducing vehicle weight and increasing energy recovery in braking are expected to enhance overall efficiency.

Vehicle concepts are being developed with the aim of using minimal new materials, focusing on recycled materials and standardized components. Demonstrations will showcase various concepts, including reduced development time, material standardization, and designs suitable for assembly and disassembly.

3.17.3 Assessment in detail

3.17.3.1 Projects' responses

Some of the consulted projects are working on reducing the costs of ownership for zero-emission LDVs:

- One of the projects aims to reduce the cost of the electric motor by 25% by 2030. The reference value used is 6€/kW based on the most sold electric vehicles in Germany in January 2022 (VW ID.4 and FIAT500e).

- Another project focuses on reducing the cost of power electronics components, specifically aiming to lower the cost of traction inverters to below 2.5€/kW, a 37.5% reduction from the 2021 reference value of 4€/kW.
- Yet another has worked on a 5-10% cost reduction by 2030, with the reference year being 2023.

3.17.3.2 Timing of expected future results

- 2025: Results from EM-TECH (second half of the year) and SMART CORNERS (end of year).
- 2026: Completed results from MAXIMA, SCAPE (beginning of the year) and ZEvRA.

3.17.3.3 Progress towards targets

- Assuming a total cost of ownership for a light duty vehicle being €50,000 and the costs for the electric motor accounting for €3,750 of that price, a reduction of 25% of the price of the e-motor would effectively reduce the total cost of ownership of such a vehicle by €940.
- An overall cost reduction of 5 to 10% would amount to €2,500 to 5,000.
- Assuming that an average electric light-duty vehicle has a power rating of 100kW, the costs of a traction inverter would amount to €600. Assuming costs of €2.49/kW, this amount would be significantly reduced to €249.

3.17.4 Related Horizon Europe/2ZERO calls for submissions for OO.KPI.3

Table 33: Horizon Europe/2ZERO calls relating to OO.KPI.2

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2022-D5-01-08 horizon-cl5-2022-d5-01-08	Modular multi-powertrain zero-emission systems for HDV (BEV and FCEV) for efficient and economic operation (2ZERO)	ZEFES ESCALATE	Vehicle
HORIZON-CL5-2023-D5-01-01 horizon-cl5-2023-d5-01-01	User-centric design and operation of EV for optimized energy efficiency (2ZERO)	SmartCorners	Vehicle
HORIZON-CL5-2021-D5-01-02 horizon-cl5-2021-d5-01-02	Nextgen EV components: Integration of advanced power electronics and associated controls (2ZERO)	SCAPE	Component
HORIZON-CL5-2022-D5-01-09 horizon-cl5-2022-d5-01-09	Nextgen EV components: High efficiency and low-cost electric motors for circularity and low use of rare resources (2ZERO)	MAXIMA	Component
HORIZON-CL5-2021-D5-01-03 horizon-cl5-2021-d5-01-03	System approach to achieve optimised Smart EV Charging and V2G flexibility in mass-deployment conditions (2ZERO)	EV4EU	Infrastructure
HORIZON-MISS-2023-CIT-01-01 horizon-miss-2023-cit-01-01	Co-designed smart systems and services for user-centred shared zero-emission mobility of people and freight in urban areas (2ZERO, CCAM & Cities' Mission)	MOBILITIES FOR EU	Miscellaneous

3.17.5 Assessment summary OO.KPI.3

Table 34: Assessment summary for OO.KPI.3

OO.KPI.3	**Demonstration of zero-emission Heavy Duty Vehicles (HDV) matching the performance and TCO (Total Cost of Ownership) of current vehicles for most of the relevant use cases, including new usage models**
The following targets were defined in the 2ZERO SRIA.	○ Standard HDV successful demonstration of zero-emission Heavy Duty Vehicles (HDV) in relevant use cases covered by 2ZERO projects with an expected outcome of nearly cost parity per tonne.km in 2030 compared to the 2020 baseline ○ FCEV powertrain efficiency (TtW): ~10-15% better than conventional ICE ○ BEV powertrain efficiency (TtW): ~ 35-45% better than conventional ICE
The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2019 Suggested baseline value: ICE powertrain efficiency ~40% under optimal conditions
Information was obtained by referring to the following information sources.	○ Public data research ○ Project questionnaires
The following more mature projects have provided input to the assessment of this particular KPI.	○ EV4EU ○ MAXIMA ○ ESCALATE ○ ZEFES ○ MOBILITIES FOR EU ○ SmartCorners
Progress has been made towards the demonstration of zero-emission Heavy Duty Vehicles (HDV) matching the performance and TCO (Total Cost of Ownership) of current vehicles.	Partially. ○ Standard HDV successful demonstration of zero-emission Heavy Duty Vehicles (HDV) in relevant use cases covered by 2ZERO projects ✓✓✓ ○ Standard HDV successful demonstration of zero-emission Heavy Duty Vehicles (HDV) with an expected outcome of nearly cost parity per tonne.km in 2030 compared to the 2020 baseline ✗ ○ FCEV powertrain efficiency (TtW): ~10-15% better than conventional ICE ✓ ○ BEV powertrain efficiency (TtW): ~ 35-45% better than conventional ICE ✓

Demonstrations of various vehicle combinations, including battery electric vehicles (BEVs), fuel cell electric vehicles (FCEVs) and e-trailers, are being conducted across Europe. These demonstrations cover main cargo flows and include intermodal and cross-border missions operated by different logistics providers under real-world conditions.
Accelerated design and testing methodologies for adaptable, efficient and user-centric smart corner systems based on in-wheel powertrains are being developed. These designs facilitate easier exchangeability of powertrain components, leading to a more competitive market and lower prices for

customers. Reducing vehicle weight and increasing energy recovery in braking are expected to enhance overall efficiency.

3.17.6 Assessment in detail

3.17.6.1 Projects' responses

Several of the consulted 2ZERO projects confirmed they have been working on HDV demonstrations and concepts with optimized cost vs. benefit and a positive impact on major cost drivers such as energy consumption, materials and production steps:

- Charging processes and charging infrastructure
- Tools for the design of electric motors and digital twins to improve performance
- Modular and scalable technology for power electronics components
- Demonstration of ten vehicle combinations in 15 use cases across Europe
- Design and testing methods for the reduction of vehicle weight

A few of the consulted 2ZERO projects confirmed they have been working on improving FCEV and BEV powertrain efficiency:

- Tank-to-wheel efficiency of 44%
- Energy consumption improvement of 8% (1.27 kW.h/km to 1.17 kW.h/km)
- Reduction of costs of traction inverters
- Improving the efficiency of traction inverters from 96% in 2021 to 97.5% in 2024

3.17.6.2 Timing of expected future results

- 2025: Results from SmartCorners (end of year).
- 2026: Completed results from MAXIMA, SCAPE (beginning of the year), ESCALATE (mid-year), and ZEFES (end of year).
- 2028: Final results from MOBILITIES FOR EU (December).
- 2030: Results from EV4EU

3.17.6.3 Progress towards targets

While 2ZERO projects confirmed progress towards the targets regarding tank-to-wheel efficiency, improvement of energy consumption and improvement of the efficiency of traction inverters, their results will only be available at a later date.

3.18 OO.KPI.4: Demonstration of technologies, components, systems and their integration in vehicles enabling affordability, high efficiency and fast charging capability

3.18.1 Related Horizon Europe/2ZERO calls for submissions

Table 35: Horizon Europe/2ZERO calls relating to OO.KPI.4

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2021-D5-01-01 horizon-cl5-2021-d5-01-01	Nextgen vehicles: Innovative zero emission BEV architectures for regional medium freight haulage (2ZERO)	NextETRUCK	Vehicle
HORIZON-CL5-2022-D5-01-10 horizon-cl5-2022-d5-01-10	New generation of full electric urban and peri-urban Bus Rapid Transit systems to strengthen climate-friendly mass transport (2ZERO)	EBRT2030	Vehicle
HORIZON-CL5-2023-D5-01-01 horizon-cl5-2023-d5-01-01	User-centric design and operation of EV for optimized energy efficiency (2ZERO)	EFFEREST	Vehicle
HORIZON-CL5-2021-D5-01-02 horizon-cl5-2021-d5-01-02	Nextgen EV components: Integration of advanced power electronics and associated controls (2ZERO)	RHODaS SCAPE PowerDrive HIPE HighScape	Component
HORIZON-CL5-2022-D5-01-09 horizon-cl5-2022-d5-01-09	Nextgen EV components: High efficiency and low-cost electric motors for circularity and low use of rare resources (2ZERO)	VOLTCAR CLIMAFlux	Component
HORIZON-CL5-2021-D5-01-03 horizon-cl5-2021-d5-01-03	System approach to achieve optimised Smart EV Charging and V2G flexibility in mass-deployment conditions (2ZERO)	XL-CONNECT	Infrastructure
HORIZON-MISS-2023-CIT-01-01 horizon-miss-2023-cit-01-01	Co-designed smart systems and services for user-centred shared zero-emission mobility of people and freight in urban areas (2ZERO, CCAM & Cities' Mission)	MOBILITIES FOR EU	Miscellaneous

3.18.2 Assessment summary

Table 36: Assessment summary for OO.KPI.4

OO.KPI.4	Development and demonstration of affordable new vehicle solutions, charging technologies and services for mass market to enable 1000 km long distance trips with no more than 10% additional time compared to conventional solutions, considering economic and environmental assessment

The following targets were defined in the 2ZERO SRIA.	○ M1 category Battery Electric Vehicles ○ Demonstrators (including M1 vehicles up to C-segment and according to technology packs) enabling 1000 km trips with less than a 10% door-to-door time penalty with respect to a conventional vehicle ○ Vehicle consumption 12 kW.h/t/100km ○ Charging time per 100 km, 8 minutes, with minimal impact on battery degradation
The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2019 Suggested baseline value: Vehicle consumption of 15–20 kW.h/100 km & 20–25 minutes of charging time per 100 km
Information was obtained by referring to the following information sources.	○ Public data research ○ Project questionnaires
The following more mature projects have provided input to the assessment of this particular KPI.	○ CliMAFlux ○ RHODas ○ SCAPE ○ HighScape ○ XLConnect ○ EBRT2030 ○ NextETruck ○ EFFEREST ○ HiPE ○ MOBILITIES FOR EU ○ VOLTCAR
Progress has been made towards the development and demonstration of affordable new vehicle solutions, charging technologies and services for mass market to enable 1000 km long distance trips.	No. ○ M1 category Battery Electric Vehicles × ○ Demonstrators (including M1 vehicles up to C-segment and according to technology packs) enabling 1000 km trips with less than a 10% door-to-door time penalty with respect to a conventional vehicle × ○ Vehicle consumption 12 kW.h/t/100km × ○ Charging time per 100 km, 8 minutes, with minimal impact on battery degradation ×

Projects that advance electric vehicle (EV) technologies are demonstrating high efficiency, affordability and fast charging capabilities through the integration of advanced electric motor technologies, components and systems. High-efficiency axial flux motors are designed to reduce energy losses, improve power density, and lower the use of rare earth materials. These motors are tested on hardware platforms, including vehicle test benches, to assess their efficiency and operational performance under realistic driving conditions.

Integrated power electronics based on silicon carbide (SiC) and gallium nitride (GaN) technologies support high-voltage operations and enable fast and ultra-fast charging capabilities. These power electronics also support modular configurations, facilitating scalability and flexibility in various vehicle applications. Novel cooling methods, such as direct oil cooling and anodized aluminium windings, enhance heat dissipation and allow higher motor performance with reduced thermal constraints. These methods are validated in laboratory and vehicle tests to ensure they meet reliability and efficiency targets. Digital twin technology is used to simulate and monitor motors and drive systems, enabling real-time performance optimization and predictive maintenance. This AI-driven control system improves energy efficiency and system life, supporting affordability and sustainability goals. The integration of motor, power electronics and mechanical transmission into a compact system allows for easy scaling and adaptation for different EV models, helping reduce production costs.

Efforts to improve the efficiency of electric integrated motor drive (IMD) powertrains for heavy-duty long-haul vehicles focus on reducing size and cost through novel semiconductor materials, optimal thermal management strategies, and disruptive power converter topologies. Intelligent control and diagnostics techniques, along with data-driven predictive maintenance, enhance resilience and performance.

A novel modular and scalable approach for the design of all power converters in electric vehicles is being proposed, incorporating multilevel conversion technology to reduce losses and distortion. This approach will be demonstrated in main power conversion systems within electric vehicles, including integrated inverter-chargers and battery interfacing converters.

Innovations in zero-emission truck technologies are being validated in real-life scenarios through strategic use case demonstrators. These include goods distribution trucks in metropolitan contexts, refuse trucks operating in zero-urban zones and back-to-base logistics solutions for express transport. Demonstrations and evaluations of innovations are conducted through physical and virtual testing, validating initial results obtained through various tools.

A scalable and modular family of wide bandgap (WBG)-based traction inverters and bidirectional on-board chargers is being developed, enabling significant size and weight reductions. These components are integrated into electric drives and high-voltage ancillaries, targeting passenger cars and commercial vehicles.

Efforts to demonstrate the reduction of CO_2, energy consumption, charging times and operational costs are being conducted through the implementation of various vehicle technologies. Electric traction motors are being developed, prototyped and tested, with life cycle assessment (LCA) employed in the process to develop digital tools for the motors.

3.18.3 Assessment in detail

3.18.3.1 Projects' responses

Several of the consulted 2ZERO projects confirm they are demonstrating new vehicle solutions, charging technologies and services aimed at the mass market:

- One project focuses on demonstrating high-efficiency, affordable axial flux motors with integrated power electronics and modular configurations. These motors are designed for scalability across different electric vehicle models, from passenger cars to vans. The project also integrates SiC- and GaN-based power electronics to support high-voltage architectures (up to 800V) compatible with fast and ultra-fast charging. Additionally, real-time digital twin and AI-based control systems provide predictive maintenance and performance optimization, enhancing vehicle reliability and operational efficiency.
- Another project aims to efficiently integrate power electronics and thermal management systems into a compact, modular integrated variable speed drive (IMD). This integration improves the overall performance of new power converters over a wide range of operating conditions while meeting automotive quality and safety standards. The project uses new wide bandgap (WBG) devices for power electronics, improved modular 3D manufactured thermal coolers, high voltage motors capable of working up to 1000VDC bus, and three-layer digital tools for enhanced control and safety of the powertrain.
- A different project involves a full powertrain demonstrator, including the traction battery, a service battery, a motor, an integrated inverter-charger and a battery interfacing converter feeding the service battery from the traction battery. Advanced prognosis and health-management strategies enable services such as predictive maintenance.
- One project is developing multiple innovative solutions for electric Bus Rapid Transit (BRT) vehicles to improve the flexibility and applicability of the EBRT system in various urban contexts. These solutions will be economically viable and integrated into vehicles and charging infrastructure.
- Another project will demonstrate three vehicles alongside three charging locations.
- A project will demonstrate an energy management system for improved EV efficiency, including the powertrain and comfort systems, based on AI-supported methods.
- One project will demonstrate two motor designs and one inverter design to control the motor.

Summary of the demonstrations confirmed by the 2ZERO projects, although not all of them pertain to the M1 vehicle category:

- High-efficiency axial flux motors with integrated power electronics and modular configurations.
- SiC- and GaN-based power electronics supporting high-voltage architectures (up to 800V) for fast and ultra-fast charging.
- Real-time digital twin and AI-based control systems for predictive maintenance and performance optimization.
- Compact, modular integrated variable speed drive (IMD) with improved power converters.
- New wide bandgap (WBG) devices for power electronics.
- Modular 3D manufactured thermal coolers.
- High voltage motors capable of working up to 1000V DC bus.
- Three-layer digital tools for enhanced control and safety of the powertrain.
- Traction battery.
- Service battery.
- Integrated inverter-chargers.
- Battery interfacing converter feeding the service battery from the traction battery.
- Advanced prognosis and health-management strategies for predictive maintenance.
- Multiple innovative solutions for electric Bus Rapid Transit (BRT) vehicles.
- Integration into vehicles and charging infrastructure.
- Energy Management Systems
- HUC-energy management system for improved EV efficiency, including powertrain and comfort systems, based on AI-supported methods.
- Hardware Demonstrations
- Motor designs, vehicles and charging stations

3.18.3.2 Timing of expected future results

- 2025: Results from RHODAS (end of year), HighScape (end of year), NextETRUCK (end of year), and initial results from SCAPE.
- 2026: Completed results from SCAPE (beginning of the year), EBRT2030, EFFEREST, and VOLTCAR.
- 2028: Final results from MOBILITIES FOR EU (December).

3.18.3.3 Progress towards targets

While the consulted 2ZERO projects confirmed many use case demonstrations for new vehicle solutions, charging technologies and services for the mass market, none of them confirmed demonstrators enabling 1000km for M1 category vehicles.

3.19 OO.KPI.5: Optimal balance between battery size, user needs and recharging infrastructure capabilities identified from EU funded projects

3.19.1 Related Horizon Europe/2ZERO calls for submissions

Table 37: Horizon Europe/2ZERO calls relating to OO.KPI.5

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2022-D5-01-08 horizon-cl5-2022-d5-01-08	Modular multi-powertrain zero-emission systems for HDV (BEV and FCEV) for efficient and economic operation (2ZERO)	ZEFES	Vehicle
HORIZON-CL5-2023-D5-01-03 horizon-cl5-2023-d5-01-03	Frugal zero-emission vehicles concepts for the urban passenger challenge (2ZERO Partnership)	ZEV-UP	Vehicle
HORIZON-CL5-2023-D5-01-02 horizon-cl5-2023-d5-01-02	Innovative battery management systems for next generation vehicles (2ZERO & Batt4EU)	iBattMan	Component
HORIZON-CL5-2021-D5-01-03 horizon-cl5-2021-d5-01-03	System approach to achieve optimised Smart EV Charging and V2G flexibility in mass-deployment conditions (2ZERO)	XL-CONNECT	Infrastructure
HORIZON-CL5-2023-D5-01-01 horizon-cl5-2023-d5-01-01	User-centric design and operation of EV for optimized energy efficiency (2ZERO)	SmartCorners	Vehicle

3.19.2 Assessment summary

Table 38: Assessment summary for OO.KPI.5

OO.KPI.5	Development and demonstration of affordable new vehicle solutions, charging technologies and services for mass market to enable 1000 km long distance trips with no more than 10% additional time compared to conventional solutions, considering economic and environmental assessment
The following targets were defined in the 2ZERO SRIA.	○ M1 category Battery Electric Vehicles ○ Demonstrators (including M1 vehicles up to C-segment and according to technology packs) enabling 1000 km trips with less than a 10% door-to-door time penalty with respect to a conventional vehicle ○ Vehicle consumption 12 kW.h/t/100km ○ Charging time per 100 km, 8 minutes, with minimal impact on battery degradation
The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2019

	Suggested baseline value: Vehicle consumption of 15–20 kW.h/100km & 20–25 minutes of charging time per 100km
Information was obtained by referring to the following information sources.	○ Public data research ○ Project questionnaires
The following more mature projects have provided input to the assessment of this particular KPI.	○ iBattMan ○ XLConnect ○ ZEV-UP ○ ZEFES ○ SmartCorners
Progress has been made towards the development and demonstration of affordable new vehicle solutions, charging technologies and services for mass market.	Yes. ○ Development and demonstration of affordable new vehicle solutions, charging technologies and services for mass market to enable 1000 km long distance trips with no more than 10% additional time compared to conventional solutions ✓✓ ○ Demonstrators (including M1 vehicles up to C-segment and according to technology packs) enabling 1000 km trips with less than a 10% door-to-door time penalty with respect to a conventional vehicle × ○ Vehicle consumption 12 kW.h/t/100km × ○ Charging time per 100 km, 8 minutes, with minimal impact on battery degradation ×

3.19.3 Assessment in detail

Algorithms are being developed to predict critical operating conditions throughout the battery's life from a limited number of experiments. These algorithms enhance the identifiability of physical parameters for on-board models and improve responses to hazardous situations. A database is being created to record new sensor information, enabling advanced connectivity between battery management systems (BMS) and electronic control units (ECU) to collect environmental and user data.
Compact surrogate models of highly accurate battery models are being developed with a focus on real-time capability and data efficiency, supported by cloud connections. The commercial viability and deployment of these technologies are also being evaluated.
Efforts to optimize battery configurations include the development of a small, swappable 76V main battery with an option for an extra battery pack for extended range. This configuration allows for charging times of less than two hours to reach 80% of battery capacity using a Type 2 plug.
Simulation tools have been developed to perform right-sizing of vehicle components, including battery size, ensuring optimal performance and efficiency. The wheel corner design enables a skateboard-like chassis design, increasing cabin volume by 15% and luggage space by over 20% compared to state-of-the-art vehicles of the same class. This additional space can be used for passenger needs or larger, possibly modular, batteries, offering new possibilities for different approaches.

3.19.3.1 Projects' responses

- One of the consulted 2ZERO projects is working on enabling 1000km trips, more specifically 1250 km trips without time penalties relative to conventional vehicles.
- One action intends to keep the same energy consumption (0.20€/km as per 2018) with a TCO reduction between 7% and 20%.
- One project confirms an improved charging time of 11.25 minutes/100km.
- Another project is working on a range recovery of 400km in 45 minutes.

Two projects are addressing user needs and concerns regarding range anxiety for long-distance travel with battery electric vehicles (BEVs) in different ways:

- One project focuses on simulation-based investigations of BEV range behaviour, including various smart charging and vehicle-to-grid (V2G) scenarios. By setting-up a comprehensive, reliable physics-oriented BEV model, the project simulates BEV behaviour and all effects on the BEV battery during operation and smart charging. This model includes a parametric electro-thermal battery model and an HVAC system for efficient thermal management. The accurate and well-validated BEV model can reliably predict the remaining driving range of the vehicle, helping to counteract range anxiety.
- Another project aims to ensure that there are enough available fast chargers to meet the needs of demonstrator vehicles, addressing range anxiety by providing sufficient charging infrastructure.

The projects use different types of battery technologies for their M1 BEV demonstrators but have not provided a lot of detailed information:

- One project investigates LFP-battery cells (lithium iron phosphate chemistry) and NMC-battery cells (nickel manganese cobalt chemistry) in their virtual BEV model.
- Another project specified they are developing efficient, scalable and modular battery packs.
- One initiative has not yet determined the type of battery technology to be used.

3.19.3.2 Timing of expected future results

- 2025: Vehicle prototype from ZEV-UP (December).

3.19.3.3 Information from other sources

One project focuses on vehicle charging behaviours, battery degradation models and forecasted electricity demand for facilities. It also optimizes operation profiles for bidirectional charging of EVs, stationary storage and flexible demand, providing structured timeseries data for analysis. This comprehensive approach aims to enhance the efficiency and reliability of EV charging infrastructure.
Another project emphasizes the development of strategies that consider the impact on batteries, user needs, power systems and integration with energy markets. These strategies are tested in four demonstration sites, ensuring their practical applicability. Additionally, tools and apps are developed to provide EV users with valuable information about vehicle usage and available energy services, facilitating a smoother transition to electric mobility.
A further action aims to shape a new energy ecosystem by harnessing the flexibility of EV batteries. It systematically assesses customer expectations, identifies user preferences, existing obstacles and potential incentives for smart charging. By deploying a user-centric approach, the project collects knowledge, removes acceptance barriers and develops solutions aligned with the needs of 800 users directly involved in pilot studies. This approach ensures that the developed solutions are both practical and user-friendly.
Information obtained from project web pages reveals that one project deploys solutions in five demonstrations, including two testbeds and three large-scale demos across various countries. These demonstrations cover a wide range of applications, such as V1G, V2B, V2H, and V2G, in different settings like public, private, semi-public, urban, rural, and touristic areas. The diversity of applications ensures that the solutions are versatile and can be adapted to various contexts.
Innovative V2X solutions are being tested through 13 use cases in real-life pilot sites across multiple countries. These use cases follow a structured approach, including preparation, execution, and data gathering phases. By focusing on different aspects of V2X technology, the project ensures complementarity and a comprehensive understanding of the technology's potential.

3.19.3.4 Progress towards targets

Of the consulted 2ZERO projects, five confirmed they were working on the optimal balance between battery size, user needs and recharging infrastructure capabilities. The projects are working on different use cases. One of them is also working on 1000km trips with less than a 10% door-to-door time penalty with respect to a conventional vehicle – however this only pertains to long-haul transportation and not to M1 category vehicles. Another project also confirmed they were working on improving the charging time to 11.25 minutes/100km and thereby to a range recovery of 400km in 45 minutes.

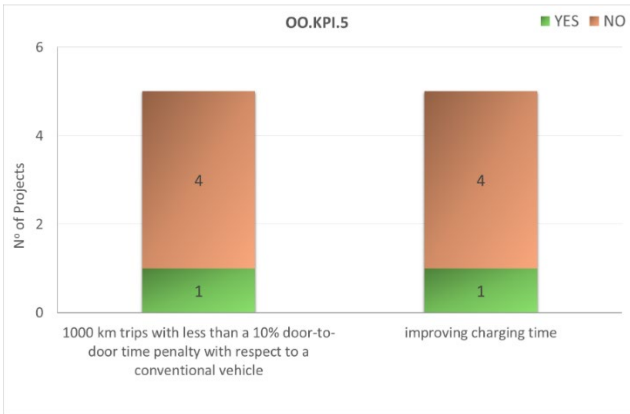

Figure 21: Visualization of project feedback for OO.KPI.5

3.20 OO.KPI.6: More efficient technologies and solutions developed in EU funded projects for the development of low-power charging infrastructure

3.20.1 Related Horizon Europe/2ZERO calls for submissions

Table 39: Horizon Europe/2ZERO calls relating to OO.KPI.6

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2022-D5-01-08 horizon-cl5-2022-d5-01-08	Modular multi-powertrain zero-emission systems for HDV (BEV and FCEV) for efficient and economic operation (2ZERO)	ZEFES ESCALATE	Vehicle
HORIZON-CL5-2022-D5-01-10 horizon-cl5-2022-d5-01-10	New generation of full electric urban and peri-urban Bus Rapid Transit systems to strengthen climate-friendly mass transport (2ZERO)	EBRT2030	Vehicle
HORIZON-CL5-2023-D5-01-03 horizon-cl5-2023-d5-01-03	Frugal zero-emission vehicles concepts for the urban passenger challenge (2ZERO)	ZEV-UP	Vehicle
HORIZON-CL5-2021-D5-01-02 horizon-cl5-2021-d5-01-02	Nextgen EV components: Integration of advanced power electronics and associated controls (2ZERO)	SCAPE PowerDrive	Component
HORIZON-CL5-2023-D5-01-02 horizon-cl5-2023-d5-01-02	Innovative battery management systems for next generation vehicles (2ZERO & Batt4EU)	InnoBMS iBattMan	Component
HORIZON-CL5-2021-D5-01-03 horizon-cl5-2021-d5-01-03	System approach to achieve optimised Smart EV Charging and V2G flexibility in mass-deployment conditions (2ZERO)	DriVe2X FLOW XL-CONNECT	Infrastructure
HORIZON-MISS-2023-CIT-01-01 horizon-miss-2023-cit-01-01	Co-designed smart systems and services for user-centred shared zero-emission mobility of people and freight in urban areas (2ZERO, CCAM & Cities' Mission)	metaCCAZE	Miscellaneous

3.20.2 Assessment summary

Table 40: Assessment summary for OO.KPI.6

OO.KPI.6	Development and demonstration of solutions for pervasive, user-friendly, low-cost and interoperable low power (22 kW) and efficient high (~150kW) / ultrahigh-power (~300 kW) charging infrastructure
The following target were defined in the 2ZERO SRIA.	• At least 25% reduction of energy losses during charging (considering both charger and vehicle) by 2030 for all types of chargers

The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2019 Suggested baseline value: 10-25% energy lost
Information was obtained by referring to the following information sources.	○ Public data research ○ Project questionnaires
The following more mature projects have provided input to the assessment of this particular KPI.	○ ESCALATE ○ ZEFES ○ DriVe2X ○ FLOW ○ iBattMan ○ PowerDrive ○ SCAPE ○ XLConnect ○ ZEV-UP ○ EBRT2030 ○ InnoBMS ○ metaCCAZE
Progress has been made towards the development and demonstration of solutions for pervasive, user-friendly, low-cost and interoperable low power.	Partially. ○ At least 25% reduction of energy losses during charging (considering both charger and vehicle) by 2030 for all types of chargers. × ○ Development and demonstration of solutions for pervasive, user-friendly, low-cost and interoperable low-power charging solutions. ✓

Several projects are contributing to advancements in electric vehicle (EV) charging and battery management systems. One project supports European charger manufacturers in developing and expanding functionalities of their charging solutions for V2X, focusing on improving EV charging efficiency. This project also measures real charging profiles and monitors charging efficiency, which varies across the charging session rather than remaining static. This approach allows for a more accurate and realistic consideration of charging efficiency in smart charging.

Another project is developing a modular DC bidirectional charging system to enhance the efficiency and flexibility of future charging and energy management systems. This system aims to provide a more adaptable solution for various charging needs. Additionally, a project is designing a universal modular battery management system (BMS) architecture platform that is technologically agnostic and suitable for a wide range of applications, from electro-mobility to vehicle-to-grid and second-life use cases for current and next-generation battery technologies. This project involves identifying and characterizing advanced sensors, developing virtual sensors and sensor fusion for increased prediction accuracy, and executing a BMS design Failure Modes and Effect Analysis to enhance reliability.

One initiative focuses on increasing the efficiency of onboard chargers, while another project contributes to the improvement of charging efficiency in slow charging. This project devises a fully integrated inverter charger that requires only one power conversion stage for charging from single- and three-phase grids. The converter employs low-loss power semiconductor devices and advanced implementation techniques to further reduce losses. The system is modular, allowing for loss-less inter-module balancing during the charging process.

A project addresses the development of megawatt charging electric vehicle supply equipment (EVSE), contributing to a charging time of 45 minutes to reach 90% state of charge (SOC) and a charging efficiency of 80%. This system is based on proven technology and includes newly developed components and software capable of controlling them. Another project develops bidirectional DC charging equipment with a focus on cost-effective concepts for massive deployment in home and tertiary applications.

One project is developing a vehicle with efficient charging features, including low power home charging capability and battery swap-ability. This vehicle is designed to charge efficiently, even in regions with limited EV charging infrastructure. Another initiative is developing innovations to improve charging efficiency for electric buses, including hybrid battery concepts, advanced SRS solutions and interoperable charging infrastructure. These concepts aim to optimize the efficiency and sustainability of electric bus operations.
A project aims to develop a cutting-edge BMS solution that maximizes battery efficiency and longevity while ensuring safety. Although charging efficiency is not a specific objective of this project, it is a necessary component in achieving the overall project goals. Another project contributes to the improvement of charging efficiency and power range for ultra-fast charging of heavy-duty vehicles. This project develops efficient and interoperable megawatt charging systems, utilizing recent wide bandgap technology and new control systems to provide fast-charging capabilities.
One initiative is developing an automated charging concept and a proof of concept for rapid charging, which can be inductive or robot-based and located in depots or on routes. This concept will be implemented in living labs across different cities, with real-life tests and measurements of electricity use. The project aims to optimize charging schedules and define the types, numbers and locations of chargers needed to support the incoming electric buses.

3.20.3 Assessment in detail

3.20.3.1 Projects' responses

Of the consulted 2ZERO projects, three confirmed they have been working on low-power charging:

- Projects are collaborating with European charger manufacturers to develop and expand the functionalities of their charging solutions for Vehicle-to-Everything (V2X). This includes improving EV charging efficiency and measuring real charging profiles to monitor efficiency, which varies across the charging session.
- They are developing a fully integrated inverter charger for slow charging. This charger uses low conduction- and switching-loss SiC wide band gap power semiconductor devices and multilevel conversion topologies to reduce losses. The system is modular, allowing for loss-less inter-module balancing during the charging process.
- Projects are focusing on cost-effective, low-power charging solutions, aiming to increase charging power range and efficiency.

3.20.3.2 Timing of expected future results

- 2025: Results from DriVe2X, XL CONNECT, ESCALATE (end of year), EBRT2030 (end of year), and ZEFES (mid-year).
- 2026: Completed results from POWERDRIVE and SCAPE (beginning of the year, with testing in charging mode).
- 2027: Final results from iBattMan (June) and ZEV-UP (end of year).

3.20.3.3 Information from other sources

One group of projects is dedicated to developing smart charging strategies and control mechanisms. These strategies aim to maximize EV drivers' satisfaction and the efficiency of the entire energy system by harnessing unused EV storage capacity and integrating renewable energy sources. By optimizing charging behaviours and improving energy management, these projects contribute to a more sustainable and efficient EV ecosystem.
Another set of projects focuses on demonstrating charge efficiency, with a target of achieving at least 80% efficiency. These efforts are crucial for ensuring that EV charging is both effective and reliable, addressing one of the key concerns of EV users.
Additional projects are working on managerial tools and fast charging concepts. These initiatives aim to overcome payload and range limitations, providing practical solutions for long-distance travel and heavy-duty applications. By developing flexible ultra-fast charging concepts, these projects seek to enhance the convenience and usability of EVs for various purposes.

Some projects are specifically targeting efficient, safe and secure flexible bus transport solutions. These projects aim to meet future user demands for convenience in both dense urban centres and less populated peri-urban environments. By developing enabling technologies and solutions, these projects offer a key opportunity to reduce the carbon footprint of the transport sector.

Other projects ensure ease of use in targeted urban and suburban areas by accounting for traffic and parking conditions, as well as the availability of battery charging and swapping points. These projects conduct systematic and thorough analyses of user-centric needs, infrastructure development requirements, and validation with real electric vehicles and battery solutions. By demonstrating the developed functions and optimizing range and battery sizing, these projects aim to match local needs and support future urban vehicle concepts.

Additionally, some projects focus on grid integration, charging infrastructure, vehicle connectivity, automation, smart fleet management, road traffic and energy management, and the safety of vulnerable road users. These projects build upon relevant experiences of cities and partnerships, co-designing implementation plans for local and regional transport authorities to roll out innovative smart mobility solutions and related infrastructure.

3.20.3.4 Progress towards targets

One of the consulted projects has confirmed a 20% increase in charging power, which helps reduce energy losses during the charging process (shorter charging duration, optimized charging profile, improved efficiency of power electronics, and reduced resistance losses). Another project has confirmed the reduction of charging time by 10%, which also contributes to the reduction of energy losses. However, none of the projects could give exact values for the measuring of the reduction of energy lost during low-power charging processes.

3.21 OO.KPI.7: Safe, secure and smooth communication exchange between vehicle and charging infrastructure including communication with the grid and roaming platforms

3.21.1 Related Horizon Europe/2ZERO calls for submissions

Table 41: Horizon Europe/2ZERO calls relating to OO.KPI.7

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2022-D5-01-08 horizon-cl5-2022-d5-01-08	Modular multi-powertrain zero-emission systems for HDV (BEV and FCEV) for efficient and economic operation (2ZERO)	ZEFES ESCALATE	Vehicle
HORIZON-CL5-2022-D5-01-10 horizon-cl5-2022-d5-01-10	New generation of full electric urban and peri-urban Bus Rapid Transit systems to strengthen climate-friendly mass transport (2ZERO)	EBRT2030	Vehicle
HORIZON-CL5-2023-D5-01-02 horizon-cl5-2023-d5-01-02	Innovative battery management systems for next generation vehicles (2ZERO & Batt4EU)	InnoBMS iBattMan	Component
HORIZON-CL5-2021-D5-01-03 horizon-cl5-2021-d5-01-03	System approach to achieve optimised Smart EV Charging and V2G flexibility in mass-deployment conditions (2ZERO)	EV4EU DriVe2X FLOW XL-CONNECT	Infrastructure

3.21.2 Assessment summary

Table 42: Assessment summary for OO.KPI.7

OO.KPI.7	Development and demonstration of solutions for pervasive, user-friendly, low-cost and interoperable low-power (22 kW) and efficient high (~150 kW) / ultrahigh-power (~300 kW) charging infrastructure
The following target was defined in the 2ZERO SRIA.	○ Interoperable charging solutions are available in Europe
The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2019 Suggested baseline value: 2 charging solutions available
Information was obtained by referring to the following information sources.	○ Public data research ○ Project questionnaires ○ Coordinator interviews
The following more mature projects have provided input to the assessment of this particular KPI.	○ EV4EU ○ FLOW ○ iBattMan ○ ESCALATE ○ XLConnect ○ EBRT2030 ○ InnoBMS ○ ZEFES

Progress has been made towards the availability of interoperable charging solutions in Europe.	No. ✗ Solutions are being designed by projects but have not yet been validated or implemented.

3.21.3 Assessment in detail

Existing standards are being tested, and new use cases are identified to optimize the charging process in various infrastructures. Improved communication and simplified data sharing are achieved through the integration of advanced platforms with legacy systems and external stakeholders. Specific connectors are implemented to facilitate these integrations, and additional services are provided to enhance platform capabilities. The outcomes of these integrations are tested and evaluated in demonstration projects.
Communication protocols with external devices, such as bi-directional charging stations and Vehicle-to-everything (V2X) applications, are being defined to improve and optimize battery management and maintenance. Relevant interfaces are developed to allow access to battery management systems (BMS) and their databases by vehicle charging infrastructure and related mobility services providers, with the consent and input of EV drivers. Improved control and communication between the battery and the vehicle control unit enhance performance and early warning capabilities. New simulation tools and test methods are developed for faster development, validation and integration of battery packs, including data from second life and V2X applications.
Safety in communications during hydrogen refuelling for fuel cell applications and fast charging for electric use cases is addressed to ensure secure and efficient operations. Hybrid interoperable charging systems are designed for demonstration projects, integrating depot charging, trolleybus catenary opportunity charging and on-board chargers.
A mobile power charger is being developed and installed in multiple countries to demonstrate its capability to operate with different grids and charge electric vehicles.

3.21.3.1 Projects' responses

Several of the consulted 2ZERO projects have been working on implementing communication protocols:

- One project utilizes ISO15118 and OCPP for secure data exchange between EVs, charging infrastructure, the grid, and roaming platforms.
- Another implements ISO15118 for bidirectional charging/discharging, IEC62196-3 for V2G capability, OCPP2.01 for managing charging station operations, REST for network operations, MQTT for smart charging sessions, and various standard protocols such as WebSocket, TCP, UDP and HTTPS. The project also uses ERC-20 tokens on the Ethereum blockchain and relies on the Polygon network for scalability and cost efficiency. IEC61850 ensures interoperability in grid management.
- A further action uses a range of standardized communication protocols including ISO15118/IEC61850, ChAdeMo, IEEE2030.5, OpenADR, OCCP, OSCP, OCPI, OCHP, OICP and eMIP. The project focuses on smart and bidirectional charging with ISO15118-2 and -20 and OCPP for communication between chargers and management systems.
- One of the projects adopts several standards for CCS2 and MCS, automated charging devices, and vehicle-to-grid power transfer. These include ENIEC 61851, ENISO15118 series, ENIEC 62196 series, and IECTS 62196-3-1 for connectors. CharIN's white paper and upcoming MCS standards are also referenced.
- One project uses high-level communication via Power Line Communication (PLC) and WLAN for automated connection devices, specified in ISO15118-2 and -20.

Fewer of the consulted projects confirm they have been working on the implementation of interoperable charging solutions. While solutions are being developed and designed, they have not been implemented nor demonstrated yet:

- One of the projects plans to implement a new charging station control solution but has not implemented it yet.
- Another will implement a CPO/EMSP e-mobility platform with bidirectional charging, a decentralized market platform for V2X flexibility, a DSO dashboard platform for V2X services, an interoperable

roaming platform for V2X, and an open-source home energy management system (HEMS) for V2H operation in 2025.
- The orchestration platform a project is working on will be validated in demonstrations by late 2025 or early 2026.
- Another project is designing a hybrid interoperable charging system for the Athens demonstration, integrating depot charging, trolleybus catenary opportunity charging and on-board chargers, but has not implemented it yet.

3.21.3.2 Timing of expected future results

- 2025: Results from DriVe2X (Q2), ESCALATE (mid-year), and EBRT2030.
- 2026: Final validation and results from FLOW and completed results from ZEFES (after testing period starting in 2025).
- 2027: Final results from iBattMan (June).
- 2030: Results from EV4EU

3.21.3.3 Progress towards targets

Since the solutions planned by the 2ZERO projects have not been demonstrated yet, the progress towards the target cannot be measured accurately yet.

3.22 OO.KPI.8: Definition of dynamic load management profiles for specific smart and bidirectional charging scenarios by EU funded projects allowing effective grid load management

3.22.1 Related Horizon Europe/2ZERO calls for submissions

Table 43: Horizon Europe/2ZERO calls relating to OO.KPI.8

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2023-D5-01-02 horizon-cl5-2023-d5-01-02	Innovative battery management systems for next generation vehicles (2ZERO & Batt4EU)	iBattMan	Component
HORIZON-CL5-2021-D5-01-03 horizon-cl5-2021-d5-01-03	System approach to achieve optimised Smart EV Charging and V2G flexibility in mass-deployment conditions (2ZERO)	EV4EU DriVe2X FLOW SCALE XL-CONNECT	Infrastructure
HORIZON-MISS-2023-CIT-01-01 horizon-miss-2023-cit-01-01	Co-designed smart systems and services for user-centred shared zero-emission mobility of people and freight in urban areas (2ZERO, CCAM & Cities' Mission)	MOBILITIES FOR EU	Miscellaneous

3.22.2 Assessment summary

Table 44: Assessment summary for OO.KPI.8

OO.KPI.8	Development and demonstration of smart charging and bi-directional energy services solutions accepted by the users and providing services to the energy grid
The following targets were defined in the 2ZERO SRIA.	• Development and testing of commonly agreed protocols for V2G for efficient integration with the grid, storage and smart charging • Number of projects delivering deployment plan of parking spots and logistics facilities combined with smart charging strategies
The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2019 Suggested baseline value: 3 protocols
Information was obtained by referring to the following information sources.	o Public data research o Project questionnaires
The following more mature projects have provided input to the assessment of this particular KPI.	o EV4EU o DriVe2X o FLOW o iBattMan o SCALE o XLConnect o MOBILITIES FOR EU
Progress has been made towards the development and demonstration of smart	o Yes.

charging and bi-directional energy services solutions.	○ Development and testing of commonly agreed protocols for V2G for efficient integration with the grid, storage and smart charging. ✓ ○ Number of projects delivering deployment plan of parking spots and logistics facilities combined with smart charging strategies. ✓✓

3.22.3 Assessment in detail

Specific demand response programs for EVs are being created to optimize the charging process and manage energy use more effectively. Dynamic load management is being improved through the development of better algorithms for forecasting EV charging needs and energy prices, supporting EV decision-making. These improvements include optimizing EV load management profiles, considering uncertainty in EV management and integrating degradation into the EV charging optimization process. Additionally, business models supporting these load management profiles are being developed and tested in various demonstration projects.

Novel adaptable models independent of cell chemistry are being developed through workflows that translate specific physics-based models into machine learning models. Real-time BMS connectivity with IoT, cloud and a network of BMS nodes is designed to enable continuous recording of critical data during first and second life operations. Interfaces for Vehicle-to-Everything (V2X) use cases are being defined and implemented, along with secure and reliable communication addressing cybersecurity concerns. Second life applications in smart grid setups are also being designed and implemented.

Efforts to develop vehicle-to-home, vehicle-to-depot, vehicle-to-business and vehicle-to-grid functionality are underway. Small-scale bidirectional charging systems are being implemented and tested in real-world settings, with simulation models developed and validated based on data from these implementations. These simulations assess the potential impact of large-scale bidirectional charging deployment on grid stability, energy efficiency and CO_2 reduction, providing insights for future scaling of these technologies in urban environments.

3.22.3.1 Projects' responses

Three of the consulted 2ZERO projects are actively working on and testing V2G capabilities and commonly agreed protocols, but only one of them specified ISO15118-20.

Two of the consulted 2ZERO projects are actively working on deployment plans for parking spots and logistics facilities with smart charging strategies. They estimate that currently about 10% of the facilities have deployed smart charging functionalities and plan to increase that percentage to 15% during project duration.

3.22.3.2 Timing of expected future results

- 2025: Results from SCALE.
- 2026: Completed results from DriVe2X and FLOW (including final results for demonstrations and testbeds).
- 2027: Final results from iBattMan (June).
- 2028: Final evaluation from MOBILITIES FOR EU (December).
- 2030: Results from EV4EU.

3.22.3.3 Information from other sources

Public data sources such as CORDIS and the Horizon Dashboard reveal that some 2ZERO projects aim to assist drivers and passengers in making optimal decisions regarding charging points and overall trip planning. This includes considerations of cost, waiting time and additional services provided to both drivers and vehicles.

A significant aspect of these projects is the understanding of the operational and economic impacts of smart and bidirectional (V2G) charging approaches. This includes evaluating installation costs, potential battery damage or degradation and the overall costs for different stakeholders involved. By assessing

customer expectations and implementing open architectures for smart and bidirectional charging solutions, these projects aim to create a mutually beneficial charging experience for both users and the grid.
The projects also focus on quantifying the impact of various bidirectional charging profiles on the life of electric vehicle (EV) batteries and power electronics. This involves collecting, exchanging and managing relevant data, particularly in relation to the battery management system. The development of smart charging strategies and control mechanisms is intended to maximize EV driver's satisfaction and the efficiency of the entire energy system. This includes increasing the use of renewable electricity sources by harnessing unused EV storage capacity, while minimizing the need for grid reinforcements and additional energy generation.
Furthermore, they demonstrate the potential of V2X (Vehicle-to-Everything) technology in promoting renewable energy growth. By integrating low-power renewable energy sources, such as photovoltaics on rooves or in parking lots, they aim to reduce energy exchange with the grid by 50%.
In addition to these technical advancements, other projects focus on power grid integration, charging infrastructure, vehicle connectivity, automation, smart fleet management, road traffic and energy management, and the safety of vulnerable road users. These projects build upon the experiences of cities and partnerships to develop integrated, shared, automated and zero-emission solutions for both people mobility and freight transport. This includes designing vehicles and functions, developing specific infrastructures for energy and data management, and implementing innovative smart mobility solutions.
The projects also emphasize the importance of co-designing implementation plans with local and regional transport authorities to roll out smart mobility solutions and related infrastructure, particularly for charging and connectivity. This collaborative approach aims to lower energy demand and develop skills within local authorities for planning and implementing smart, shared and zero-emission urban mobility systems.
Browsing through the web pages of these projects provides additional insights. For instance, one project focuses on decarbonizing and alleviating stress on the grid through smart charging, fostering cross-sector harmonization of charging infrastructure, and developing interoperable solutions to boost V2X. Another project emphasizes user-centric management strategies to enable the growth of electric vehicle market, integrating renewable energy production in buildings and parking lots, and managing the impact of electric vehicles on the grid.

Other projects are testing and validating next-generation bidirectional chargers across multiple demonstration sites in Europe, using AI and machine learning to capture flexibility potential. They aim to accelerate the uptake of vehicle electrification through new bidirectional smart charging technologies and widespread awareness of V2X.

3.22.3.4 Progress towards targets

Three of the consulted 2ZERO projects are actively working on and testing V2G capabilities and commonly agreed protocols, but only of them specified ISO15118-20.
Two of the consulted 2ZERO projects are actively working on deployment plans for parking spots and logistics facilities with smart charging strategies.

3.23 OO.KPI.9: Demonstrated charging operations answering the freight and logistics requirements avoiding logistics losses

3.23.1 Related Horizon Europe/2ZERO calls for submissions

Table 45: Horizon Europe/2ZERO calls relating to OO.KPI.9

Topic ID	Topic Title	Related Projects	Group
HORIZON-CL5-2023-D5-01-02 horizon-cl5-2023-d5-01-02	Innovative battery management systems for next generation vehicles (2ZERO & Batt4EU)	InnoBMS	Component
HORIZON-CL5-2021-D5-01-03 horizon-cl5-2021-d5-01-03	System approach to achieve optimised Smart EV Charging and V2G flexibility in mass-deployment conditions (2ZERO)	SCALE	Infrastructure
HORIZON-CL5-2022-D5-01-08 horizon-cl5-2022-d5-01-08	Modular multi-powertrain zero-emission systems for HDV (BEV and FCEV) for efficient and economic operation (2ZERO)	ZEFES ESCALATE	Vehicle

3.23.2 Assessment summary

Table 46: Assessment summary for OO.KPI.9

OO.KPI.9	Development and demonstration of smart charging and bi-directional energy services solutions accepted by the users and providing services to the energy grid
The following targets were defined in the 2ZERO SRIA.	• N/A
The following baseline was suggested to coordinators in the questionnaire they received.	Suggested baseline year: ~ 2019 Suggested baseline value: 0
Information was obtained by referring to the following information sources.	○ Public data research ○ Project questionnaires
The following more mature projects have provided input to the assessment of this particular KPI.	○ SCALE ○ ESCALATE ○ InnoBMS ○ ZEFES
Progress has been made in demonstrating charging operations answering freight and logistics requirements.	Yes. ○ Charging procedures along the transport logistics value chain are being planned, optimized and tested. ✓✓✓ ○ Hydrogen infrastructure is being integrated in projects. ✓✓ ○ Fast chargers are being rolled out to replace old ones, to minimize downtime. ✓✓

3.23.3 Assessment in detail

A model has been developed to predict the monetary impact of bidirectional charging on logistics, providing valuable insights for optimizing costs and efficiency.

Innovative refuelling and grid- and user-friendly charging solutions for heavy-duty vehicles (HDVs) are being developed and defined. These solutions include the study and further development of associated charging and refuelling interfaces and protocols, with a strong emphasis on safety aspects, including explosion-proof features. The goal is to boost the adoption of electric trucks by logistics companies.
Charging procedures along the transport logistics value chain are being planned, optimized and tested. This includes reviewing depot charging and enroute charging/refuelling in both simulation and operational scenarios to ensure efficiency and reliability.

3.23.3.1 Projects' responses

Two projects confirmed they are working on the integration of charging solutions with logistics management systems:

- One project integrates hydrogen infrastructure and end-users (carriers, logistics service providers and cargo owners) for daily operations in real conditions, aligning with drive and resting time regulations. It utilizes a multi-fuel station (G-MFS) for fast recharging of fuel cell trucks during cross-border demonstrations.
- The other is rolling out new chargers and include existing ones. The logistics network design may change over time, allowing access to new charger locations and leading to new network design possibilities for charging/refuelling. Multiple trips/uses per vehicle per day are planned. The use of fast chargers leads to limited charging time, minimizing downtime for logistics purposes.

3.23.3.2 Timing of expected future results

- 2025: Results from SCALE and ZEFES (Q2).
- 2026: Completed results from ESCALATE (mid-year, with the end of the demonstration).

3.23.3.3 Progress towards targets

At least two of the consulted projects have been demonstrating new charging solutions with the logistics requirements in mind.

3.24 OO.KPI.10: Breakdown of EU funding across stakeholder types

Table 47: Stakeholder types and share of funding

Legal Entity Type	Signed Grants	Participation	Unique Participants	Net EU Contribution	Total Cost
Total	**32**	**672**	**479**	**300 693 827**	**361 091 178**
Higher or Secondary Education Establishments	31	109	61	50 237 320	50 237 574
Other	18	52	38	16 613 948	16 613 949
Private for-profit entities (excluding Higher or Secondary Education Establishments)	32	394	310	163 626 241	224 023 334
Public bodies (excluding Research Organisations and Secondary or Higher Education Establishments)	6	22	21	13 305 482	13 305 482
Research Organisations	29	95	49	56 910 836	56 910 839

3.25 OO.KPI.11: Breakdown of members in the association

The 2ZERO Partnership has the following current member structure:

- 15 OEMs
- 27 automotive suppliers
- 4 smart system industry
- 4 smart grid industry
- 1 logistics operator and freight transport user
- 24 research organisations
- 30 universities
- 19 associate members

3.26 OO.KPI.12: Share of funding going to SMEs

So far, the share of funding that has gone to SMEs in 2ZERO projects is 16.93%.

3.27 OO.KPI.13: Number of organisations reached in the engagement activities of projects

285 organisations have been reached in the engagement activities (advisory boards, dissemination efforts) of 2ZERO projects so far.

3.28 OO.KPI.14: Number of projects launching standardisation activities

One 2ZERO project has launched one standardisation activity during the 2ZERO Work Programme so far.

3.29 OO.KPI.15: Number of standardisation committee working on topics related to the partnership area

So far, three standardisation committees have been working (at least partly) in the areas covered by the 2ZERO Partnership: CEN (European Committee for Standardization), CENELEC (European Committee for Electrotechnical Standardization) and ETSI (European Telecommunications Standards Institute) during the 2ZERO Work Programme.

3.30 OO.KPI.16: IPR generated in funded projects

So far, during 2ZERO Work Programme, no 2ZERO project has confirmed an approved IPR item. However, one of the projects submitted a patent application.

3.31 OO.KPI.17: Number of publications from funded projects

2ZERO projects have reported 40 publications so far during the years 2021-2024 of the 2ZERO Work Programme.

3.32 OO.KPI.18: 2ZERO contribution to roadmaps preparation

2ZERO members have contributed to the preparation of the following roadmaps:

- **ERTRAC**: Circular Economy and Competitiveness of the European Road Transport (2025); Integrated Urban Mobility Roadmap (2024); ERTRAC-2Zero-CCAM Position paper on Road Transport Research (2024); Paving the way for Infrastructure and Long Distance Freight Transport cooperation (2024); Decarbonizing Freight Transport with available green energy (2024); Connected, Cooperative and Automated Mobility (2022); A Mapping of Technology Options for Sustainable Energies and Powertrain for Road Transport (2022); Safe Road Transport Research (2021); Urban Mobility Resilience (2021); New Mobility Services (2021)
- **BEPA**: Fast Charge – Definition & Requirements Position Paper (2021), Mobility Applications and Integration WG
- **Hydrogen Europe**: Hydrogen Standardisation (2023)
- **CCAM**: ERTRAC-2Zero-CCAM Position paper on Road Transport Research (2024),

3.33 OO.KPI.19: SRIA updates

The 2ZERO SRIA has been updated once. The update was published in March 2024.

3.34 OO.KPI.20: Number of policy recommendations issued by funded projects

Two policy recommendations have been reported by 2ZERO projects so far.

3.35 OO.KPI:21: Total number of events organised by funded projects

234 events have been organised by 2ZERO projects so far.

3.36 OO.KPI.22: Number of events organised by the organisation

2ZERO has organised 35 events so far. This number does not include internal meetings, meetings of the General Assembly, SRG meetings and meetings of the Partnership Board.

3.37 OO.KPI.23: Number of events organised by supporting platforms

2ZERO currently has 20 associated members and is supported by at least two European Technology Platforms.

3.38 OO.KPI.24: Number of professionals trained in funded projects

1045 professionals (category C and D researchers) have worked and been trained in 2ZERO projects so far.

3.39 **OO.KPI.25**: Number of training materials provided by funded projects

This number could not be obtained for the initial assessment of the Direct KPIs, because the periodic reporting structure of the projects did not allow for it.

3.40 **OO.KPI.26** Number of members of the public reached by funded projects

10 2ZERO projects reported to have reached members of the public with their outreach and dissemination activities. The exact numbers could not be obtained due to the phasing of the periodic reporting.

PROJECT DEEP-DIVE ANALYSIS

The following section highlights some of the key findings of the deep-dive analysis, related to the projects' contributions to the 2ZERO Objectives and considerations of the impact pathways.

6.1 ESCALATE

ESCALATE is designed to advance zero-emission mobility through the deployment of interoperable, scalable charging technologies and integration with renewable energy systems. Its overarching goal is to facilitate a holistic transition to electric mobility in both urban and peri-urban areas.

6.1.1 Project Background and Overview

Table 48: Overview of ESCALATE project

Title	**Powering EU Net Zero Future by Escalating Zero Emission HDVs and Logistic Intelligence**		
Start Date	01/01/2023	**Legal Basis**	HORIZON.2.5
End Date	30/06/2026	**Topics**	HORIZON-CL5-2022-D5-01-08
Total Cost	€ 22,401,515.43	**EC Signature Date**	13/12/2022
EC Maximum Contribution	€ 16,594,389.50	**Framework Programme**	HORIZON EUROPE
Grant DOI	10.3030/101096598	**Funding Scheme**	HORIZON-IA
Coordinator	FEV	**Cluster**	AEVETO
Reporting Period 1	01/01/2023 – 30/06/2024	***Le*Mesurier Evaluation**	January 2025
Reporting Period 2	01/07/2024 – 31/12/2025		
Reporting Period 3	01/01/2026 – 31/08/2026		

6.1.2 Partners

- A consortium of 37 partners from 13 countries is dedicated to increasing component efficiency, developing highly standardizable, ingenious, scalable and modular eco-designed electric powertrain components and flexible platforms for battery, fuel cell and range extender trucks.

- The consortium provides a good foundation through its coherent structure and a balanced partnership that aims to achieve the greatest benefits from a technological and market perspective.

6.1.3 Use Cases/ Living Labs

The ESCALATE project is running five Heavy-Duty Vehicle (HDV) pilots across Europe to innovate using Multidimensional Innovative Behaviour (MIB). These pilots bring together manufacturers, end-users, and implementers. Here is a brief overview:

- Pilot 1 (Finland): Flexible 40-ton HDV prototype for regional & long-haul use with a single refill/charge. Routes: Helsinki–Jyväskylä.

- Pilot 2 (Germany, France, Turkey): Fuel-cell tractor-truck with a brief refuelling time. Routes: Munich–Paris (800 km) & Istanbul region (510 km).

- Pilot 3 (Turkey, Bulgaria): Battery-electric truck for long-haul transport. Route: Istanbul–Sofia (510 km).
- Pilot 4 (UK, Germany): Battery-electric refrigerator truck with photovoltaic panels. Routes: Stuttgart–Flensburg (800 km) & Cwmbran–Dundee (500 km).
- Pilot 5 (France, Spain, Switzerland): Virtual long-haul fuel cell vehicle using modular electric powertrain. Route: Geneva–Lyon–Barcelona (800 km).

Each pilot is tailored to specific use cases and regions while promoting collaboration and innovation in sustainable HDV technologies.

6.1.4 Data collection project outputs

Documents included in the deep-dive analysis:

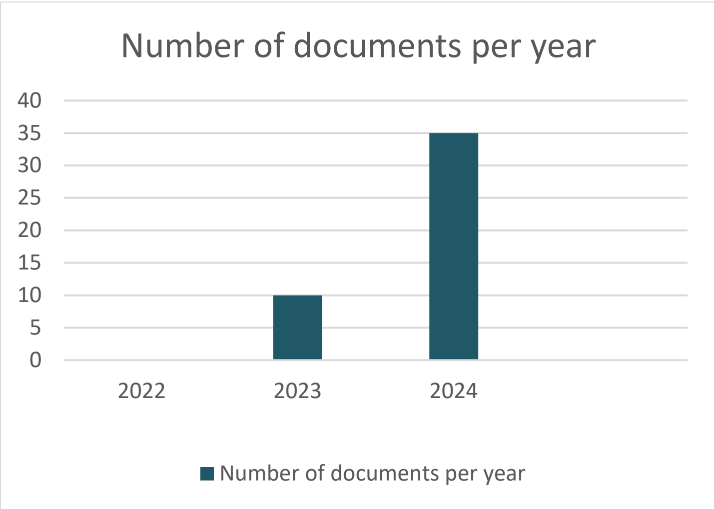

Figure 22: Year-wise breakdown of reviewed documents (ESCALATE Project)

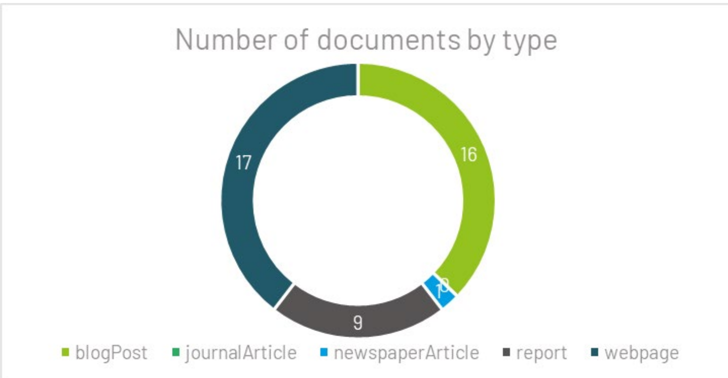

Figure 23: Distribution of document types reviewed in the ESCALATE Project deep-dive analysis

6.1.5 Key Contributions to 2ZERO Objectives

Accelerating Electrification

- **Interoperability and Scalability:** By developing and demonstrating charging solutions that function across a range of vehicle types and regions, ESCALATE directly supports one of 2ZERO's core aims: to develop new reliable and affordable solutions which are tailor-made for zero emission vehicles, which do not introduce compromises in terms of safety and performance (including noise and vibration) - 2ZERO SRIA, 2024, page. 48. [18] [19] [20] .

- **Synergy with Renewables:** Integrating charging infrastructure with renewable energy generation promotes sustainable growth and helps reduce the carbon footprint of the operations.

Reducing Emissions in Transport

- **Targeted Emissions Reduction:** Leveraging advanced energy management systems (e.g. smart charging algorithms or load balancing) helps reduce peak energy consumption and overall emissions, thus propelling 2ZERO's target of minimizing carbon emissions in the transport sector[21] [22] [23].

Economic and Societal Impacts

- **Business Models and Tools:** The project's exploration of innovative financing models and its development of city-level planning tools bolster the commercial viability of zero-emission systems — an important 2ZERO focus area [20] [24] [25] [26].
- **Stakeholder Engagement:** Partnerships among municipalities, industry players and communities serve to amplify the potential impact and foster wider acceptance of zero-emission mobility options[27] [28] [29].

6.1.6 Impact Pathway

- **Technology Development and Validation**: Demonstration of EV charging solutions across multiple sites builds confidence among policymakers and investors[30].
- **Market Uptake**: Once validated, these solutions can be replicated in cities and communities across the EU, leading to broad-scale market uptake of zero-emission vehicles [31].
- **Policy Influence**: Project findings can inform policy frameworks and standardization efforts (e.g., charging protocols), ensuring that regulations keep pace with technological advancements[32].

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[25] 'Goals & Impact', Escalate-eu. Accessed: Dec. 10, 2024. [Online]. Available: https://www.escalate-eu.com/goals-impact/
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- **Long-Term Societal Benefits**: Over time, reduced reliance on fossil fuels and the proliferation of green energy solutions contribute to improved air quality, noise reduction and healthier environments.

6.1.7 Reconstructed Theory of Change

ESCALATE focuses on empowering communities and industries to adopt circular economy models, thereby addressing resource inefficiency and environmental degradation. The project's outputs include tools for waste reduction, training programmes for entrepreneurs and frameworks for monitoring progress. These outputs produce outcomes such as increased reuse and recycling rates, creation of green jobs and heightened awareness of circular practices among stakeholders. By embedding circularity into supply chains, ESCALATE drives systemic changes that diminish environmental footprints and build more resilient local economies, culminating in its broader impact of sustainable production and consumption patterns.

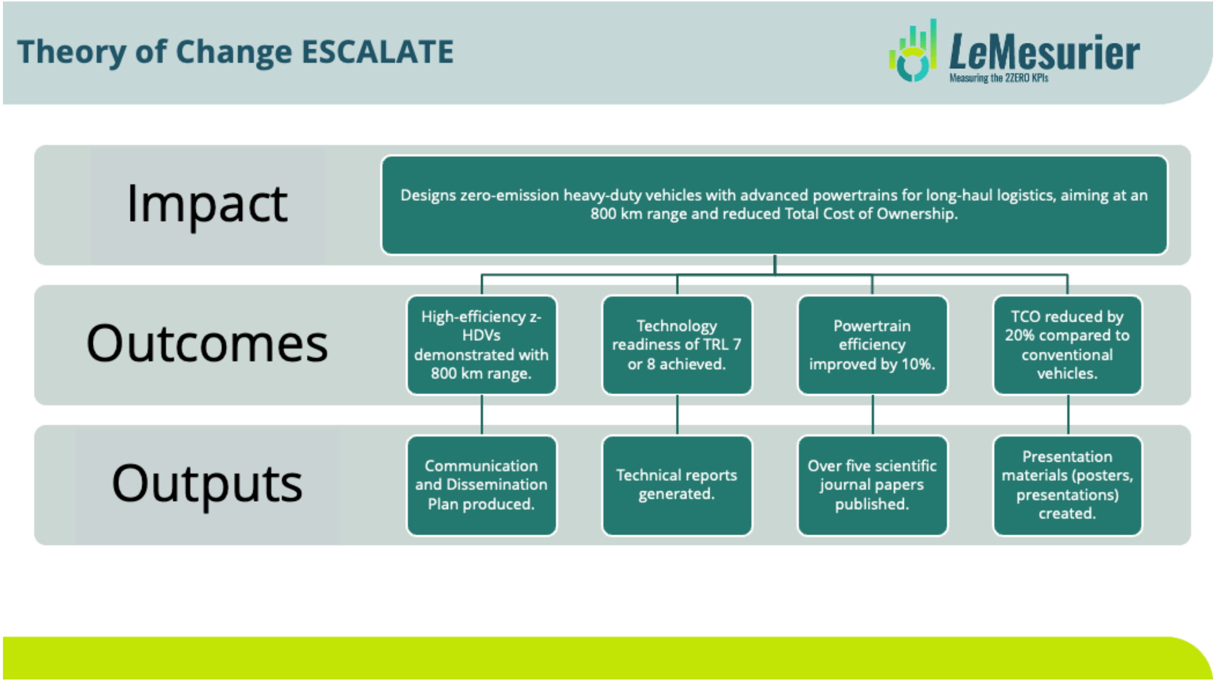

Figure 24: Theory of Change ESCALATE project

6.1.8 Observed Strengths and Achievements

- **Strong Consortium and Collaboration:** A multidisciplinary approach involving research institutions, municipalities and private sector stakeholders has been effective in combining expertise and securing buy-in from relevant parties[33] [34].
- **Holistic Systems Approach:** ESCALATE has emphasized integrating charging infrastructure with energy systems (renewable sources and storage solutions), addressing both immediate mobility needs and broader sustainability objectives[35].
- **Scalability Potential:** The modular nature of the developed solutions enhances replicability, making it easier to transfer lessons learned to other regions.

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6.1.9 Challenges and Areas for Further Focus

- **Regulatory Alignment:** Inconsistent regulations and permitting processes across regions can hamper rapid scalability. Harmonizing policies and providing clear incentives at multiple governance levels would enhance progress[36].
- **Cost and Business Viability:** While advanced technologies can demonstrate strong environmental benefits, stakeholder concerns around high initial costs and uncertain returns need to be addressed more explicitly.
- **User Adoption:** Improving user awareness and confidence in the reliability and interoperability of charging systems remains an ongoing challenge.

6.1.10 Recommendations

- **Strengthen Interoperability Standards:** Encourage ESCALATE's engagement in shaping EU-wide interoperability standards and guidelines to simplify infrastructure integration and reduce market fragmentation.
- **Enhance Policy Advocacy:** Facilitate dialogue with policymakers to streamline permitting processes, offer targeted incentives and clarify governance structures around EV infrastructure deployment.
- **Foster Innovation in Financial Models:** Continue exploring and refining new financing approaches (e.g., public-private partnerships and pay-per-use models) that reduce upfront costs and risks for both public and private stakeholders.
- **Intensify Stakeholder Engagement:** Build on existing collaborations by including more community-led initiatives, consumer-awareness campaigns and training programmes for local authorities to further drive adoption.
- **Leverage Data and Monitoring:** Utilize real-time data from pilots to refine system performance and build a stronger evidence base that demonstrates the economic and environmental benefits of ESCALATE's solutions.

ESCALATE contributes significantly to the goal of transitioning Europe's transport sector to zero emissions. Its holistic approach — focusing on scalable charging technology, renewables integration and stakeholder collaboration — can serve as a blueprint for other zero-emission initiatives. By continuing to harmonize regulations, refine business models and boost stakeholder engagement, ESCALATE can further accelerate market uptake and solidify its impact on reducing transportation emissions across the EU.

6.2 EBRT2030

EBRT2030 aims to revolutionize urban mobility with sustainable, zero-emission electric Bus Rapid Transit (eBRT) systems. It emphasizes CO_2 reductions, interoperable charging standards, scalability through replication and innovative charging infrastructure. The project promotes flexible, economically viable eBRT solutions that boost passenger capacity, enhance speed and shift urban transport towards public options. Its focus on emissions reduction aligns with cleaner energy goals.

6.2.1 Project Background and Overview

Table 49: Overview of EBRT2030 project

Title	**European Bus Rapid Transit of 2030: electrified, automated, connected**		
Start Date	01/01/2023	**Legal Basis**	HORIZON.2.5

[36] D. Crousle, ESCALATE, 'D4.2 Refueling Solutions and Protocols', 2024.

End Date	31/12/2026	**Topics**	HORIZON-CL5-2022-D5-01-10
Total Cost	€ 30,491,980.11	**EC Signature Date**	19/12/2022
EC Maximum Contribution	€ 22,776,213.57	**Framework Programme**	HORIZON
Grant DOI	10.3030/101095882	**Funding Scheme**	HORIZON-IA
Coordinator	UITP	**Cluster**	Sub-urban / urban mobility
Reporting Period 1	01/01/2023 - 30/06/2024	***Le*Mesurier Evaluation**	November 2024 – January 2025
Reporting Period 2	01/07/2024 – 01/12/2025		
Reporting Period 3	01/01/2026 – 01/12/2026		

6.2.2 Partners

- The EBRT2030 project involves 49 partners from various sectors.
- These partners include public transport associations, research institutions, technology and engineering companies, bus manufacturers and public transport operators.

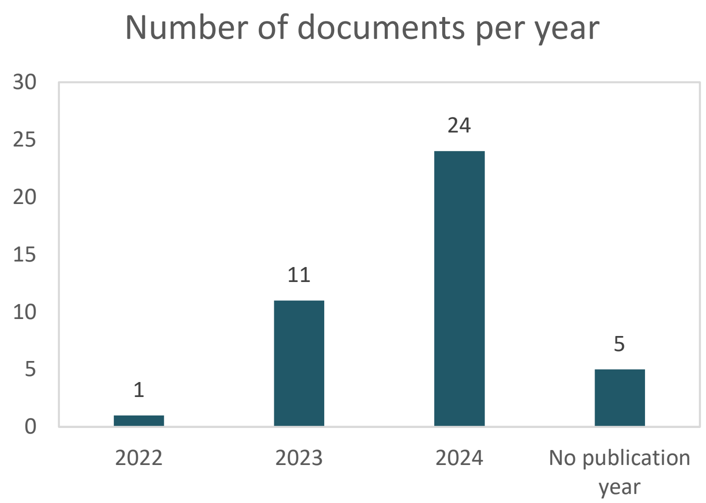
6.2.3 Use Cases/ Living Labs

This project involves seven demonstration sites across Europe (Barcelona, Amsterdam, Athens, Prague, Rimini and the Eindhoven Region) and Colombia (Bogotá). These sites act as living lab's to test and validate innovative electric Bus Rapid Transit (eBRT) solutions in real-world conditions. The project is structured into 10 Work Packages, including management, system requirements, innovative technology development, automation, implementation, global evaluation, feasibility studies and dissemination efforts. This initiative drives sustainable, reliable, and zero-emission urban transit solutions globally.

Figure 25: Overview of EBRT2030 Living Labs

6.2.4 Data collection project outputs

Documents included in the deep-dive analysis:



*No Publication Year- No year of publication given

Figure 26: Year-wise breakdown of reviewed documents (EBRT2030 Project)

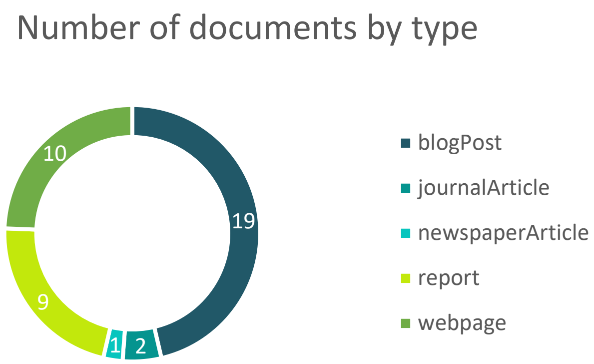


Figure 27: Distribution of document types reviewed in the EBRT2030 Project deep-dive analysis

6.2.5 Key Contributions to 2ZERO Objectives

Accelerating Electrification

- Develops comprehensive eBRT systems, advancing vehicle infrastructure and connectivity technologies[37].
- Focuses on innovative reliable charging solutions, addressing range anxiety and improving efficiency.
- Supports standardization to ensure interoperability, fostering scalability.
- Conducts real-world validations at seven demonstration sites, proving eBRT viability[38] [39].

Reducing Emissions in Transport

- Aims for CO_2 emission reductions: 70% during operation and 50-85% over the life cycle[40].
- Promotes zero-emission buses, improving air quality and reducing tailpipe emissions.
- Addresses urban air and noise pollution, enhancing environmental quality.

[37] European Commission, 'GRANT AGREEMENT Project 101095882 — EBRT2030', 2022.
[38] F. Grazian et al., 'On the Road to a Concept for BRT', EBRT2030, Project Report, 2024.
[39] G. Flavio, EBRT, 'D1.1 Project Management Plan', 2023.
[40] EBRT2030, 'About', EBRT2030. Accessed: Dec. 03, 2024. [Online]. Available: https://EBRT2030.eu/about/

- Aligns with the European Green Deal and 2ZERO Partnership goals as it contributes to the action plan of Innovative zero emission people mobility solutions in urban, peri-urban and rural areas, to support large-scale implementation (2ZERO SRIA, 2024, page. 80) [Pg-110-20]..

Economic and Societal Impacts

- Targets 10% reductions in both cost per kilometre per passenger and Total Cost of Ownership (TCO).
- Enhances passenger experience and accessibility, encouraging public transport use.
- Builds knowledge and capacity through toolkits and training programmes for stakeholders[41].
- Supports economic development by catalysing market growth and job creation.
- Encourages collaboration with related projects, increasing acceptance of e-mobility solutions.

6.2.6 Impact Pathway

- **Technology Development and Validation:** Demonstrations across seven diverse sites validate eBRT solutions, showcasing real-world feasibility and effectiveness to boost stakeholder confidence[42].
- **Market Uptake:** Focus on scalable, replicable solutions ensures wider adoption, supported by feasibility studies and knowledge-sharing resources.
- **Policy Influence:** Evidence-based findings and best practices inform urban transport policies, aligning with European Green Deal goals.
- **Long-Term Societal Benefits:** Successful implementation reduces reliance on fossil fuels, enhances air quality, lowers noise pollution and improves urban living environments.

6.2.7 Reconstructed Theory of Change

EBRT2030 envisions modernizing and electrifying Bus Rapid Transit (BRT) systems to accelerate the shift toward cleaner and more efficient public transportation. The project's outputs, including the introduction of reliable e-bus fleets, strategic route planning and inclusive stakeholder collaboration, yield immediate outcomes of improved service quality and ridership growth. As these outcomes are sustained, they reduce traffic congestion and greenhouse gas emissions. This bolsters long-term climate resilience, enhances urban mobility and paves the way for inclusive economic development, thus achieving the desired overall impact.

[41] C. van Hek, EBRT, 'D10.1 Dissemination & Communication Strategy', 2023.
[42] UITP Press Office, 'Press Release. Electric And Innovative Bus Rapid Transit For Greener Cities: Uitp Coordinates New Flagship Project On Electric Mobility', 2023.

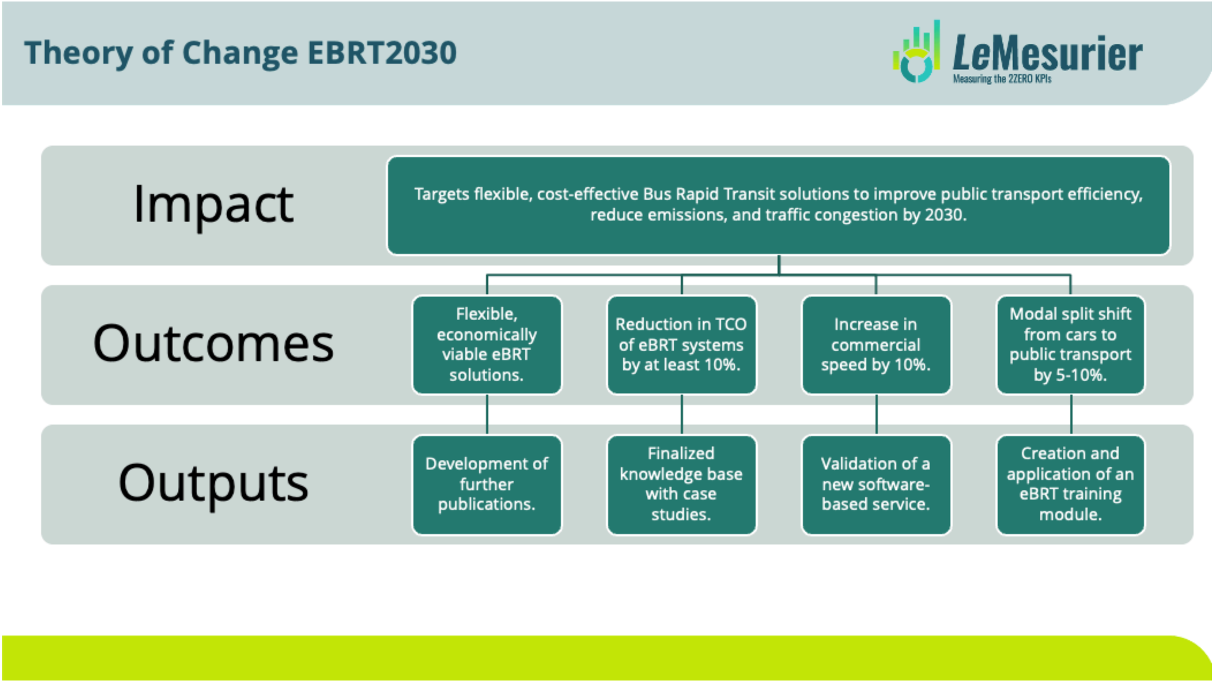


Figure 28: Theory of Change EBRT2030 project

6.2.8 Observed Strengths and Achievements

- **Strong Consortium and Collaboration:** A multidisciplinary consortium ensures diverse expertise and stakeholder engagement[43].
- **Holistic Systems Approach:** Tackles all eBRT deployment components, from electric buses to IoT connectivity.
- **Scalability and Replicability Potential:** Develops solutions for diverse urban contexts, emphasizing broader applicability[44].
- **Knowledge Creation and Sharing:** Provides toolkits, training and open science infrastructure for capacity building.
- **Alignment with Goals:** Sets ambitious emissions and cost-efficiency targets, contributing to key European environmental objectives.

6.2.9 Challenges and Areas for Further Focus

- **Multi-Level Governance and Policy Coordination:** Effective coordination among authorities is critical; inconsistent regulations and investment strategies require clearer governance frameworks.
- **Economic Sustainability and Funding Models:** High initial costs demand exploration of public-private partnerships and innovative financing mechanisms.
- **Data Availability and Standardisation:** Reliable data collection and sharing protocols are essential for effective analysis and replication.
- **Interoperability and Technology Standardisation:** Seamless integration of vehicles, infrastructure and systems needs further industry-wide standardisation efforts.
- **Stakeholder Engagement and Public Acceptance:** Addressing user concerns and engaging public transport operators, policymakers and communities remain vital.

[43] EBRT2030, ‘Advanced technologies for operational efficiency and better passenger experience: Interview Start Romagna’, EBRT2030. Accessed: Dec. 03, 2024. [Online]. Available: https://EBRT2030.eu/advanced-technologies-for-operational-efficiency-and-better-passenger-experience-interview-start-romagna/
[44] B. M. Sodiro, EBRT, ‘D1.5 Data Management Plan’, 2024.

6.2.10 Recommendations

- **Strengthen Multi-Level Governance Frameworks:** Develop clear guidelines for collaboration and consistent policy frameworks to streamline eBRT deployment.
- **Enhance Sustainable Funding Models:** Explore diverse funding mechanisms, including green finance initiatives and public-private partnerships, to reduce financial barriers.
- **Promote Data Standardisation:** Create common data protocols and secure platforms for knowledge sharing across stakeholders.
- **Drive Interoperability Efforts:** Support the adoption of industry-wide standards and modular design principles for seamless technology integration.
- **Intensify Stakeholder Engagement:** Raise public awareness with targeted strategies and enhance collaboration through consultations and pilot projects.

The EBRT2030 project supports the 2ZERO Partnership's goals by establishing sustainable, efficient eBRT systems. The project's focus on CO_2 reduction targets, a new European eBRT concept and zero-emission public transport lays the groundwork for decarbonising urban mobility. By promoting international cooperation and user-friendly designs, EBRT2030 drives the adoption of electric public transport. Key to its success will be stakeholder engagement, scaling pilot successes and aligning eBRT systems with urban mobility plans.

6.3 EV4EU

EV4EU focuses on user-centric Vehicle-to-Everything (V2X) strategies to accelerate EV adoption across Europe. The project emphasizes smart charging (V1G), bidirectional charging (V2G/V2X) and the development of tools and business models for EV integration. Real-world tests in Denmark, Greece, Portugal and Slovenia evaluate solutions for scalability and interoperability. By addressing user needs, promoting renewable energy coordination and supporting carbon neutrality goals, EV4EU paves the way for a sustainable, user-friendly EV ecosystem.

6.3.1 Project Background and Overview

Table 50: Overview of EV4EU project

Title	**Electric Vehicles Management for carbon neutrality in Europe**		
Start Date	06/01/2022	**Legal Basis**	HORIZON.2.5
End Date	11/30/2025	**Topics**	HORIZON-CL5-2021-D5-01-03
Total Cost	€ 8,989,682.00	**EC Signature Date**	05/02/2022
EC Maximum Contribution	€ 8,989,682.00	**Framework Programme**	HORIZON
Grant DOI	10.3030/101056765	**Funding Scheme**	HORIZON-RIA
Coordinator	University Lisbon	**Cluster**	Charging
Reporting Period 1	01/06/2022 – 30/11/2023	***Le*Mesurier Evaluation**	November – December 2024
Reporting Period 2	01/12/2023 – 31/05/2025		
Reporting Period 3	01/06/2025 – 31/01/2026		

6.3.2 Partners

- The EV4EU project involves 26 partners from various sectors.
- These partners include public transport associations, research institutions, technology and engineering companies, bus manufacturers, and public transport operators.

6.3.3 Use Cases/ Living Labs

The project focuses on developing innovative tools, methodologies and solutions that address the impact on vehicles, user needs, the environment, power systems, business models and urban transformation. Strategies will be tested at four demonstration sites in Denmark, Greece, Portugal and Slovenia, enabling evaluation, consolidation of promising solutions and aligning business models. These efforts aim to coordinate electric vehicles with renewables, reduce greenhouse gas emissions, and decarbonize road transport.

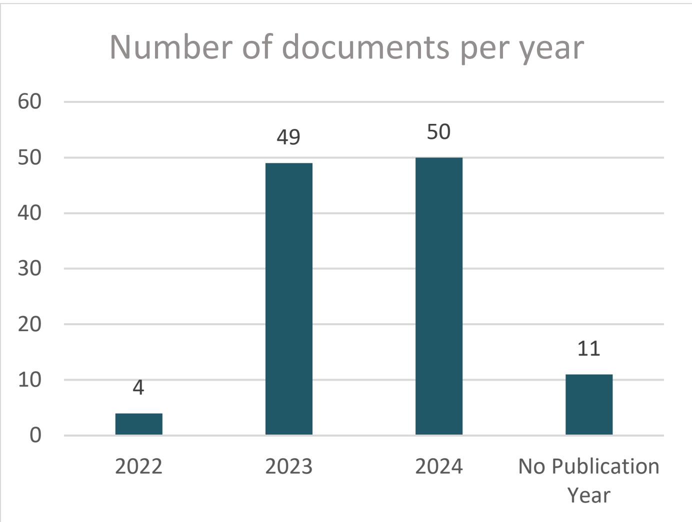
Demonstration sites:

Figure 29: Overview of EV4EU Living Labs

- **Portugal (São Miguel, Azores):** Tests V2X strategies for EV charging in homes, buildings and companies.
- **Slovenia (Krško and Elektro Celje):** Assesses V2X impact on the electricity network, energy market and system services.
- **Greece (Attica, Mesogia):** Evaluates an intuitive platform for managing charging stations and EV grid impact.
- **Denmark (Risø Campus Bornholm):** Examines energy management in buildings and parking lots, integrating renewable energy.

6.3.4 Data collection project outputs

Documents included in the deep-dive analysis



*No Publication Year- No year of publication given

Figure 30: Year-wise breakdown of reviewed documents (EV4EU Project)

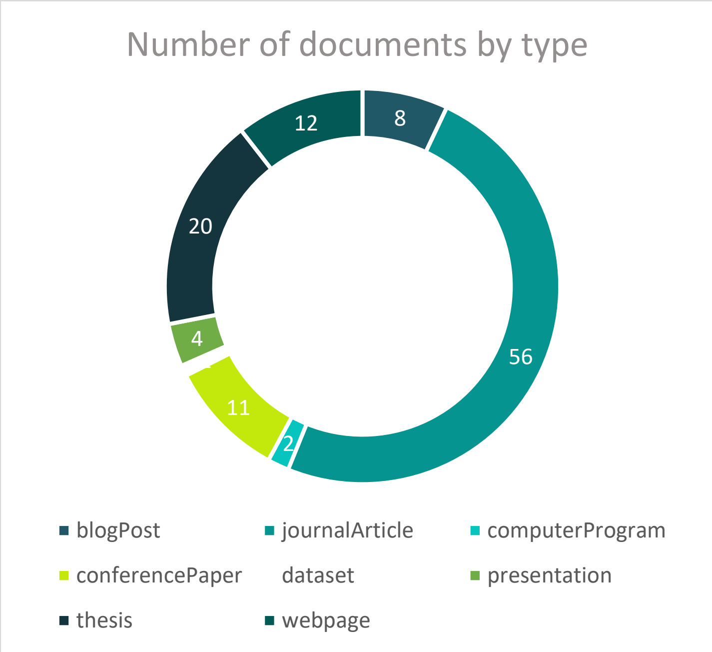


Figure 31: Distribution of document types reviewed in the EV4EU Project deep-dive analysis

6.3.5 Key Contributions to 2ZERO Objectives

Accelerating Electrification

- **User-Centric V2X Management:** Focus on user needs to drive mass EV adoption[45][46].
- **Development of Charging Infrastructure Solutions:** Creation of cost-effective, scalable V2X stations[47] [48].
- **Interoperability and Standards:** Compliance with international standards for smooth electrification.
- **Addressing Grid Connection Challenges:** Tackling grid connection issues in parking areas for seamless charging[49].

Reducing Emissions in Transport

- **Promoting Coordination with Renewables:** Supporting EV and renewable energy integration to cut emissions[50] [51].
- **Smart Charging and V2G Capabilities:** Developing smart and bidirectional charging for energy optimization.
- **Optimal Management of EV Fleets:** Enhancing fleet efficiency to reduce greenhouse gas emissions.

Economic and Societal Impacts

[45] Rocha et al.,EV4EU, 'Deliverable D3.1 EV Users' Needs and Concerns - Preliminary Report', p. 72, Apr. 2023.
[46] P. A. F. Pereira, EV4EU, 'Impact of mass deployment of electric vehicles in energy and power systems', Tecnico Lisboa, 2023.
[47] C. Dalamagkas, V. D. Melissianos, G. Papadakis, A. Georgakis, V.-M. Nikiforidis, and K. Hrissagis-Chrysagis, EV4EU, 'The Open V2X Management Platform: An intelligent charging station management system', Inf. Syst., p. 27, Dec. 2024, doi: 10.1016/j.is.2024.102494.
[48] A. Koutounidis and E. Rodrigues, EV4EU, 'Deliverable D2.1 Control Strategies for V2X Integration in Houses', p. 43, Jun. 2023.
[49] M. Marinelli and M. Zajc, EV4EU, 'Deliverable D2.4 Optimal management of EV fleets in companies', p. 32, Mar. 2024.
[50] D. E. M. Santos and P. Thüne, EV4EU, 'Business cases and technological trends in V2G applications for residential users and fleet vehicles', DTU, 2024.
[51] I. Mendek, T. Marentič, K. Anžur, and M. Zajc, EV4EU, 'A Case Study on Electric Vehicles as Nationwide Battery Storage to Meet Slovenia's Final Energy Consumption with Solar Energy', Energies, vol. 17, no. 11, p. 17, Jun. 2024, doi: 10.3390/en17112733.

- **Development of New Business Models:** Innovating V2X-focused business models for wider EV adoption[52].
- **Tools and Apps for EV Users:** Building user-friendly tools to offer valuable energy insights.
- **Consideration of User Needs and Concerns:** Addressing key cost, battery and infrastructure issues.
- **Evaluation in Real-World Demonstrations:** Testing solutions at four European sites for validation.
- **Potential for Job Creation and Economic Growth:** Boosting green mobility sectors for job growth[53].
- **Contribution to Policy Frameworks:** Providing insights to support carbon-neutral policies.

6.3.6 Impact Pathway

Technology Development and Validation:

- Development of V2X strategies, a prototype management station and a scalable charging infrastructure across four EU demonstration sites.
- Validation of smart (V1G) and bidirectional (V2G) charging solutions in real-world scenarios to build stakeholder confidence[54] [55] [56].

Market Uptake:

- Creation of cost-effective V2X charging solutions for mass deployment; supported by patent applications.
- Introduction of V2X-based business models and user tools to enhance EV adoption.
- Emphasis on international standards and interoperability for a seamless EV ecosystem[57] [58].

Policy Influence:

- Comprehensive analysis of regulatory barriers (Deliverable D1.3) and policy recommendations.
- Data on grid impacts from mass EV adoption (Deliverable D1.2) to guide grid modernization and renewables integration.
- Exploration of frameworks for user-friendly V2X services to influence EU and national policies[59].

Long-Term Societal Benefits:

- Advancement of renewable integration with EVs, aiding decarbonisation.
- Development of grid-stabilizing technologies such as smart/V2G charging for broader energy benefits[60].
- Contributions to economic growth and green job creation via EV expansion.
- Real-world testing in diverse contexts to foster sustainable, accepted mobility solutions[61].

6.3.7 Reconstructed Theory of Change

EV4EU focuses on fostering widespread adoption of electric vehicles through improved infrastructure, supportive policies and stakeholder engagement. Key outputs — such as the

[52] Zajc et al., EV4EU, ‘Deliverable D1.4 Business models centred in the V2X value chain’, p. 59, Mar. 2023.
[53] H. Amezquita, C. P. Guzman, and H. Morais, EV4EU, ‘Forecasting Electric Vehicles’ Charging Behavior at Charging Stations: A Data Science-Based Approach’, Energies, vol. 17, no. 14, Art. no. 14, Jan. 2024, doi: 10.3390/en17143396.
[54] X. Cao, S. Striani, J. Engelhardt, C. Ziras, and M. Marinelli, EV4EU, ‘A semi-distributed charging strategy for electric vehicle clusters’, Energy Rep., vol. 9, p. 7, Nov. 2023, doi: 10.1016/j.egyr.2023.10.014.
[55] M. Rui and C. Rui, EV4EU, ‘Deliverable D1.7 Patent of V2X Management Station’, p. 11, Mar. 2024.
[56] Rui Costa and Diogo Brito, EV4EU, ‘Deliverable D1.6 Real-scale prototype of V2X management station’, p. 33, Apr. 2023.
[57] Mariana Carmo and Hugo Morais, EV4EU, ‘Deliverable D10.2 Plan for the dissemination and exploitation of results including communication activities - Update’, p. 47, May 2024.
[58] Ana Rita Nunes and Hugo Morais, EV4EU, ‘Deliverable D10.1 Plan for the dissemination and exploitation of results including communication activities’, p. 48, Nov. 2022.
[59] J. Mateus, EV4EU, ‘Deliverable D1.2 Impact of V2X in energy and power systems’, p. 38, Feb. 2023.
[60] F. Pastorelli, T. Unterluggauer, B. J. Höyer, M. M. Wagner, and M. Marinelli, EV4EU, ‘Smart Electric Vehicle Management vs. Battery Storage for Energy Communities: A Case Study from Denmark’, p. 9, 2024.
[61] O. Mikkelsen and C. Ziras, EV4EU, ‘Deliverable D4.1 Distribution Network Planning Strategies considering V2X Flexibilities’, p. 40, Mar. 2023.

establishment of charging stations, the formulation of EV-friendly regulations and awareness campaigns — lead to short-term outcomes of increased consumer trust and reduced operational barriers for transport operators. These outcomes drive broader adoption of electric mobility, which in turn lowers carbon emissions and air pollution. Ultimately, the overall impact is the creation of sustainable, low-carbon transport networks that enhance public health and contribute to meeting climate targets.

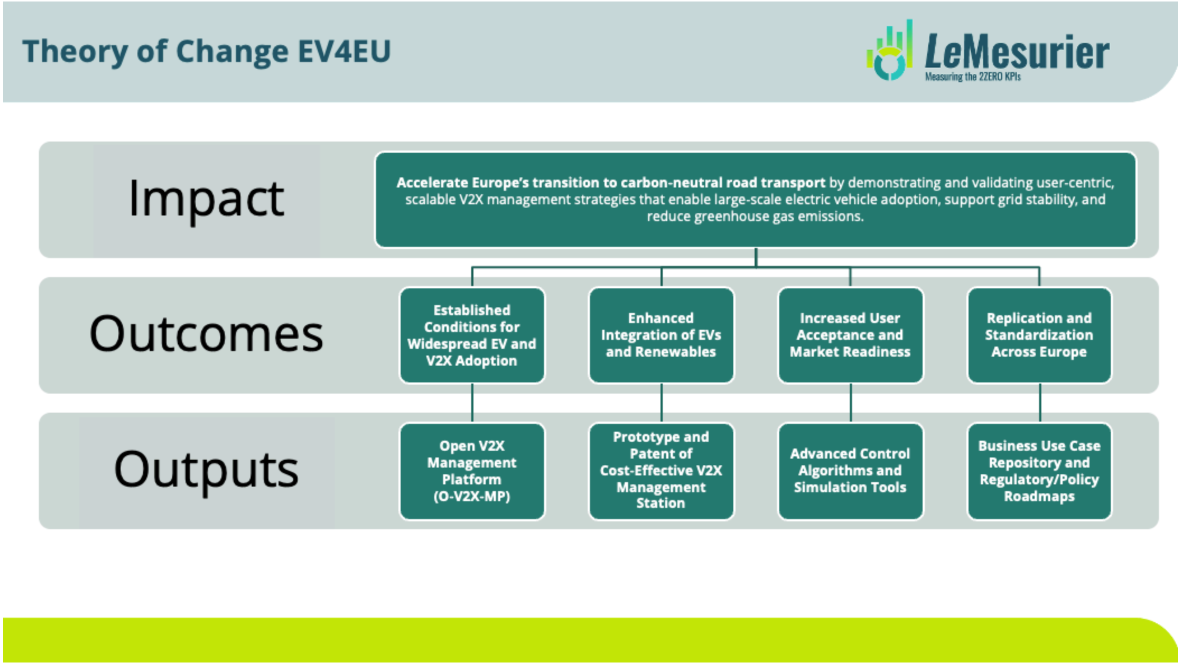


Figure 32: Theory of Change EV4EU project

6.3.8 Observed Strengths and Achievements

- **User-Centric Approach:** Focus on practical V2X strategies aligned with user needs.
- **System Integration:** Comprehensive planning for EV integration with grids, markets and urban settings.
- **Practical Solutions:** Outputs such as a V2X management prototype, charging solutions and apps.
- **Real-World Validation:** Testing at four diverse EU sites for replicability.
- **Knowledge Contribution:** Deliverables on e-mobility, V2X flexibility and standard adherence.
- **Stakeholder Engagement:** Workshops and an open platform for effective dissemination.
- **Scalability:** Focus on replicable infrastructure and a distributed control system.
- **Alignment with EU Goals:** Strong support for 2050 carbon neutrality and 2ZERO Objectives.

6.3.9 Challenges and Areas for Further Focus

- **Regulatory Landscape Fragmentation:** Lack of V2X laws in Portugal and Greece; installation barriers in multi-apartment buildings (Slovenia) [62].
- **V2G in Regulations:** Bidirectional charging not yet fully integrated into the EU framework.
- **Feasibility of V2X Services:** Challenges with technical/economic viability, equipment availability and standardisation[63].
- **User Awareness:** Addressing concerns on battery health and economic value of V2X.

[62] Panagiotis Pediaditis, Athanasios Karathanasopoulos, Ioannis Kordis, Antonios Koutounidis, and Konstantinos Michos, EV4EU, 'Deliverable D1.3 Regulatory opportunities and barriers for V2X deployment in Europe', p. 85, Mar. 2023.

[63] Catarina Nogueira, Diogo Brito, and Hugo Morais, EV4EU, 'Deliverable D1.8 Characterization of Batteries degradation considering the participation in V2X services', p. 56, Apr. 2024.

- **Interoperability Gaps:** Ensuring seamless communication across platforms and energy systems.
- **Grid Integration Issues:** Unpredictable EV charging behaviour risks grid congestion.

6.3.10 Recommendations

- **Harmonised V2X Legislation:** Engage policymakers to establish consistent, supportive laws for V2X and V2G integration.
- **Include V2G in EU Frameworks:** Provide data-backed recommendations for policy inclusion of bidirectional charging.
- **Develop Standardised V2X Tech:** Collaborate with stakeholders to create commercially viable, standardised solutions.
- **Educate and Engage Users:** Launch campaigns to raise awareness of V2X benefits and tackle user concerns.
- **Boost Interoperability:** Advance protocols for seamless operations and secure data exchange.
- **Intelligent Grid Solutions:** Scale smart charging strategies to mitigate grid issues and support renewables.
- **Validate Business Models:** Refine models to ensure economic feasibility for stakeholders, from users to energy providers.

EV4EU makes a crucial contribution to the aim of achieving zero emissions in Europe's road transport sector by focusing on the intelligent integration of electric vehicles into the energy system through Vehicle-to-Everything (V2X) strategies. Its work on developing user-centric V2X management, fostering the coordination between EVs and renewables, and addressing the deployment of charging infrastructure provides a vital pathway for mass EV adoption. By continuing to advocate for harmonized regulatory frameworks for V2X, further develop and standardize V2X technologies, and enhance user engagement strategies, EV4EU can significantly accelerate the transition to a zero-emission road transport landscape across the EU and solidify the role of smart EV integration in achieving climate neutrality.

6.4 HighScape

HighScape focuses on advancing battery electric vehicles (BEVs) by developing efficient, high-power density, cost-effective and modular power electronics for in-wheel powertrains. It emphasizes cost reduction, reliability, component integration and sustainability, with solutions tested on BEV prototypes. By supporting zero-emission mobility, standardization, collaboration and economic growth, HighScape aims to position Europe as a leader in green mobility innovation.

6.4.1 Project Background and Overview

Table 51: Overview of HighScape project

Title	**High efficiency, high power density, cost effective, scalable and modular power electronics and control solutions for electric vehicles**		
Start Date	01/01/2023	**Legal Basis**	HORIZON.2.5
End Date	31/12/2025	**Topics**	HORIZON-CL5-2021-D5-01-02
Total Cost	€ 4,589,292.50	**EC Signature Date**	05/12/2022
EC Maximum Contribution	€ 4,589,291.00	**Framework Programme**	HORIZON
Grant DOI	10.3030/101056824	**Funding Scheme**	HORIZON-RIA
Coordinator	AVL	**Cluster**	e-VOLVE
Reporting Period 1	01/01/2023 – 30/06/2024	***Le*Mesurier Evaluation**	February 2025

Reporting Period 2	01/07/2024 – 31/12/2025		
Reporting Period 3	-		

6.4.2 Partners

The HighScape project involves 12 partners from various segments: Segment 1 - End Users, Segment 2 - OEMs, Segment 3 - Suppliers & Engineering, Segment 4 - SMES, Segment 5 - Research Sector.

6.4.3 Use Cases/ Living Labs

Business impact:

- Tier 1 and engineering partners enabling fast distribution of the technology in the market.
- Completeness of innovation chain (research. engineering and product) and value chain (power electronics, systems and full vehicles)

E-mobility uptake Impact:

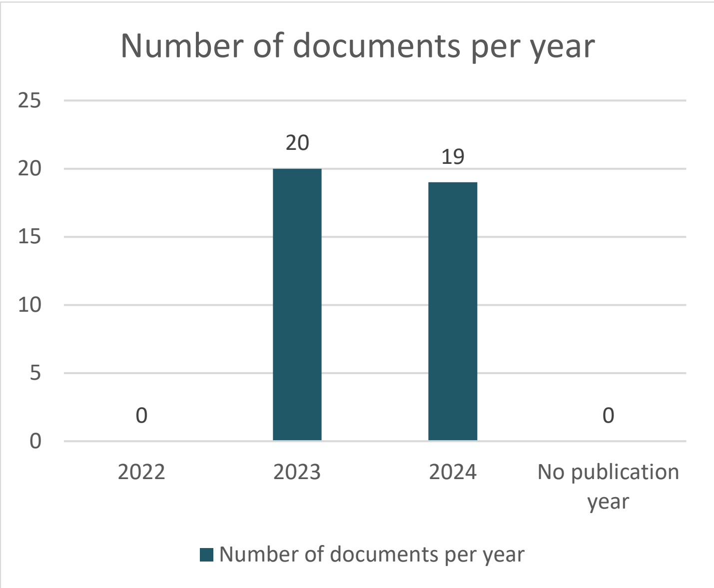
- A combined overall cost reduction (>25%) and downsizing of PE components (>25 kW/kg specific power and >25 kW/litre power density)
- Increased EV operational safety (fault-tolerant PE with smart predictive maintenance strategy)

Scientific and community impact:

- Visibility through industrial expert groups such as ERTRAC, EGVIA, EPOSS, ECSEL, AVERE
- Visibility through professional societies such as SAE, IEEE, FISITA
- Universities with unique know-how in EV systems design

6.4.4 Data collection project outputs

Documents included in the deep-dive analysis:



*No Publication Year- No year of publication given

Figure 33: Year-wise breakdown of reviewed documents (HighScape Project)

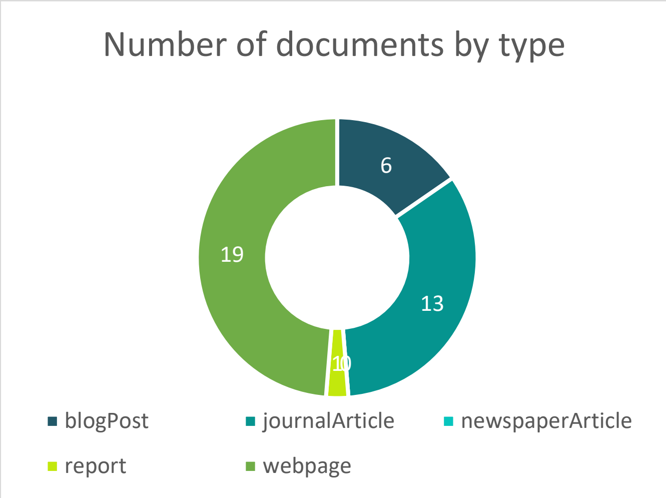


Figure 34: Distribution of document types reviewed in the HighScape Project deep-dive analysis

6.4.5 Key Contributions to 2ZERO Objectives

Accelerating Electrification

- **Advanced BEV Technology:** Focuses on efficient power electronics for BEVs, including components such as traction inverters and on-board chargers, and explores distributed multiple wheel drives.
- **Efficient and Reliable Components:** Aims for higher power density, energy efficiency and reliability through intelligent health monitoring.
- **Standardisation Efforts:** Contributes to CCAM system standards and addresses gaps.
- **Cost Reduction:** Targets lower costs via dual use of parts and model-based design.
- **Building on EVC1000 Knowledge:** Utilizes prior results for optimised powertrain and chassis systems, increasing EV range and user acceptance.

Reducing Emissions in Transport

- **Zero-Emission Mobility Support:** Actively promotes zero tailpipe emission transformation.
- **Energy Efficiency Focus:** Reduces energy consumption with advanced power electronics.
- **Digital Technology Use:** Leverages digital tools to optimise BEV systems[64].

Economic and Societal Impacts

- **European Competitiveness:** Strengthens leadership in green mobility and key technologies.
- **Job Creation:** Spurs demand for skilled workers through technological advancements.
- **CCAM Benefits:** Improves driving quality, safety and fosters sustainable transport.
- **Collaboration & Knowledge Sharing:** Works with E-VOLVE, EM-TECH, and HiPE for alignment with European strategies[65].
- **Policy and Ecosystem Contributions:** Aids in regulatory development and engages in collaborative exploration to boost value creation.

6.4.6 Impact Pathway

Technology Development and Validation

[64] E-VOLVE Cluster, 'E-VOLVE Cluster Newsletter 10/23', 2023, Accessed: Dec. 05, 2024. [Online]. Available: https://zenodo.org/records/10527908
[65] E-VOLVE Cluster, 'E-VOLVE Cluster Newsletter 07/23', 2023, Accessed: Dec. 05, 2024. [Online]. Available: https://zenodo.org/records/10527881

- **Research in BEV Components:** Focuses on efficient power electronics, including traction inverters, on-board chargers and in-wheel powertrains[66] [67].
- **Testing Prototypes:** Validates solutions on test rigs and two BEV prototypes under real-world conditions[68].
- **Improved Performance Metrics:** Aims for higher power density, specific power and energy efficiency.

Market Uptake

- **Cost Reduction and Reliability:** Strives for cost-effective, reliable power electronics to appeal to consumers and OEMs.
- **Enhancing Industrial Leadership:** Strengthens European global competitiveness in green mobility[69].
- **Collaboration and Sharing:** Engages in E-VOLVE and projects like EM-TECH for industry-wide knowledge dissemination[70].

Policy Influence

- **Evidence-Based Policy Recommendations:** Develops strategies for zero-emission vehicle deployment and informs regulatory frameworks.
- **Standardisation Contributions:** Addresses CCAM gaps to ensure interoperability and adoption[71].

Long-Term Societal Benefits

- **Emissions and Air Quality:** Supports zero-emission mobility, reducing greenhouse gases and improving air quality.
- **Noise Pollution Reduction:** Promotes quieter urban environments through BEV advancements.
- **Economic and Job Growth:** Boosts competitiveness, fostering job creation in advanced BEV sectors.
- **Climate Neutrality Goals:** Aligns with the EU's 2050 carbon-neutral transport objective.

6.4.7 Reconstructed Theory of Change

HighScape revolves around implementing innovative technologies and land-use practices to preserve high-value landscapes while boosting local economies. The project generates outputs such as advanced land-management tools, capacity-building workshops for stakeholders and data-driven policy recommendations. These outputs lead to outcomes such as improved land stewardship, stronger community engagement and increased biodiversity. By embedding sustainable land-use practices in regional planning, HighScape ultimately contributes to healthier ecosystems, greater resilience to climate change and more inclusive rural livelihoods — forming the project's overarching impact.

[66] M. Heydrich et al., 'Integrated Chassis Control for Energy-Efficient Operation of a 2WD Battery-Electric Vehicle with In-Wheel Propulsion', presented at the WCX SAE World Congress Experience, SAE International, 2024. doi: 10.4271/2024-01-2550.
[67] '202410_E-VOLVE_Newsletter_v2'.
[68] B. Wang, 'D2.3 Simulation models of the High-Scape vehicles, PE systems and components', 2023.
[69] 'RTR2024-Summary-Reports-final', 2024.
[70] E-VOLVE Cluster, 'E-VOLVE Cluster Newsletter 04/23', 2023, doi: 10.5281/zenodo.10527294.
[71] 'September 2023', HighScape. Accessed: Dec. 11, 2024. [Online]. Available: https://highscape.eu/2023/09/

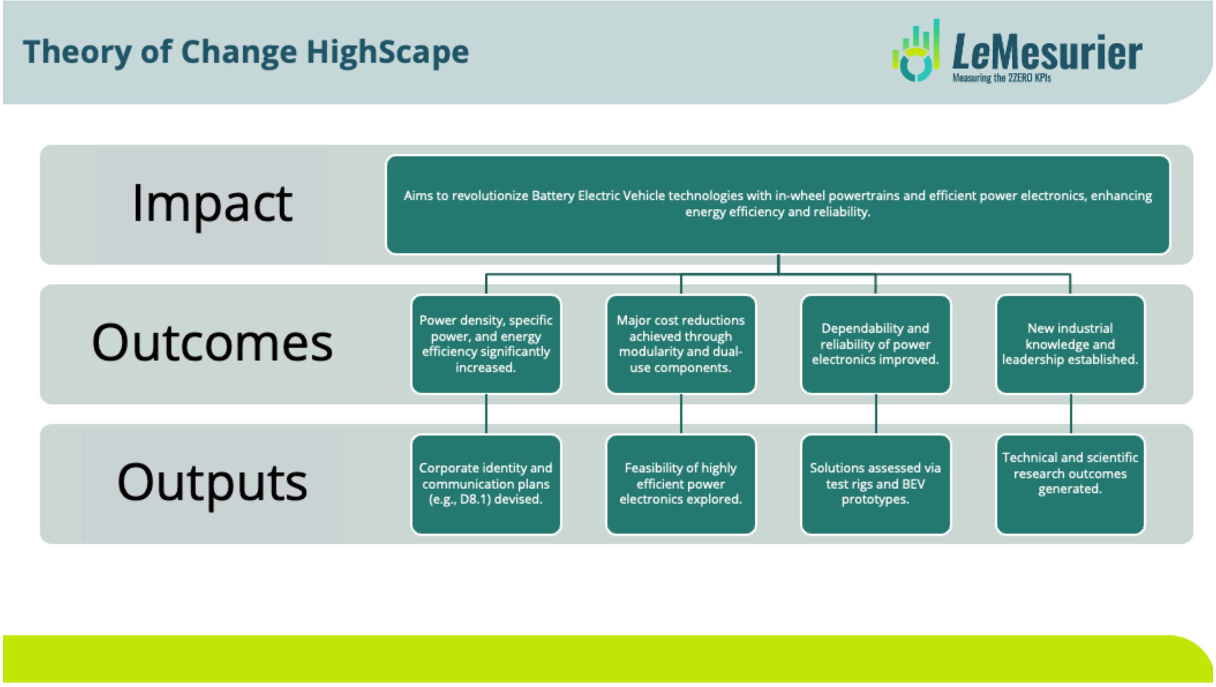


Figure 35: Theory of Change HighScape project

6.4.8 Observed Strengths and Achievements

- **Strong Consortium and Collaboration:** A multidisciplinary consortium of OEMs, technology providers and universities from seven countries fosters a robust, collaborative environment. Participation in the E-VOLVE cluster enhances knowledge sharing across European research[72] [73] [74].
- **Focus on BEV Technology Advancement:** Dedicated to highly efficient power electronics components, such as integrated traction inverters and in-wheel powertrains, demonstrating a clear focus on innovation[75] [76].
- **Technological Improvement Potential:** Targets significant gains in power density, specific power, energy efficiency, major cost reductions and reliability through predictive health monitoring.
- **Alignment with EU Objectives:** Directly supports the 2ZERO initiative and strengthens industrial leadership in green mobility, aligning with Europe's strategic goals for a carbon-neutral transport system.
- **Commitment to Knowledge Dissemination:** Emphasizes sharing outcomes through publications, workshops and conferences, supported by a corporate identity and communication plan.
- **Use of Advanced Simulation Techniques:** Adopts a co-simulation platform for efficient component designs and collaborates on a vehicle simulation toolchain, promoting open innovation for increased development efficiency[77].

[72] J. A. Kniewallner, 'D8.1 Project's corporate identity including communication plan', 2023.
[73] 'highscape_leaflet_projectoverview'. Accessed: Dec. 10, 2024. [Online]. Available: https://highscape.eu/wp-content/uploads/2023/03/highscape_leaflet_projectoverview.pdf
[74] 'August 2024', HighScape. Accessed: Dec. 11, 2024. [Online]. Available: https://highscape.eu/2024/08/
[75] E-VOLVE Cluster, 'E-VOLVE Cluster Newsletter 12/23', 2023, Accessed: Dec. 05, 2024. [Online]. Available: https://zenodo.org/records/10527915
[76] L. Verkroost, M. Demeyer, H. Soltani Gohari, J. Lecoutere, P. Sergeant, and H. Vansompel, 'E-Gear Functionality Based on Mechanical Relays in Permanent Magnet Synchronous Machines', IET Electr. Syst. Transp., vol. 2024, no. 1, p. 12, 2024, doi: 10.1049/2024/6582973.
[77] M. Goderis, A. Buruzs, F. Giordano, T. Barz, W. Beyne, and M. D. Paepe, 'Numerical modelling of thermal hysteresis in melting and solidification of phase change materials', J. Phys. Conf. Ser., vol. 2766, no. 1, p. 012227, 2024, doi: 10.1088/1742-6596/2766/1/012227.

6.4.9 Challenges and Areas for Further Focus

- **Transitioning to Market Readiness:** Bridging the gap between prototype performance and reliable, cost-effective large-scale manufacturing.
- **Adoption of Novel Architectures:** Overcoming potential user and OEM reluctance towards distributed multiple wheel drives and in-wheel powertrains.
- **Charging Infrastructure Integration:** Ensuring seamless compatibility with diverse charging standards and smart grid technologies.
- **Ecosystem Challenges:** Addressing skilled workforce shortages, supply chain development for advanced materials and recycling strategies for specialised components.
- **Regulatory Alignment:** Keeping pace with evolving vehicle safety standards, environmental regulations and interoperability needs.
- **Highlighting Societal Benefits:** Enhancing communication of societal and environmental impacts like noise and air quality improvements and strengthening Life Cycle Assessment (LCA) considerations.

6.4.10 Recommendations

- **Champion Standardisation:** Engage with standardisation bodies to promote standards for power electronics and in-wheel powertrains, improving manufacturing, costs and interoperability across platforms.
- **Inform Policy on Deployment:** Provide evidence-based recommendations to policymakers to influence regulations supporting advanced BEV technologies and zero-emission vehicles.
- **Develop Cost-Effective Manufacturing:** Explore modular and integrated manufacturing strategies for large-scale, cost-efficient production of BEV components, possibly through open-source designs.
- **Enhance Engagement with Stakeholders:** Collaborate further with vehicle manufacturers and gather end-user feedback to address concerns and improve adoption of in-wheel powertrains and other innovations.
- **Utilise Testing and Simulation Data:** Leverage data from prototypes and simulations to validate and refine HighScape's power electronics and demonstrate their performance and reliability.
- **Communicate Benefits Clearly:** Highlight the environmental (e.g., reduced emissions) and performance (e.g., energy efficiency) advantages of HighScape's technologies to stakeholders and the public for confidence and adoption.

HighScape plays a vital role in 2ZERO's ambition for a zero-emission transport sector by pushing the boundaries of core BEV technology [Pg-110-20]. Its focus on efficiency, cost reduction and reliability in key components positions it to make significant contributions. By actively pursuing standardization, informing policy, facilitating cost-effective manufacturing, broadening stakeholder engagement and leveraging its data, HighScape can maximize its impact and accelerate the transition to a cleaner and more efficient electric mobility landscape across Europe.

6.5 GIANTS

GIANTS focuses on developing an affordable, modular electric vehicle platform for L-category vehicles, aimed at both advanced and emerging markets. It emphasizes sustainability, user-centric design and integration with energy systems. Through innovative technologies, living lab's and green principles, GIANTS supports zero-emission urban mobility, fostering EU leadership in global transport solutions.

6.5.1 Project Background and Overview

Table 52: Overview of GIANTS project

Title	Green Intelligent Affordable New Transport Solutions		
Start Date	1/1/2024	**Legal Basis**	HORIZON.2.5
End Date	6/30/2027	**Topics**	HORIZON-CL5-2023-D5-01-03
Total Cost	€ 15 103 522,50	**EC Signature Date**	12/7/2023
EC Maximum Contribution	€ 11 959 732,51	**Framework Programme**	HORIZON
Grant DOI	https://doi.org/10.3030/101138220	**Funding Scheme**	HORIZON-IA
Coordinator	VIRTUAL VEHICLE RESEARCH GMBH Austria	**Cluster**	Electrification (FEV/PHEV)
Reporting Period 1	01.01.2024 – 30.06.2025	***Le*Mesurier Evaluation**	January 2025
Reporting Period 2	01.07.2025 – 31.12.2026		
Reporting Period 3	01.01.2027 – 31.08.2027		

6.5.2 Partners

- The GIANTS project involves 23 partners from various sectors.
- These partners include public transport associations, research institutions, technology and engineering companies, bus manufacturers and public transport operators.

6.5.3 Use Cases/ Living Labs

The project aims to establish Living Labs across Bruges (Belgium), Stockholm (Sweden), Kisumu (Kenya), Delhi (India) and Manila (Philippines) as real-life test environments for e-mobility innovations. These lab's will address sustainable passenger and freight transport in diverse socio-economic contexts:

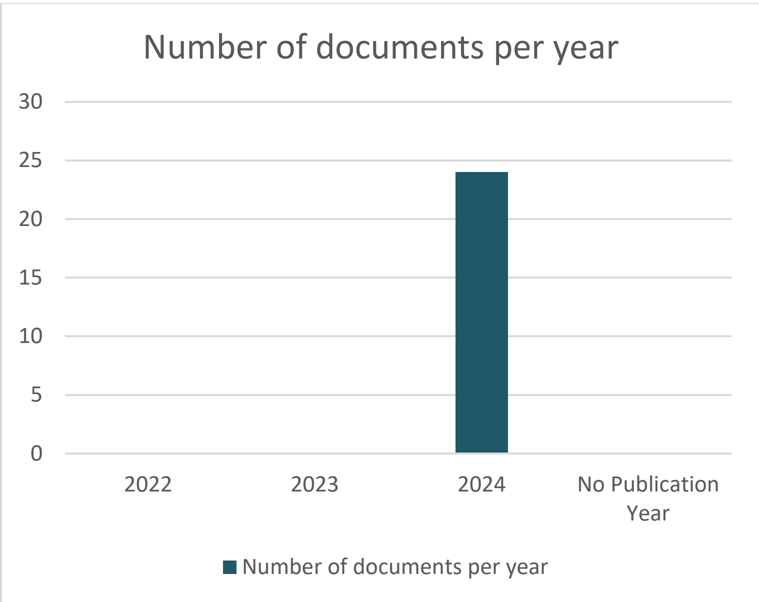
- **Stockholm:** CleanMotion vehicles and Bzzt service for last-mile deliveries of goods and meals.
- **Bruges:** SQUAD Mobility vehicles tested for city logistics with features like battery swapping and MaaS app integration.
- **Delhi:** Electrification of auto-rickshaws using a fleet with swappable batteries, charging and swapping stations.
- **Kisumu:** Micro-mobility solutions for suburban transport, addressing power supply challenges with off-grid and solar charging.
- **Manila:** Integration of GIANTS components into local SME vehicles for passenger and freight transport in Pasig City.

Figure 36: Overview of GIANTS Living Labs

The Living Labs will showcase tailored configurations of GIANTS solutions under real-world conditions to boost sustainable mobility worldwide.

6.5.4 Data collection project outputs

Documents included in the deep-dive analysis:



*No Publication Year- No year of publication given

Figure 37: Year-wise breakdown of reviewed documents (GIANTS Project)

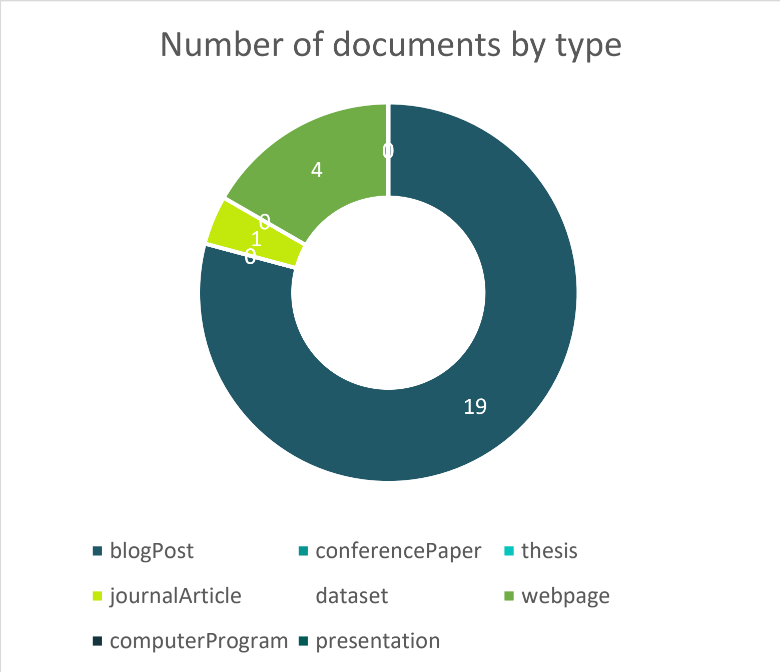


Figure 38: Distribution of document types reviewed in the GIANTS Project deep-dive analysis

6.5.5 Key Contributions to 2ZERO Objectives

Accelerating Electrification

- Developing an affordable and accessible electric vehicle platform for diverse markets to boost EV adoption.
- Introducing a flexible, modular, and mission-specific L-EV platform (L5, L6, L7) catering to varied urban transport needs[78].
- Featuring innovative energy solutions: 48V batteries, scalable e-drivetrains, standardized systems and solar panels to enhance convenience and reduce reliance on traditional charging.
- Lowering TCO (Total Cost of Ownership) through frugal design, local manufacturing and recyclability.
- Providing user-friendly charging infrastructure with smart V2G services and off-grid energy solutions.
- Establishing Urban Living Labs to validate solutions in cities with limited charging infrastructure[79].

Reducing Emissions in Transport

- Designing zero-emission L-EVs for mission-specific urban transport, reducing air pollution and GHG emissions.
- Adopting circular economy principles: modular designs for refurbishment and recycling.
- Using solar-supported charging, minimizing grid electricity dependency in fossil-fuel-heavy regions.
- Prioritizing sustainable design with locally manufactured components for reduced environmental impact.
- Improving air quality and noise levels via EV promotion[80].

[78] 'Giants Project | The GIANTS project tackles the urban passenger challenge by developing frugal zero-emission L-type vehicles.' Accessed: Dec. 11, 2024. [Online]. Available: https://giants-project.eu/
[79] 'Launch of the Manila Living Lab | Giants Project'. Accessed: Feb. 05, 2025. [Online]. Available: https://giants-project.eu/2024/12/12/launch-of-the-manila-living-lab/
[80] P. Sonnberger, 'Green Intelligent Affordable New Transport Solutions', 2024.

Economic and Societal Impacts:

- Creating inclusive mobility solutions for diverse socio-economic contexts via Living Labs in Europe, Africa, and Asia[81].
- Stimulating local economies through local manufacturing and assembly, reducing costs and creating jobs.
- Innovating through a flexible vehicle platform, enabling third-party design opportunities.
- Ensuring user acceptance with energy-efficient, socially adapted vehicle designs and a Social Index.
- Supporting green mobility growth with increased EV demand and job creation.
- Showcasing European leadership with cost-effective sustainable transport technologies.
- Ensuring equitable access to sustainable mobility by addressing affordability and adaptability.

6.5.6 Impact Pathway

Technology Development and Validation

- Development of a frugal zero-emission L-type vehicle platform with modular designs.
- Urban Living Labs in Europe, Africa and Asia demonstrate and validate technology in real-world conditions.
- Focus on innovative charging solutions, such as portable batteries and solar panels, tested in diverse contexts.

Market Uptake

- Providing affordable and accessible mobility solutions to emerging and advanced markets.
- Enhancing user acceptance via user-centric design and Living Lab validations.
- Promoting scalable and modular platforms for broader urban transport needs and markets.
- Anticipating new business models and significant market penetration, targeting 1.5 million global annual vehicle sales by 2028[82].

Policy Influence

- Proposing policy recommendations to support zero-emission mobility.
- Offering scientific input for regulation and standardisation efforts.
- Integrating concepts into Sustainable Urban Mobility Plans (SUMPs).

Long-Term Societal Benefits

- Contributing to improved air quality and noise reduction in urban areas.
- Promoting circular economy principles through sustainable design.
- Providing accessible mobility solutions, enhancing quality of life.
- Encouraging local manufacturing and job creation in the green mobility sector[83] [84].

6.5.7 Reconstructed Theory of Change

GIANTS is designed to accelerate green infrastructure investments in cities and regions aiming to meet ambitious sustainability targets. The project's outputs — targeted technical assistance, financial schemes promoting green building and public-private partnerships — equip local authorities and businesses with the resources to scale up sustainable projects. As a result, the near-term outcomes include heightened

[81] 'Demo Sites | Giants Project'. Accessed: Dec. 11, 2024. [Online]. Available: https://giants-project.eu/demo-sites/
[82] 'First GIANTS General Assembly Meeting | Giants Project'. Accessed: Feb. 05, 2025. [Online]. Available: https://giants-project.eu/2024/06/27/first-giants-general-assembly-meeting-online/
[83] 'Mission Suitability Profile | Giants Project'. Accessed: Dec. 11, 2024. [Online]. Available: https://giants-project.eu/2024/10/16/mission-suitability-profile/
[84] 'Contributing to the LeMesurier Project KPI Assessment | Giants Project'. Accessed: Dec. 11, 2024. [Online]. Available: https://giants-project.eu/2024/11/20/contributing-to-the-lemesurier-project-kpi-assessment/

investment flows, stronger stakeholder collaboration and the adoption of best practices in urban sustainability. Over time, these outcomes foster low-emission growth, cleaner urban environments and more equitable access to green spaces, ensuring a lasting transformative impact.

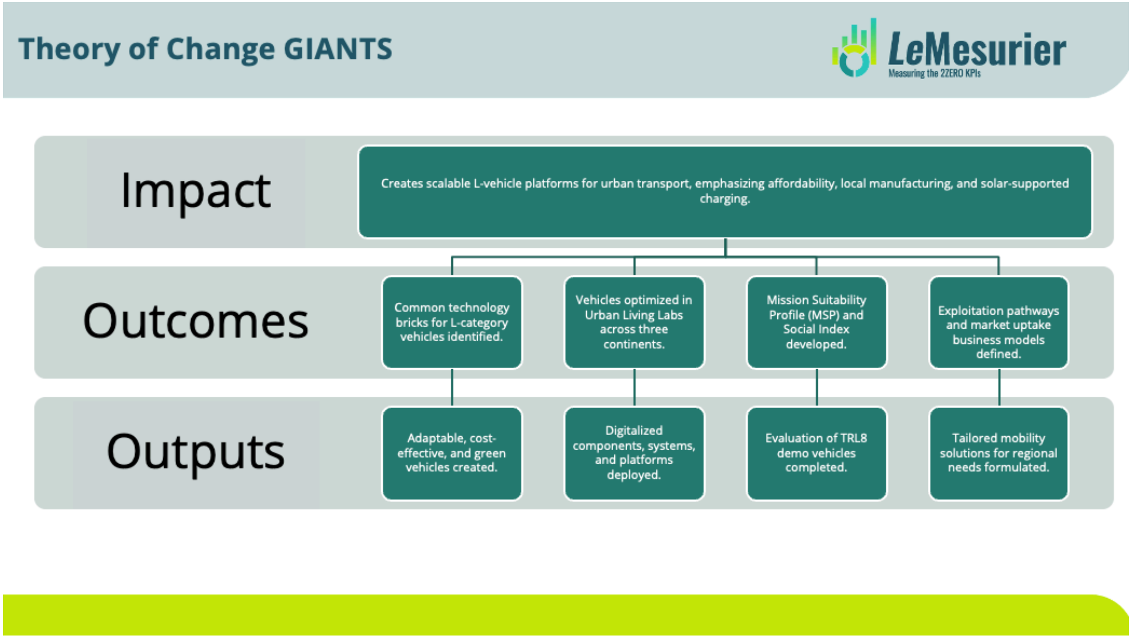


Figure 39: Theory of Change GIANTS project

6.5.8 Observed Strengths and Achievements

Strong Consortium and Collaboration:

- Partnerships across EU, Asia and Africa ensure global adaptability.
- Urban Living Labs in five cities (e.g., Brugge, Kisumu and Manila) foster end-user involvement.
- Collaboration with climate and mobility initiatives maximises impact[85].

Holistic Systems Approach:

- Mission-centric vehicle designs tailored to urban needs.
- Lifecycle integration of circular economy concepts.
- Platform integration with smart charging and grid interaction.
- Development of Mission Suitability Profile (MSP) and a Social Index[86].

Scalability Potential:

- Modular, scalable designs enable diverse L-EV models.
- Local manufacturing reduces supply chain complexities and costs.
- Support for standardisation facilitates broader technology adoption.
- Living Labs ensure global applicability and scalability.

6.5.9 Challenges and Areas for Further Focus

- **Infrastructure Readiness in Diverse Contexts:** Variability in charging infrastructure and grid reliability, especially in emerging markets such as Kisumu, pose challenges. Focus needed on robust, adaptable solutions for weak or intermittent power supply.
- **Ensuring Affordability and Business Viability:** Initial investment costs and business model viability require attention to refine profitability pathways, especially for SMEs.

[85] 'GIANTS at the Annual POLIS Conference 2024 | Giants Project'. Accessed: Feb. 05, 2025. [Online]. Available: https://giants-project.eu/2024/12/02/giants-at-the-annual-polis-conference-2024/

[86] 'Kick-off Meeting | Giants Project'. Accessed: Dec. 11, 2024. [Online]. Available: https://giants-project.eu/2024/01/31/giants-news-1/

- **Achieving User Acceptance Across Varied Demographics:** Ensuring broad acceptance across socio-economic and cultural contexts is key; addressing concerns about safety, comfort and perceived value remains critical.
- **Navigating Regulatory Landscapes:** Lack of harmonised regulations and varied permitting processes may hinder deployment. Active engagement with policymakers is essential.
- **Standardisation and Interoperability:** Achieving true interoperability of charging and vehicle components needs ongoing collaboration with industry stakeholders and standardisation bodies.
- **Defining and Measuring Social Impact:** A clear definition and measurable framework for the Social Index is essential to assess societal benefits like equity and sustainability.

6.5.10 Recommendations

Strengthen Infrastructure Partnerships and Innovation:

- Collaborate with energy providers to develop adaptable solutions such as off-grid and solar-supported charging.
- Support innovation in affordable, widespread infrastructure, including mobile and on-street options.

Enhance Business Model Development and Financial Viability:

- Conduct TCO analyses to demonstrate GIANTS' long-term economic benefits over traditional vehicles.
- Promote innovative financing models such as leasing, subscriptions and public-private partnerships.

Intensify User-Centric Engagement and Customisation:

- Expand public awareness and feedback initiatives to build trust in L-type vehicles.
- Leverage modular platform designs to tailor features for diverse user needs.

Proactively Engage in Policy Advocacy and Regulatory Harmonisation:

- Provide evidence-based policy recommendations to support zero-emission mobility.
- Streamline permitting processes by engaging with local and national authorities.

Advance Standardisation and Interoperability Efforts:

- Promote open standards by contributing technological insights to standardisation bodies.
- Collaborate with industry to ensure interoperability in charging and operations.

Refine the Social Impact Assessment Framework:

- Define and develop measurable Social Index indicators to assess societal benefits.
- Integrate the Social Index into evaluations to highlight GIANTS' societal impact.

GIANTS significantly contributes to 2ZERO's goal of decarbonising Europe's transport sector with its frugal, modular zero-emission L-type vehicles tailored for advanced and emerging markets. By prioritising adaptability, refurbishment and recyclability, it adopts a lifecycle perspective aligned with circular economy principles (2ZERO SRIA, 2024, page. 88.)[Pg-110-20]. Through cross-continental collaboration and diverse Living Labs, GIANTS ensures globally relevant solutions adaptable to varying infrastructures and user needs. It supports standardisation efforts and develops cost-effective, user-centric solutions to overcome EV adoption barriers. By refining its Social Index and advancing policy advocacy, GIANTS accelerates sustainable urban transport and strengthens its role in achieving EU zero-emission goals.

6.6 ZEV-UP

ZEV-UP aims to develop affordable, user-centric battery electric vehicles (BEVs) with swappable battery systems for both passenger and cargo needs. The project emphasizes modularity, sustainability and adaptability, offering three versatile vehicle variants. By addressing challenges such as high BEV costs, charging infrastructure or urban congestion, ZEV-UP accelerates EV adoption, promotes zero-emission mobility and contributes to Europe's Fit-for-55 and climate neutrality goals. It combines frugal innovation with global collaboration to create sustainable urban transport solutions.

6.6.1 Project Background and Overview

Table 53: Overview of ZEV-UP project

Title	Frugal Zero-Emission Vehicles for the Urban Passenger challenge		
Start Date	1/1/2024	**Legal Basis**	HORIZON.2.5
End Date	6/30/2027	**Topics**	HORIZON-CL5-2023-D5-01-03
Total Cost	€ 12,580,906.25	**EC Signature Date**	12/7/2023
EC Maximum Contribution	€ 9,619,202.63	**Framework Programme**	HORIZON
Grant DOI	101138721	**Funding Scheme**	HORIZON-IA
Coordinator	ERTICO	**Cluster**	Sub-urban / urban mobility
Reporting Period 1		***Le*Mesurier Evaluation**	February 2025
Reporting Period 2			
Reporting Period 3			

6.6.2 Partners

- The ZEV-UP project involves 17 partners from 11 countries.
- These partners include public transport associations, research institutions, technology and engineering companies, bus manufacturers and public transport operators.

6.6.3 Use Cases/ Living Labs

ZEV-UP will conduct demonstrations of its three zero-emission vehicle variants in Budapest (Hungary) and Istanbul (Turkey). The demonstrations aim to validate the design and technological innovations of vehicles and evaluate end-user acceptance in real conditions, including various road topography, weather conditions and vehicle weighs.
Different use cases will be tested with the passenger and commercial variants, which will both be demonstrated in turn in Budapest and Istanbul. The project will demonstrate the following use cases:

URBAN USE
- Moving from home to work with home charging
- Shopping activities, such as visiting a supermarket

PERI-URBAN USE
- Traveling long distances (> 70km)

PERI-URBAN USE, CAR SHARING
- Traveling longer distances
- (> 70km), picking up another passenger

LAST MILE MISSION
- Small and light parcel delivery

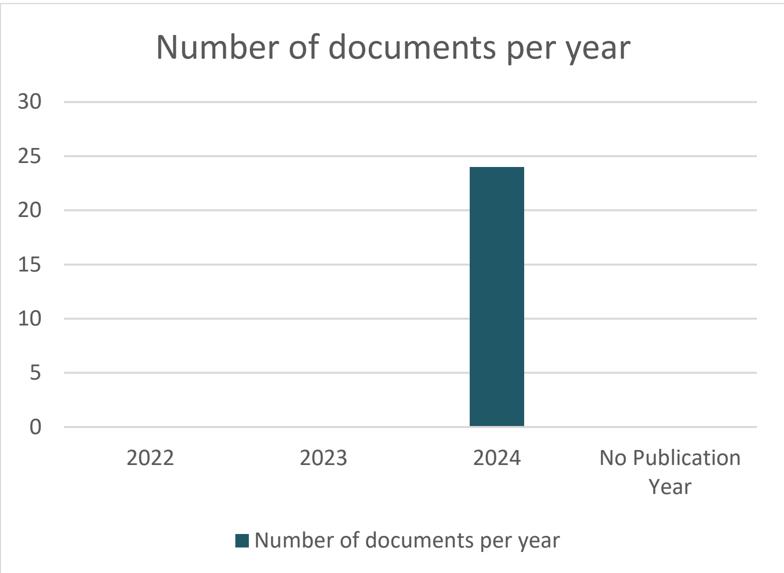
PERI-URBAN DELIVERIES

- Heavier cargo delivery with opportunity charging
- Company service vehicle
- Support vehicle, mainly for warehouse use

Figure 40: Overview of ZEV-UP Living Labs

6.6.4 Data collection project outputs

Documents included in the deep-dive analysis:



*No Publication Year- No year of publication given

Figure 41: Year-wise breakdown of reviewed documents (ZEV-UP Project)

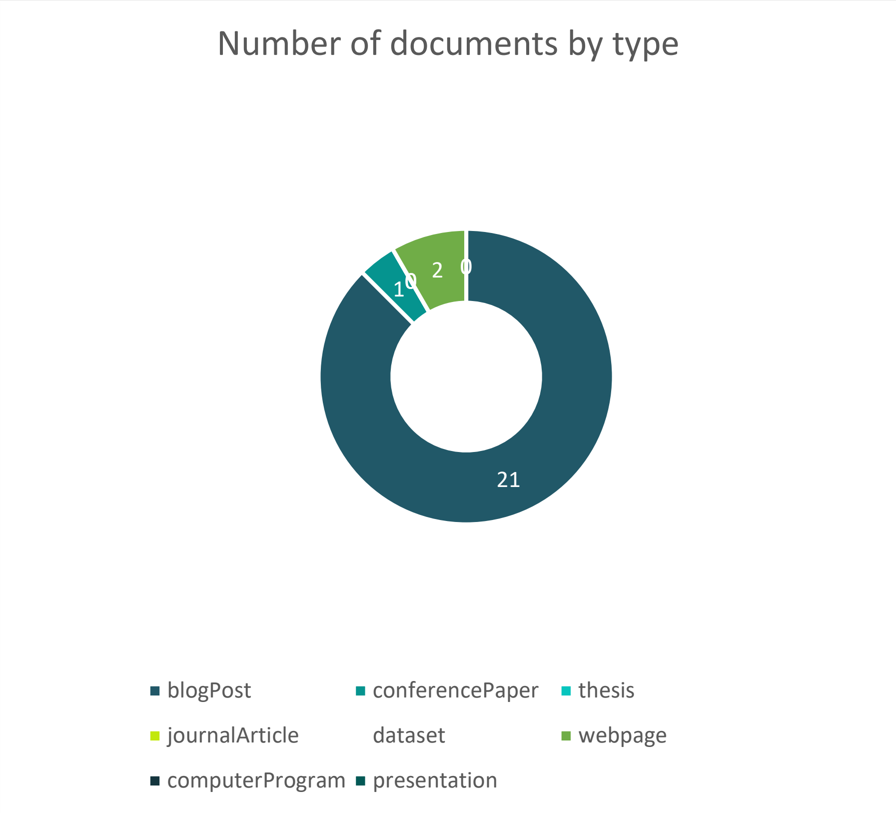


Figure 42: Distribution of document types reviewed in the ZEV-UP Project deep-dive analysis

6.6.5 Key Contributions to 2ZERO Objectives

Accelerating Electrification

- Developing user-centric and affordable BEVs tailored to various markets.
- Introducing a modular, scalable platform for frugal BEVs to cut development costs.
- Implementing swappable battery systems to improve convenience and address charging concerns.
- Focusing on reducing total cost of ownership and validating designs via real-world testing.
- Supporting decision-makers for faster ZEV adoption[87].

Reducing Emissions in Transport

- Aligning with the European Fit-for-55 objective for CO_2 reduction.
- Adopting Life Cycle Assessment (LCA) for environmental impact evaluation.
- Using lightweight and sustainable materials to enhance efficiency.
- Prioritizing better air quality and reduced CO_2, especially in urban areas[88].

Economic and Societal Impacts

- Driving job creation and economic growth in green mobility sectors.
- Tackling urban issues such as congestion and infrastructure integration.
- Promoting sustainable urban mobility and equitable access for all demographics.
- Emphasizing stakeholder collaboration and circular economy strategies, including reusable components and battery recycling.

6.6.6 Impact Pathway

[87] 'Power2Drive Europe - ZEV-UP'. Accessed: Dec. 11, 2024. [Online]. Available: https://zev-up.eu/power2drive-europe/
[88] 'Urban Transitions 2024 - ZEV-UP'. Accessed: Dec. 11, 2024. [Online]. Available: https://zev-up.eu/urban-transitions-2024/

Technology Development and Validation

- Creating a modular, scalable BEV platform with lightweight, sustainable materials.
- Innovating with swappable batteries, modular battery packs, and solar panel charging[89] [90].
- Validating innovations through real-world testing in Budapest and Istanbul.

Market Uptake

- Addressing barriers like high costs with affordable, user-centric BEVs for global markets.
- Enhancing user acceptance via improved charging solutions, range, and safety.
- Empowering decision-makers to drive accelerated BEV adoption[91].

Policy Influence

- Contributing to policy frameworks by showcasing viable BEV solutions.
- Aligning with goals like European Fit-for-55 and climate neutrality by 2050.

Long-Term Societal Benefits

- Supporting CO_2 reduction and better air quality, especially in urban areas.
- Encouraging job creation and growth in the green mobility sector[92].

6.6.7 Reconstructed Theory of Change

ZEV-UP aims to scale up zero-emission vehicle (ZEV) deployment by creating supportive ecosystems for manufacturers, fleet operators, and end users. The project outputs — pilot programs, technical guidelines and financing mechanisms — address both demand- and supply-side barriers, leading to short-term outcomes of reduced cost barriers, improved confidence in ZEV technology and growing market penetration. Progress in these areas underpins the longer-term shift toward low-carbon mobility systems, benefiting both the environment (through emissions reduction) and public health. Ultimately, ZEV-UP's overall impact is a substantial contribution to global decarbonization goals and cleaner, more equitable urban transport.

[89] 'ZEV-UP Car - ZEV-UP'. Accessed: Dec. 11, 2024. [Online]. Available: https://zev-up.eu/zev-up-car/

[90] 'ZEV-UP: Introducing a modular, frugal, zero-emission electric vehicle with a swappable battery system to make urban mobility more sustainable - ZEV-UP'. Accessed: Dec. 11, 2024. [Online]. Available: https://zev-up.eu/zev-up-introducing-a-modular-frugal-zero-emission-electric-vehicle-with-a-swappable-battery-system-to-make-urban-mobility-more-sustainable/

[91] 'Exploring the market dynamics for the ZEV-UP frugal vehicles - ZEV-UP'. Accessed: Dec. 11, 2024. [Online]. Available: https://zev-up.eu/exploring-the-market-dynamics-for-the-zev-up-frugal-vehicles/

[92] 'ZEV-UP defines key metrics to measure project success - ZEV-UP'. Accessed: Dec. 11, 2024. [Online]. Available: https://zev-up.eu/zev-up-defines-key-metrics-to-measure-project-success/

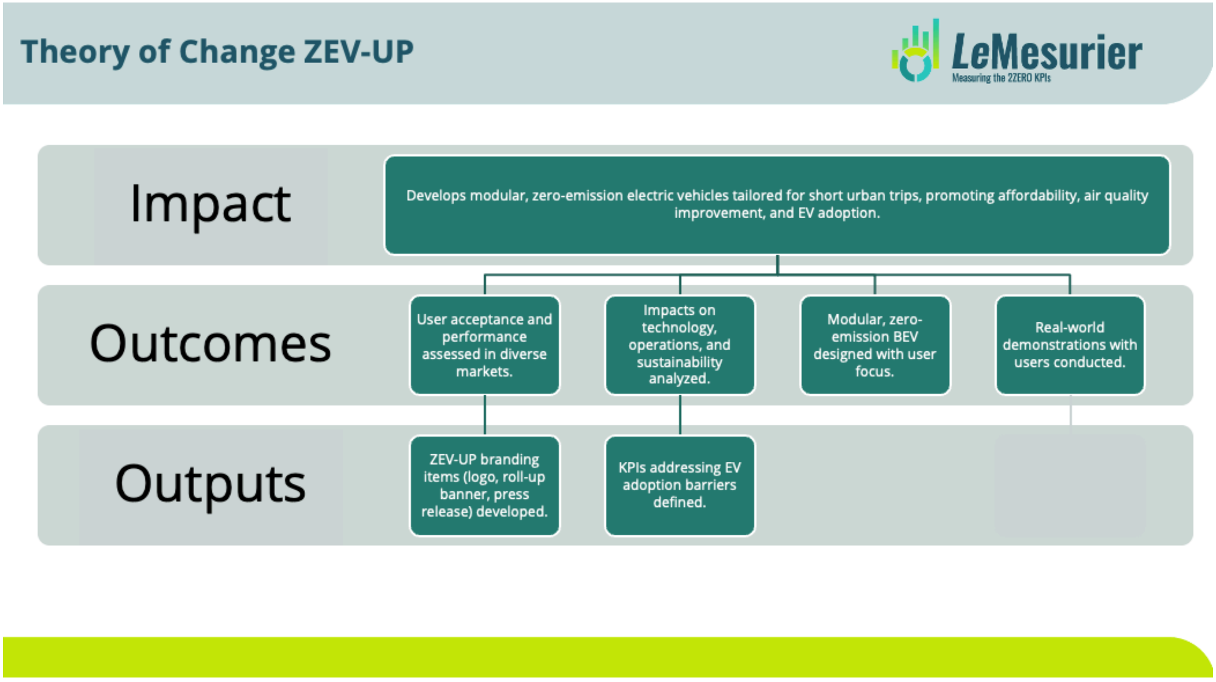


Figure 43: Theory of Change ZEV-UP Project

6.6.8 Observed Strengths and Achievements

- **Strong Collaboration:** Involves 17 partners across 11 countries, fostering diverse, multidisciplinary expertise[93] [94] [95] [96] [97] [98] [99].
- **User-Centric Approach:** Focuses on affordable, scalable BEVs with shared parts for lower costs and swappable battery systems for convenience[100].
- **Scalability Potential**: Modular design ensures adaptability for various markets and cost efficiency, supported by local production strategies.
- **Global Impact**: Participation in international conferences promotes concept dissemination and replication globally.

6.6.9 Challenges and Areas for Further Focus

- **High Capital Costs**: Continued efforts required to lower total cost of ownership and make BEVs affordable.
- **Charging Infrastructure Readiness**: Ensure widespread and accessible charging/swapping infrastructure, especially in emerging markets.
- **Standardisation of Battery Swapping**: Support industry-wide standards for battery and swapping infrastructure to enable adoption.
- **User Acceptance and Range Anxiety**: Address user concerns about range, convenience and charging availability through real-world testing and design improvements.

[93] 'Promotional materials - ZEV-UP'. Accessed: Feb. 17, 2025. [Online]. Available: https://zev-up.eu/categories/promotional-materials/
[94] 'AVERE E-Mobility Conference - ZEV-UP'. Accessed: Dec. 11, 2024. [Online]. Available: https://zev-up.eu/avere-e-mobility-conference/
[95] 'ITS World Congress 2024 - ZEV-UP'. Accessed: Dec. 11, 2024. [Online]. Available: https://zev-up.eu/its-world-congress-2024/
[96] 'London EV Show - ZEV-UP'. Accessed: Dec. 11, 2024. [Online]. Available: https://zev-up.eu/london-ev-show/
[97] 'New Mobility Congress - ZEV-UP'. Accessed: Dec. 11, 2024. [Online]. Available: https://zev-up.eu/new-mobility-congress/
[98] 'ZEV-UP holds its second general assembly meeting in Thessaloniki - ZEV-UP'. Accessed: Dec. 11, 2024. [Online]. Available: https://zev-up.eu/zev-up-holds-its-second-general-assembly-meeting-in-thessaloniki/
[99] 'Extrême Défi 3rd Conference on Ultralight EV - ZEV-UP'. Accessed: Dec. 11, 2024. [Online]. Available: https://zev-up.eu/extreme-defi-3rd-conference-on-ultralight-ev/
[100] 'Participate in the ZEV-UP survey and help shape our future electric car! - ZEV-UP'. Accessed: Dec. 11, 2024. [Online]. Available: https://zev-up.eu/participate-in-the-zev-up-survey-and-help-shape-our-future-electric-car/

- **Integration with Existing Infrastructure**: Plan for smooth integration of ZEV-UP vehicles with urban and energy infrastructure.
- **Market-Specific Viability**: Tailor solutions to diverse market needs in emerging regions such as Asia and Africa.

6.6.10 Recommendations

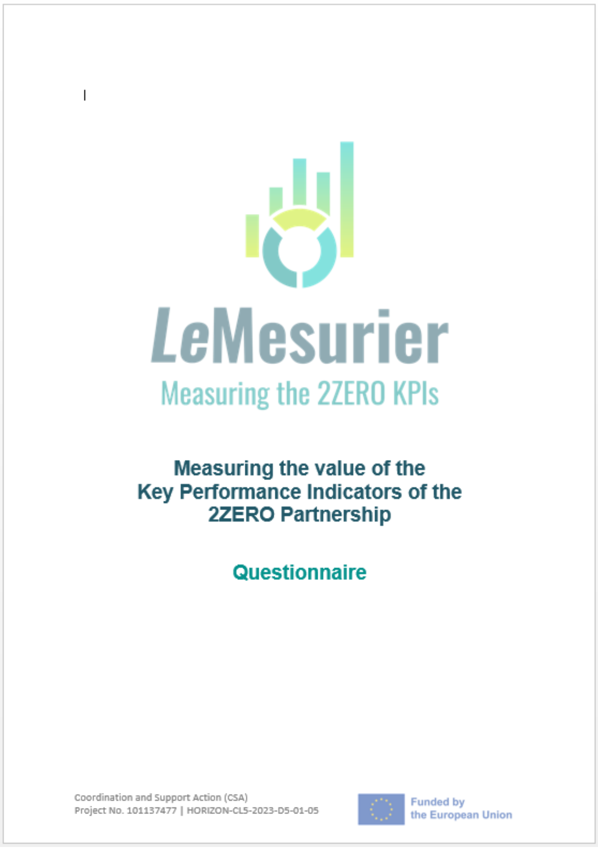
- **Prioritise and Support Standardisation Efforts**: Engage with standardisation bodies for interoperable swappable battery systems.
- **Continue to Drive Down Costs**: Focus on reducing costs via modularity, sustainable materials and efficient manufacturing.
- **Advance Charging and Swapping Infrastructure Solutions**: Develop the ECIRL Index and pilot accessible battery-swapping models.
- **Enhance User Engagement and Address Concerns**: Proactively gather user feedback and communicate the benefits of ZEV-UP vehicles.
- **Foster Public-Private Partnerships**: Collaborate with stakeholders to deploy essential infrastructure and advocate supportive policies.
- **Tailor Solutions for Specific Market Needs**: Adapt designs and business models to local challenges in emerging markets.
- **Investigate Grid Integration Strategies**: Develop energy-efficient solutions such as smart grid integration and V2G technologies.
- **Promote Circular Economy Practices**: Focus on reusable components, sustainable materials and battery recycling strategies.

ZEV-UP significantly contributes to the 2ZERO Partnership's aim at meeting the mobility requirements, optimising public and private vehicle ownership in all sectors and levels of the society (2ZERO SRIA, 2024, page. 79). [Pg-110-20]. Its user-centric, affordable, modular and zero-emission BEVs with swappable battery systems tackle key EV adoption barriers. By prioritizing reduced TCO (Total Cost Of Ownership) and conducting real-world urban testing in cities such as Budapest and Istanbul, ZEV-UP generates crucial insights into user acceptance and implementation. Its commitment to circular economic principles and sustainable technologies enhances long-term environmental benefits. Through standardization efforts for battery swapping, cost-reduction strategies and stakeholder engagement for infrastructure development, ZEV-UP can drive the widespread adoption of its BEVs, advancing carbon-neutral road transport in Europe and globally.

ANNEX

The following screenshots show the examples of the project questionnaire designed.

Word Questionnaire



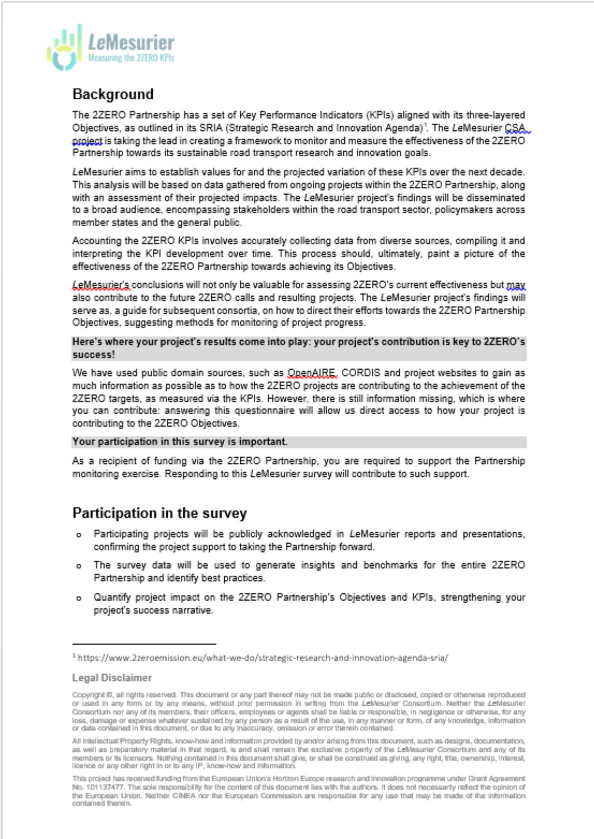
LeMesurier
Measuring the 2ZERO KPIs

Measuring the value of the Key Performance Indicators of the 2ZERO Partnership

Questionnaire

Coordination and Support Action (CSA)
Project No. 101137477 | HORIZON-CL5-2023-D5-01-05

Funded by the European Union



LeMesurier
Measuring the 2ZERO KPIs

Background

The 2ZERO Partnership has a set of Key Performance Indicators (KPIs) aligned with its three-layered Objectives, as outlined in its SRIA (Strategic Research and Innovation Agenda)[1]. The *Le*Mesurier CSA project is taking the lead in creating a framework to monitor and measure the effectiveness of the 2ZERO Partnership towards its sustainable road transport research and innovation goals.

*Le*Mesurier aims to establish values for and the projected variation of these KPIs over the next decade. This analysis will be based on data gathered from ongoing projects within the 2ZERO Partnership, along with an assessment of their projected impacts. The *Le*Mesurier project's findings will be disseminated to a broad audience, encompassing stakeholders within the road transport sector, policymakers across member states and the general public.

Accounting the 2ZERO KPIs involves accurately collecting data from diverse sources, compiling it and interpreting the KPI development over time. This process should, ultimately, paint a picture of the effectiveness of the 2ZERO Partnership towards achieving its Objectives.

*Le*Mesurier's conclusions will not only be valuable for assessing 2ZERO's current effectiveness but may also contribute to the future 2ZERO calls and resulting projects. The *Le*Mesurier project's findings will serve as, a guide for subsequent consortia, on how to direct their efforts towards the 2ZERO Partnership Objectives, suggesting methods for monitoring of project progress.

Here's where your project's results come into play: your project's contribution is key to 2ZERO's success!

We have used public domain sources, such as OpenAIRE, CORDIS and project websites to gain as much information as possible as to how the 2ZERO projects are contributing to the achievement of the 2ZERO targets, as measured via the KPIs. However, there is still information missing, which is where you can contribute: answering this questionnaire will allow us direct access to how your project is contributing to the 2ZERO Objectives.

Your participation in this survey is important.

As a recipient of funding via the 2ZERO Partnership, you are required to support the Partnership monitoring exercise. Responding to this *Le*Mesurier survey will contribute to such support.

Participation in the survey

- Participating projects will be publicly acknowledged in *Le*Mesurier reports and presentations, confirming the project support to taking the Partnership forward.
- The survey data will be used to generate insights and benchmarks for the entire 2ZERO Partnership and identify best practices.
- Quantify project impact on the 2ZERO Partnership's Objectives and KPIs, strengthening your project's success narrative.

[1] https://www.2zeroemission.eu/what-we-do/strategic-research-and-innovation-agenda-sria/

This project has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101137477. The sole responsibility for the content of this document lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither CINEA nor the European Commission are responsible for any use that may be made of the information contained therein.

Overview of the questionnaire

The questions in the following table are based on the information of the 2ZERO SRIA (Strategic Research and Innovation Agenda) and correlate the objectives with their KPIs, their baseline timing and value plus the targets for each KPI. Hence, in the first instance, answers are expected in relation to Europe and its road transport sector.

There are many KPIs, hence an identifier per KPI is used in the format "GO.KPI.X" for KPIs related to the 2ZERO General Objectives, "SO.KPI.X" for KPIs related to Specific Objectives and "OO.KPI.X" for KPIs related to Operational Objectives. This identifier will be used for easier administration in the *Le*Mesurier project. Clearly your project does not relate to all KPIs, hence please only answer questions to those relevant to your project.

The baseline timing refers usually to 2020, which is the year before the start of the 2ZERO Partnership; nevertheless, values before the effect of COVID-19 may be more suitable, please let us know if you believe this to be the case. Please let us know if you have used alternative baseline values to those suggested for your project.

At the end of the questionnaire, there is a broader question related to more generic objective parameters for road transport research. Please just let us know which of these parameters is relevant for your project. We may come back to related these particular answers at a future date.

Structure of the questionnaire

For the majority of the following KPIs you will find the following questions below:

- Does your particular project contribute to achieving the KPI?
- If yes, ...
  - Please describe, how it contributes.
  - Please give an estimate of when relevant results are expected.
  - Does your project introduce innovative methods or demonstrations (or similar)?
  - Can you cite a publication or results that supports your statements?
  - Have you encountered any specific issues or challenges in your contributions to the achievement of the KPI?

If possible, please support your answers with the corresponding values.

The on-line version of the questionnaire expects free format text answers. Please feel free to reference other documents, cite and use content therefrom, as is best to give and support your answers.

Glossary

Abbreviation	Definition
KPI	Key Performance Indicator
CSA	Coordination & Support Action
SRIA	Strategic Research and Innovation Agenda
GO.KPI	KPIs related to the 2ZERO General Objectives
SO.KPI	KPIs related to the 2ZERO Specific Objectives
OO.KPI	KPIs related to the 2ZERO Operational Objectives
EV	Electric Vehicle
RES	Renewable Energy Sources

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V2G	Vehicle-to-Grid
BEV	Battery Electric Vehicle
SUMP guidelines	Sustainable Urban Mobility Plan guidelines
LCA	Life Cycle Assessment
CE	Circular Economy
LCI	Life Cycle Inventory
FCEV	Fuel Cells Electric Vehicles
LDV	Light Duty Vehicles
HDV	Heavy Duty Vehicles
WLTP	Worldwide Harmonised Light Vehicle Test Procedure
TCO	Total Cost of Ownership
EEA	European Environment Agency
tCO_2e	ton CO_2 equivalent
GHG	Greenhouse gases

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Questionnaire

2ZERO Objectives | **KPIs / measures of success, targets & baseline information**

Specific objectives — Develop affordable, user-friendly charging infrastructure concepts and technologies that include vehicle and grid interaction;

SO.KPI.4

Improvement of the integration of EVs into the grid (and related improvement on the load curve management and integration of Renewable Energy Sources).

Targets:

1. Commonly agreed charging protocols enabling V2G options for BEV by 2030
2. 100% of new BEV and infrastructure offering smart charging possibilities by 2030

Suggested Baseline:

Year: ~2019

Value: 3 charging protocols, 50% of BEV and infrastructure

Target year: 2030

A) Does your project contribute to the improvement of the integration of EVs into the grid?

☐ Yes ☐ No ☐ Partially ☐ I don't know

***If your answer is 'I don't know'**, please point us towards a source that may be able to answer questions about your project's contributions to this particular KPI.*

If your answer is 'yes' or 'partially', please provide:

B) Please generally describe how your project contributes or will contribute to the integration of EVs into the grid.
C) Please give an estimate of when relevant project results are expected.
D) Is your project working on charging protocols enabling V2G options for BEVs?
E) (If yes) At the time of submission, what value and year did your proposal use as a reference to measure the increase of BEVs supporting V2G capabilities against?
F) (If yes) As of today (or the end of your last reporting period, if applicable), please estimate the percentage of the number of BEVs that support V2G capabilities.
G) (If yes) Please estimate the percentage of BEVs that will support V2G capabilities by 2030.
H) Is your project working on smart charging possibilities for BEVs?
I) (If yes) At the time of submission, what value and year did your proposal use as a reference to measure the percentage of BEVs and the infrastructure offering smart charging possibilities against?
J) (If yes) As of today (or the end of your last reporting period, if applicable), please estimate the percentage of the number of BEVs and the infrastructure offering smart charging possibilities.
K) (If yes) Please estimate the percentage of the number of BEVs and the infrastructure offering smart charging possibilities by 2030.
L) Please cite project publications or results that support your statements. Please provide web-links, where feasible.

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M) Have you encountered any specific issues in your work that hindered improving the integration of EVs into the grid? If so, please describe the issues (regulatory/technological/skills/financial/other) you have faced in more detail.
N) Would have answering one or more of the questions above cause a potential confidentiality issue? If so, please explain.

SO.KPI.5 / OO.KPI.6

Improvement in charging efficiency demonstrated for

- **Slow charging/ Low power (3 kW up to 22 kW)**
- **Fast charging/ High power (>150 kW)**
- **Ultra-fast charging / Ultra high (> 300 kW)**

Target: At least 25% reduction of energy losses during charging (considering both charger and vehicle) for all types of chargers by 2030

Suggested Baseline:

Year: ~2019

Value: 10 – 25% energy lost

A) Does your project contribute to the improvement of charging efficiency for slow, fast and/or ultra-fast charging?

☐ Yes ☐ No ☐ Partially ☐ I don't know

***If your answer is 'I don't know'**, please point us towards a source that may be able to answer questions about your project's contributions to this particular KPI.*

If your answer is 'yes' or 'partially', please provide:

B) Please describe how your project will contribute to the improvement of charging efficiency for slow, fast and/or ultra-fast charging.
C) Please give an estimate of when relevant project results are expected.
D) Is your project working on charging power range for low-power charging infrastructure?
E) (If yes) At the time of submission, what value and year did your proposal use as a reference to measure the increase of charging power range against?
F) (If yes) As of today (or the end of your last reporting period, if applicable), please estimate the increase in the charging power range for low-power charging infrastructure.
G) (If yes) Please estimate the increase in the charging power range for low-power charging infrastructure by 2030.
H) Is your project working on charging power range for high power charging infrastructure?
I) (If yes) At the time of submission, what value and year did your proposal use as a reference to measure the increase of charging power range against?
J) (If yes) As of today (or the end of your last reporting period, if applicable), please estimate the increase in the charging power range for high-power charging infrastructure.
K) (If yes) Please estimate the increase in the charging power range for high-power charging infrastructure by 2030.

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*Le*Mesurier
Measuring the 2ZERO KPIs

Online Questionnaire

Contribution ID: a90f862f-ce53-4e9a-a764-a4776b29e868
Date: 03/12/2024 19:40:02

*Le*Mesurier Project Questionnaire

*Le*Mesurier
Measuring the 2ZERO KPIs

Coordination and Support Action (CSA)
Project No. 101137477 | HORIZON-CL5-2023-D5-01-05

Background

The 2ZERO Partnership has a set of Key Performance Indicators (KPIs) aligned with its three-layered Objectives, as outlined in its SRIA (Strategic Research and Innovation Agenda[1]). The *Le*Mesurier CSA project is taking the lead in creating a framework to monitor and measure the effectiveness of the 2ZERO Partnership towards its sustainable road transport research and innovation goals.
*Le*Mesurier aims to establish values for and the projected variation of these KPIs over the next decade. This analysis will be based on data gathered from ongoing projects within the 2ZERO Partnership, along with an assessment of their projected impacts. The *Le*Mesurier project's findings will be disseminated to a broad audience, encompassing stakeholders within the road transport sector, policymakers across member states and the general public.
Accounting the 2ZERO KPIs involves accurately collecting data from diverse sources, compiling it and interpreting the KPI development over time. This process should, ultimately, paint a picture of the effectiveness of the 2ZERO Partnership towards achieving its Objectives.
*Le*Mesurier's conclusions will not only be valuable for assessing 2ZERO's current effectiveness but may also contribute to the future 2ZERO calls and resulting projects. The *Le*Mesurier project's findings will serve as a guide for subsequent consortia, on how to direct their efforts towards the 2ZERO Partnership Objectives, suggesting methods for monitoring of project progress.
Here's where your project's results come into play: your project's contribution is key to 2ZERO's success!
We have used public domain sources, such as OpenAIRE, CORDIS and project websites to gain as much information as possible as to how the 2ZERO projects are contributing to the achievement of the 2ZERO targets, as measured via the KPIs. However, there is still information missing, which is where you can contribute: answering this questionnaire will allow us direct access to how your project is contributing to the 2ZERO Objectives.
Your participation in this survey is important.
As a recipient of funding via the 2ZERO Partnership, you are required to support the Partnership monitoring exercise. Responding to this *Le*Mesurier survey will contribute to such support.

1

Participation in the survey

- Participating projects will be publicly acknowledged in *Le*Mesurier reports and presentations, confirming the project support to taking the Partnership forward.
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- Quantify project impact on the 2ZERO Partnership's Objectives and KPIs, strengthening your project's success narrative.

Overview of the questionnaire

The questions in the following table are based on the information of the 2ZERO_SRIA (Strategic Research and Innovation Agenda) and correlate the objectives with their KPIs, their baseline timing and value plus the targets for each KPI. Hence, in the first instance, answers are expected in relation to Europe and its road transport sector.
There are many KPIs, hence an identifier per KPI is used in the format "GO.KPI.X" for KPIs related to the 2ZERO General Objectives, "SO.KPI.X" for KPIs related to Specific Objectives and "OO.KPI.X" for KPIs related to Operational Objectives. This identifier will be used for easier administration in the *Le*Mesurier project. Clearly your project does not relate to all KPIs, hence please only answer questions to those relevant to your project.
The baseline timing refers usually to 2019, with a few exceptions. Please let us know if you have used alternative baseline values to those suggested for your project.
At the end of the questionnaire, there is a broader question related to more generic objective parameters for road transport research. Please just let us know which of these parameters is relevant for your project. We may come back to related these particular answers at a future date.

Structure of the questionnaire

For the majority of the following KPIs you will find the following questions below:

- Does your particular project contribute to achieving the KPI?
- If yes, ...
  - Please describe, how it contributes.
  - Please give an estimate of when relevant results are expected. Does your project introduce innovative methods or demonstrations (or similar)?
  - Can you cite a publication or results that supports your statements?
  - Have you encountered any specific issues or challenges in your contributions to the achievement of the KPI?

If possible, please support your answers with the corresponding values.
The on-line version of the questionnaire expects free format text answers. Please feel free to reference other documents, cite and use content therefrom, as is best to give and support your answers.

Glossary

2

Abbreviation	Definition
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LCA	Life Cycle Assessment
CE	Circular Economy
LCI	Life Cycle Inventory
FCEV	Fuel Cells Electric Vehicles
LDV	Light Duty Vehicles
HDV	Heavy Duty Vehicles
WLTP	Worldwide Harmonised Light Vehicle Test Procedure
TCO	Total Cost of Ownership
EEA	European Environment Agency
tCO_{2e}	ton CO_2 equivalent
GHG	Greenhouse gases

[1] https://www.2zeroemission.eu/what-we-do/strategic-research-and-innovation-agenda-sria/

1. Please fill in your name, surname and the project acronym you are responsible for.

2. Which of the following 2ZERO KPIs (you can choose more than one) does your project contribute to?

- [x] **SO.KPI.4**
Improvement of the integration of EVs into the grid (and related improvement on the load curve management and integration of Renewable Energy Sources).
- [x] **SO.KPI.5 / OO.KPI.6**
Improvement in charging efficiency demonstrated. For slow charging (3kW up to 22kW) For fast (>150 kW) and For ultra-fast charging (> 300 kW).
- [ ] **SO.KPI.6**
Development of well-established decision-making tools and stakeholder engagement practices to implement integrated deployment strategies for boosting e-mobility as project follow-ups.
- [ ] **SO.KPI.7**
Well-established fleet managerial tools to smoothly incorporate zero tailpipe vehicles in transportation fleets.
- [ ] **SO.KPI.8a**
Number of (public and private) transport operators implementing zero tailpipe business models and use cases for freight and passenger transport.
- [ ] **SO.KPI.8b**

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Demonstrated innovative use cases using zero tailpipe trucks for regional, medium, and long-haul, addressing payloads from 7.5 t to 40+ t by 2025-2027.
- [ ] **SO.KPI.9**
Commonly accepted Life Cycle Assessment (LCA) approach.
- [ ] **SO.KPI.10**
Implementation of a Life Cycle Inventory (LCI) database.
- [ ] **SO.KPI.11**
Feasibility of advanced circular economy (CE) strategies in zero emission mobility solutions demonstrated by performed use cases.
- [x] **OO.KPI.1**
Demonstration of technologies, components, systems and their integration in vehicles enabling affordability, high efficiency and fast charging capability.
- [ ] **OO.KPI.2**
Demonstrator vehicles and concepts realized in 2ZERO with an optimized cost vs. benefit and an expected positive impact on cost drivers such as for example.
- [ ] **OO.KPI.3**
Demonstrator vehicles and concepts realized in 2ZERO with an optimized cost vs. benefit and an expected positive impact on cost drivers, such as Energy consumption in production, in use and at the end-of-life; Material used; Production steps and number of parts and; Usage models and productivity.
- [ ] **OO.KPI.4**
Demonstration of technologies, components, systems and their integration in vehicles enabling affordability, high efficiency and fast charging capability.
- [x] **OO.KPI.5**
Optimal balance between battery size, user needs and recharging infrastructure capabilities identified from EU funded projects.
- [x] **OO.KPI.7**
Safe,secure and smooth communication exchange between vehicle and charging infrastructure, including communication with the grid and roaming platforms (including access of third parties to the charging infrastructure).
- [x] **OO.KPI.8**
Definition of dynamic load management profiles for specific smart and bidirectional charging scenarios (office building, private house/garage, public space) by EU funded projects, allowing effective grid load management that can lead to increase RES penetration.
- [ ] **OO.KPI.9**
Demonstrated charging operations, answering the freight and logistics requirements avoiding logistics losses.
- [ ] **SO.KPI.1**
Ability of determining realistically and reliably the energy intensity (tank-to-wheel).
- [ ] **SO.KPI.2**
Reduce GHG of mobility of people and goods (expressed in tonCO2eq./pkm or tkm and toe /pkm and toe /tkm).
- [ ] **SO.KPI.3**
Reduction of time and effort needed for the development of zero tailpipe emission solutions
- [ ] **GO.KPI.3**
Reduction of CO_2 emission from road transport for all types of vehicles

SO.KPI.4

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LeMesurier
Measuring the 2ZERO KPIs

Is your project working on charging protocols enabling V2G options for BEVs?

YES

At the time of submission, what value and year did your proposal use as a reference to measure the increase in the number of BEVs supporting V2G capabilities against?

Text of 1 to 2000 characters will be accepted

As of today (or the end of your last reporting period, if applicable), please estimate the percentage of the number of BEVs that support V2G capabilities.

Text of 1 to 2000 characters will be accepted

Please estimate the percentage of the number of BEVs that will support V2G capabilities by 2030.

Text of 1 to 2000 characters will be accepted

Is your project working on a deployment plan of parking spots and/or logistics facilities combined with smart charging strategies?

- YES
- NO

Please cite project publications or results that support your statements. Please provide web-links where feasible.

Text of 1 to 2000 characters will be accepted

Have you encountered any specific issues when implementing dynamic load management profiles for specific smart and bidirectional charging scenarios to increase RES penetration?

- YES
- NO

Would answering one or more of the questions above cause a potential confidentiality issue? If so, please explain.

Text of 1 to 2000 characters will be accepted

3. Does your project contribute to the following areas?

	YES	NO	PARTIALLY
Carbon Neutrality	○	○	●
Air Pollution and Health Effects	○	○	○
European Competitiveness	○	○	●
Technology Leadership	○	○	●
Economic Growth	○	○	●
Circular Economy	○	○	○

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Thank you for taking the time to complete the '2ZERO Partnership' impact assessment! We greatly appreciate your contribution.

Contact

Contact Form

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