



# MONITORING PROGRAMMES FOR 2ZERO, CCAM AND POWER GRID ACTIONS IN MADRID AND DRESDEN

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## List of abbreviations

ACRONYM	DESCRIPTION
2Zero	Towards Zero Emission Road Transport
CCAM	Cooperative, Connected, and Automated Mobility
CCC	Climate City Contract
DVB	Dresdner Verkehrsbetriebe AG
EU	European Union
EV	Electric Vehicle
KPI	Key Performance Indicator
LC	Leading City
LCA	Life Cycle Assessment
LCC	Life Cycle Cost
NZC	NetZeroCities
PM	Particulate Matter
PU	Public
RES	Renewable Energy Sources
SUMI	Sustainable Urban Mobility Indicators
TRL	Technological Readiness Level
UT- Labs	Urban Transport Laboratories
V2G	Vehicle-to-Grid

## List of symbols

SYMBOL	DESCRIPTION
CO	Carbon Monoxide
CO <sub>2</sub>	Carbon Dioxide
dB	Decibel
€	Euro (Used in Economic KPIs)
Hours/units	Hours per Unit (Charging Time)
Km	Kilometres
KWh	Kilowatt-hours
KWp	kilowatt 'peak
Microg/m <sup>3</sup>	Micrograms per Cubic Meter (Air Quality Metric)
NO <sub>x</sub>	Nitrogen Oxides
Ppb	Parts per Billion
SF <sub>6</sub>	Sulfur Hexafluoride
TnCO <sub>2</sub> eq	Tonnes of CO <sub>2</sub> Equivalent
%	Percentage

## Publishable Summary

MOBILITIES FOR EU is a Horizon Europe innovation project and is dedicated to pioneering sustainable solutions for urban mobility across Europe.

Deliverable D3.2 builds on the foundations set in D3.1 (Evaluation Framework) by moving from what to measure toward how to measure it. Its main goal is to design and launch the monitoring programmes that will track the performance of innovative mobility and energy solutions being implemented in Madrid and Dresden.

These monitoring programmes will support the collection of reliable, comparable, and meaningful data on the twenty-seven pilot solutions – ranging from autonomous vehicles to smart charging systems – ensuring that their impact on CO<sub>2</sub> emissions, energy efficiency, and public acceptance can be accurately assessed. A systematic monitoring programme enables the structured compilation of data on implemented solutions, supporting informed decisions to optimise resources and advance learning for replicable urban planning.

The monitoring programme combines digital innovation and the evaluation of the pilots:

- Sensors & Devices – Air quality monitors, smart meters, and connected vehicle data will provide direct insights on emissions, energy use, and system performance.
- Digital Data Platforms – Real-time systems developed by project partners like SAP and T-Systems will integrate information from sensors, vehicles, energy grids, and urban infrastructure into a unified “Data Intelligent Hub” to support the calculation of the KPIs.
- Citizen & Stakeholder Feedback – The Urban Transport Labs (UT-Labs) will continue to play a key role, collecting social acceptance and user experience data through surveys, workshops, and interactive sessions.
- Economic Footprint – Monitoring costs, investments, and economic gains allows for a robust evidence base of MOBILITIES’ economic footprint, informing policy decisions and replication in other EU cities.
- Aligned Methodology – All monitoring follows the evaluation framework defined in D3.1 -Evaluation framework-, drawing on CIVITAS, SUMI, and the Cities Mission Platform (NetZeroCities) to ensure comparability and EU-wide relevance.

This deliverable transparently documents the development of monitoring programmes for 27 pilot measures and serves as a practical guide for cities seeking to replicate these approaches. It defines the scope of monitoring across three action pillars—2ZERO, CCAM, and Power Grid Actions—and presents a harmonised KPI monitoring methodology aligned with NetZeroCities, CIVITAS, and SUMI, covering environmental, energy, transport, social, and economic impacts.

The core of the deliverable details the monitoring programmes per action, explaining how data collection, modelling, performance and process evaluation, and citizen engagement through Urban Transport Labs are applied consistently across pilots in Madrid and Dresden. Dedicated sections address social acceptance and economic evaluation, while digital monitoring platforms developed by T-Systems and SAP support data integration, analysis, and reporting, ensuring robust, scalable, and actionable evidence for climate-neutral urban mobility.

By setting up these monitoring programmes, MOBILITIES FOR EU will:

- Generate robust datasets on the environmental, economic, and social effects of the pilots in Madrid and Dresden.

- Track real progress toward climate neutrality by measuring changes in CO<sub>2</sub> emissions while enhancing understanding of energy demand and associated co-benefits, including improved air quality.
- Support decision-makers and citizens with clear evidence on the viability, benefits and limitations of new mobility solutions.
- Create a replicable blueprint for other European cities, ensuring that the monitoring methods developed here can be scaled up to the five Replication Cities and beyond.

Ultimately, the work done in task T3.2, Monitoring Programmes, and reflected in this deliverable D3.2 ensures that the innovative mobility actions piloted under MOBILITIES FOR EU are not just tested, but properly understood — turning data into actionable insights for a cleaner, smarter, and more sustainable urban future.

## 1. Introduction

### Background of the MOBILITIES FOR EU Project

MOBILITIES FOR EU is a Horizon Europe innovation project and part of the European Commission’s Climate-Neutral and Smart Cities Mission, which is dedicated to pioneering sustainable solutions for urban mobility across Europe.

In this project, forward-thinking solutions from autonomous vehicles to hydrogen buses, smart grids, and Urban Transport Labs (UT-Labs) are tested to make city mobility cleaner, safer, and more inclusive. The cities of Madrid and Dresden lead the way by assessing a total of twenty-seven innovative measures. Moreover, five Replication Cities—Ioannina (Greece), Trenčín (Slovakia), Espoo (Finland), Gdańsk (Poland), and Sarajevo (Bosnia & Herzegovina)—will participate directly through their own UT-Labs, enabling better replicability and scaling planning in the future.

The aim of the project is to demonstrate that innovative concepts for passenger mobility and freight transport, developed and implemented using approaches focused on the participation of the users, have the potentiality to be cost-effective, environmentally friendly and viable solutions. These innovations play a key role in advancing cities toward climate neutrality, accelerating efforts to achieve emissions reductions by 2030.

### Contribution from Partners

Deliverable D3.2 is part of Work Package 3 (Performance Assessment and CO<sub>2</sub> Emissions Reduction), led by CARNET, with the active involvement of key partners like T-Systems, SAP, local authorities and technical partners in Madrid and Dresden. Together, they bring expertise in data integration, evaluation methods, and urban mobility planning to design a monitoring system that is technically solid and easy to replicate. Furthermore, the partners provided the necessary values to create the monitoring programme framework. The following depicts the main contributions from participating partners in the development of this deliverable. The contributions are based on the responsibility of the partners for the different ethical concerns.

Table 1. Partners Contribution

PARTNER SHORT NAME	CONTRIBUTIONS
CARNET	Overall Framework for Monitoring Programme. Responsible for and main contributor of this deliverable.
MADRID	KPI and monitoring data for Madrid Pilot they are involved in. Overall view as demo leader.
MERCAMADRID	KPI and monitoring data for Madrid Pilot they are involved in.
EMT	KPI and monitoring data for Madrid Pilot they are involved in. Deliverable review for LCC/LCA

ORANGE	KPI and monitoring data for Madrid Pilot they are involved in.
FERROVIAL	KPI and monitoring data for Madrid Pilot they are involved in.
T-SYS	Monitoring Platform for Madrid ecosystem information KPI and monitoring data for Madrid Pilot they are involved in.
PLEXIGRID	KPI and monitoring data for Madrid Pilot they are involved in.
UPM	KPI and monitoring data for Madrid Pilot they are involved in.
PZGR	KPI and monitoring data for Madrid Pilot they are involved in.
ALSA	KPI and monitoring data for Madrid Pilot they are involved in.
DRESDEN	KPI and monitoring data for Dresden Pilots they are involved in. Overall view as demo leader and Responsible for task T3.3 - Data collection and KPI calculation.
VWGI	KPI and monitoring data for Dresden Pilot they are involved in.
FHG	KPI and monitoring data for Dresden Pilot they are involved in.
SAP	Monitoring Platform for Dresden Ecosystem information KPI and monitoring data for Dresden Pilot they are involved in.
TUD	KPI and monitoring data for Dresden Pilot they are involved in.
RC	Monitoring Programme for Social Acceptance and Social Readiness
CARTIF	Overall view as coordinator and responsible for task T3.4 - Evaluation and contribution to City-wide Climate Neutrality objectives, 2Zero and CCAM partnerships.  Deliverable Review.

## Purpose of the Deliverable

This deliverable is linked to the WP3 and outlines the evaluation framework for the MOBILITIES FOR EU project, with a focus on performance assessment and the reduction of CO<sub>2</sub> emissions. It can be observed in the Figure 1 how this WP3 is established in the MOBILITIES FOR EU Work Plan.

Building on the evaluation framework created in D3.1 -Evaluation framework-, this deliverable defines how the project's impacts will be tracked in real-world conditions. It sets up the monitoring programmes for the pilot actions, detailing which data will be gathered, how often, by whom, and using which tools. This step is crucial to ensure that future reporting on CO<sub>2</sub> reduction, energy savings, and societal impacts is consistent, credible, and comparable across cities.

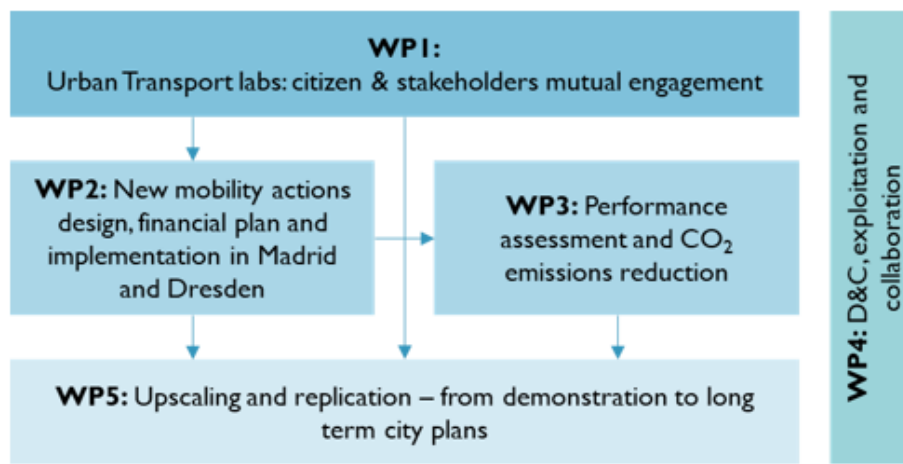


Figure 1 - MOBILITIES FOR EU Work Plan

Building on the KPIs identified in Task 3.1, specific monitoring programmes will be established for individual, packaged, and city-level interventions in Madrid and Dresden, with the aim of systematically assessing direct, indirect, and induced impacts.

- ST3.2.1 Monitoring programme for energy efficiency, CO<sub>2</sub> emissions at demo/city level for Madrid and Dresden.
- ST3.2.2 Monitoring programme for demand changes, and associated costs (LCA/LCC) in Madrid and Dresden.
- ST3.2.3 Monitoring programme for noise/pollutants in Madrid and Dresden.
- ST3.2.4 Monitoring programme for social acceptance and social readiness in Madrid and Dresden.

## Intended Audience

This document, D3.2, has been primarily developed for the MOBILITIES FOR EU consortium partners and the European Commission evaluators. However, it also serves as a publicly accessible reference for city officials, transport planners, researchers, and citizens interested in understanding the methodologies used to assess sustainable mobility solutions. The document provides a transparent account of the evidence collection processes that underpin decision-making on the pathway toward climate-neutral cities.

With a public (PU) dissemination level, this document functions both as an internal guideline for project beneficiaries and as a broader resource for urban administrators, policymakers, and the wider public to comprehend the project's benefits, progress, and societal impacts.

## 2. Scope of Monitoring

### 2.1 Overview of 2ZERO, CCAM and Power Grid Actions (Geographical Focus: Madrid and Dresden)

The MOBILITIES FOR EU project focuses on transforming urban mobility in two leading cities Madrid and Dresden through a carefully selected set of innovative interventions. These fall under three key action areas:

- **2ZERO (Towards Zero Emission Road Transport):** Measures designed to drastically cut emissions from road transport, including the rollout of electric buses, hydrogen fuel cell vehicles, and charging infrastructure. Madrid is pioneering initiatives like the full electrification of a major bus depot supported by smart pantograph charging systems and the introduction of ten hydrogen buses, while Dresden is monitoring the use of 20 electric buses.
- **CCAM (Cooperative, Connected and Automated Mobility):** Actions that integrate autonomous and connected vehicle technologies into the urban environment. In Madrid, autonomous e-vehicles are being tested for last-mile freight delivery, and a mid-size autonomous e-bus will serve the Mercamadrid market area. Dresden is piloting similar concepts for people and freight, including small, automated vehicles for sports facilities and charging robots for dynamic fleet charging.
- **Power Grid Actions:** Upgrades to the local energy infrastructure are implemented to support the shift to electrified mobility. This includes smart grids, V2G (vehicle-to-grid) chargers, renewable energy integration, and energy management systems. Both cities are testing how these systems can balance demand, increase flexibility, and provide clean energy for transport fleets.

Together, these actions represent in total eleven pilot initiatives with twenty-seven distinct measures, forming a unique living laboratory for sustainable mobility. Madrid and Dresden were chosen because they offer two diverse urban contexts, from Madrid's dense, metropolitan environment to Dresden's more mid-sized, mixed urban fabric, allowing the project to test solutions that can later be replicated across Europe.

### 2.2 Relevance of Monitoring for Climate Neutrality Goals

To reach climate neutrality by 2030, it is not enough to simply deploy innovative mobility solutions, but their real impact must be measured, verified, and understood. That is where monitoring becomes essential.

The monitoring program defined in this document, D3.2, will capture data across environmental, energy, transportation, social and economic dimensions:

- It will quantify reductions in CO<sub>2</sub> and other greenhouse gas emissions from the transition to electric and hydrogen vehicles.
- It will track energy use and efficiency gains, ensuring that electrification is truly powered by cleaner sources and that demand on the grid is optimized.
- It will consider the use of vehicles, mileage, speed, and operations.
- It will evaluate user acceptance and societal benefits, such as improved air quality, reduced noise, and greater access to sustainable transport.
- It will control economic capital and operational costs, as well as pollution impacts.

By systematically gathering and analysing this information, MOBILITIES FOR EU can provide evidence-based insights to city leaders, policymakers, and citizens. These insights will answer critical questions: Are the new

systems delivering the expected emissions reductions? Are they financially and operationally viable? Are people comfortable using them?

The results will not only inform the ongoing pilots in Madrid and Dresden but will also create a guide for the five Replication Cities, and for many other European cities striving to achieve climate neutrality. Monitoring will help turn ambitious climate goals into measurable progress and actionable knowledge.

### 3. Methodology for KPI Monitoring

This chapter sets out how the MOBILITIES FOR EU project will monitor the performance of its pilot actions in Madrid and Dresden. Building on the evaluation framework defined in Deliverable D3.1 -Evaluation framework-, this methodology translates the theory of performance assessment into a practical monitoring programme that can deliver consistent, reliable, and comparable results.

#### 3.1 Alignment with NetZeroCities, CIVITAS and SUMI Indicators

The KPI monitoring approach is firmly anchored in three major European reference frameworks to ensure methodological robustness and EU-wide relevance:

- **NetZeroCities (NZN):** The EU's Cities Mission platform provides the conceptual foundation for climate neutrality targets by 2030. NZN focuses on measuring Scope 1, 2 and 3 emissions (direct, indirect, and induced). MOBILITIES FOR EU adopts these definitions, ensuring its data can be seamlessly integrated into NZN reporting and the Climate City Contracts (CCC) developed by Madrid and Dresden.
- **CIVITAS Process and Impact Evaluation Framework:** CIVITAS offers a long-tested approach to evaluating urban mobility measures. MOBILITIES FOR EU mirrors CIVITAS' structure, analysing both impact (environmental, social, economic effects) and process (how measures are implemented and received).
- **Sustainable Urban Mobility Indicators (SUMI):** SUMI provides a standardised set of urban mobility KPIs recognised across Europe. MOBILITIES FOR EU integrates SUMI's baseline indicators (e.g. access to mobility, safety, affordability) and enriches them with project-specific metrics for innovative pilots like autonomous freight and hydrogen buses.

This alignment ensures that data from Madrid and Dresden is credible, comparable and future-proof — and can directly feed into EU policy, replication strategies, and benchmarking exercises for other cities.

#### 3.2 Selection and Categorization of KPIs (linked to D3.1 -Evaluation framework)

Deliverable D3.1 -Evaluation framework- created the structure of the evaluation framework by identifying a robust set of 23 Key Performance Indicators (KPIs) that MOBILITIES FOR EU will track throughout the project. These KPIs reflect not just the technical performance of the pilots, but also their environmental, social, and economic impacts — ensuring the assessment is holistic and aligned with NetZeroCities, CIVITAS, and SUMI standards.

In this document, D3.2, these KPIs move from concept to practical monitoring. Each KPI is categorised into one of five main domains: Environment, Energy, Transport, Society, and Economy. Together, they provide a view of how the twenty-seven pilot measures in Madrid and Dresden are contributing to the project's objectives. Here a short recap of the in D3.1 -Evaluation framework- defined and outlined KPIs:

##### 3.2.1 ENVIRONMENT

Environmental KPIs measure how MOBILITIES for EU's innovations impact climate, air quality, and overall ecological performance. This category is central to the project's mission of achieving climate neutrality by 2030.

- CO<sub>2</sub> and GHG reductions (Scope 1, 2, and 3): Calculated in tonnes of CO<sub>2</sub>-equivalent, these KPIs track direct emissions (from transport fleets), indirect emissions (from purchased electricity), and induced emissions (e.g., from supply chains).
- Air quality improvements: Concentrations of pollutants like NO<sub>x</sub>, PM<sub>2.5</sub>/PM<sub>10</sub>, and SO<sub>2</sub> will be measured using city monitoring stations and IoT sensors to assess the health benefits of electric fleets.
- Noise reduction: Transitioning from diesel to electric vehicles reduces urban noise; decibel (dB) levels before and after deployment will show the real change in public spaces.
- Circularity and waste metrics: KPIs will also look at how materials are reused, batteries recycled, and infrastructure managed, contributing to a circular economy perspective.

These indicators ensure that MOBILITIES FOR EU demonstrates measurable environmental progress, not just promises giving cities a clear case for further investment in green mobility.

### 3.2.2 ENERGY

Energy KPIs capture how the pilots use, manage, and optimise power, a vital component for a future where transport electrification does not overload the grid. Indicators considered include:

- Total energy consumption (kWh): Tracks the electricity or hydrogen needed to operate new fleets and services, giving insight into efficiency.
- Renewable energy share: Measures what percentage of the energy powering mobility solutions comes from renewables like solar or other RES.
- Charging and refuelling efficiency: Analyses energy losses in the charging process, from grid to vehicle, to pinpoint areas for optimisation.
- Grid flexibility and resilience: Looks at how interventions like smart charging, vehicle-to-grid (V2G) and load shifting reduce peak demand, helping cities balance their networks.

Energy KPIs prove whether electrification is truly sustainable, showing if new systems are clean, efficient, and capable of scaling without causing strain on energy infrastructure.

### 3.2.3 TRANSPORT

Transport KPIs focus on how the mobility system itself performs and evolves as pilots are deployed. The KPIs considered in this case include:

- Mileage: Tracks the total kilometres travelled by the new fleets (e.g., buses, autonomous shuttles, delivery robots). This helps assess the scale and intensity of use and provides context for environmental and energy impacts.
- Quantity of waste collected: For pilots involving autonomous freight or waste management solutions (e.g., automated waste trolleys in Mercamadrid), this KPI measures how much material is actually being moved. It shows the practical value of these services and their contribution to operational efficiency.
- Number of trips per day: Records the frequency of vehicle operations (e.g., how many shuttle runs or delivery trips are made daily). This reflects both service utilisation and user demand.
- Charging times: Monitors how long vehicles spend connected to chargers, offering insights into operational downtime, charging infrastructure efficiency, and the potential for optimising schedules.

- Commercial speed: Calculates the average speed of service (including stops), providing a measure of service reliability and user convenience. Faster, predictable services are more likely to attract and retain passengers or freight clients.
- Perception of security: Drawn from surveys and feedback in UT-Labs, this KPI gauges how safe users feel when using new transport modes (e.g., autonomous buses, shared mobility services). A positive sense of security is critical for public acceptance and wider adoption.

These transport KPIs go beyond abstract measures to capture the operational heartbeat of the MOBILITIES FOR EU pilots. They show whether the innovative solutions are not only running, but running well — delivering services that are frequent, efficient, reliable, and trusted by the people who use them.

### 3.2.4 SOCIETY

Societal KPIs capture the human dimension of MOBILITIES for EU, focusing on how people perceive, accept, and engage with the new mobility solutions and how well local ecosystems collaborate to make them succeed.

- Acceptance: Measures the degree to which citizens, commuters, and businesses are willing to use or support the new mobility solutions. Collected through UT-Lab surveys, interviews, and events, this KPI reflects overall trust in innovations like autonomous vehicles, hydrogen buses, and smart freight systems.
- Awareness: Tracks how well-informed different target groups are about the pilots — for example, do citizens know about new services, their environmental benefits, and how to access them? A higher level of awareness is a prerequisite for active use and broader community support.
- Customer Satisfaction Index: Summarises how users rate their experience with the pilots, including aspects like comfort, usability, and perceived value. This KPI provides clear feedback on what is working and where improvements are needed to encourage regular adoption.
- Quality of Cooperation Structures with Stakeholders: Evaluates how effectively municipalities, technology providers, operators, and civic groups are working together to implement the measures. It covers the strength of partnerships, communication channels, and the level of mutual trust built through the UT-Labs and other engagement activities.

These societal KPIs ensure MOBILITIES FOR EU is not just deploying technology, but also building public trust and fostering strong local alliances. Measuring acceptance, awareness, satisfaction, and cooperation creates a full picture of whether the solutions are socially embedded and ready for replication across Europe.

### 3.2.5 ECONOMY

Economic KPIs track the financial footprint of MOBILITIES for EU's pilots, assessing not only the costs and investments involved but also the broader economic value they generate. These indicators help determine if the solutions are financially sustainable and if they create measurable benefits for the cities and their citizens.

- Capital Investment: Captures all upfront spending for the pilots, from the purchase of e-buses, hydrogen refuelling stations, and charging robots to infrastructure upgrades. This KPI shows the scale of commitment required and supports comparisons with similar projects across Europe.
- Average Operating Costs: Tracks the ongoing expenses of running the solutions (e.g., maintenance, energy, staff). Monitoring these costs helps evaluate whether the pilots offer cost efficiencies compared to traditional transport systems and whether they could be scaled affordably.

- **Pollution Cost Avoided:** Estimates the economic value of improved air quality and reduced greenhouse gas emissions by translating environmental benefits into monetary terms (e.g., reduced healthcare costs, fewer sick days, less damage to infrastructure).
- **Economic Impact:** Measures the wider effects of the pilots on the local economy, such as new jobs, supply chain activity, or induced business opportunities. It considers both direct and indirect impacts, creating a picture of how innovation fuels local growth.

By combining costs, investments, and economic gains, these KPIs answer a key question for decision-makers, making sure the MOBILITIES FOR EU solutions are not only environmentally and socially sound, but also financially viable and beneficial in the long term. This evidence is crucial for justifying future funding, scaling up the pilots, and encouraging other cities to invest in similar measures.

### 3.3 Defining Roles and Responsibilities

Monitoring pilots is a collaborative effort; therefore, it is important to clearly define roles and responsibilities for each measure taken. Based on the detailed outline in D3.1 -Evaluation framework-, the following roles are defined to ensure accountability:

- **Project Evaluation Manager (PEM)** – CARNET (WP3 leader) oversees KPI methodology, consistency, and quality assurance across all pilots.
- **Local Evaluation Managers (LEM)** – based in Madrid and Dresden (appointed by the municipalities) manage data collection and coordinate with local partners.
- **Site Coordinators & Measure Leaders** – assigned to each pilot measure (e.g. EMT for electric buses in Madrid, Dresden’s DVB – public transport company in the city of Dresden – for e-bus charging infrastructure) to implement the solutions and/or provide the necessary data for the KPIs.
- **Technology Partners (SAP, T-Systems)** – provide digital platforms, real-time data integration, and analytics support.

### 3.4 Integration with the Urban Transport Labs (UT-Labs)

MOBILITIES FOR EU is built on the belief that technical innovation alone is not enough to achieve climate-neutral cities. Real transformation requires active citizen involvement, trust, and shared ownership of solutions. This principle is brought to life through the Urban Transport Labs (UT-Labs): collaborative hubs are set up in each of the seven project cities, including the two lead cities (Madrid and Dresden) and the five replication cities (Ioannina, Trenčín, Espoo, Gdańsk, and Sarajevo).

The UT-Labs are more than consultation forums; they are intended to be co-creation spaces where various stakeholders come together to design, refine, and evaluate the new mobility solutions being tested.

For Madrid and Dresden, the UT-Labs are deeply integrated into the monitoring programme in a dual role:

1. **Data Collection and Social Insight Generation:** UT-Labs are the primary source of qualitative and participatory data for the Social KPIs identified in D3.1 -Evaluation framework- and refined in this deliverable. Through workshops, surveys, interviews, “world café” sessions, and digital platforms, the UT-Labs will provide real-time feedback on how the public experiences the pilots, from autonomous buses to smart freight vehicles. This social data complements the quantitative KPIs (like mileage or CO<sub>2</sub> reduction) by showing the human reaction to the innovation, making the evaluation richer and more balanced.

2. **Validation and Co-Creation of Monitoring Processes:** Beyond collecting data, the UT-Labs will act as testing grounds for the monitoring system itself. Citizens and stakeholders can help validate survey tools, suggest better ways to frame questions, and highlight blind spots (for example, if certain neighbourhoods or groups are being overlooked). This makes the monitoring more inclusive and ensures that MOBILITIES FOR EU is not just observing citizens but engaging them as active contributors to the project's success.

With the UT-Labs approach qualitative depth is added to the KPI monitoring, turning statistics into insights. They ensure that social KPIs are based on reality, reflecting lived experiences rather than abstract assumptions. Furthermore, they strengthen trust and transparency by involving people directly, making citizens see how their input shapes decisions which boosts acceptance of pilots and their monitoring. Finally, they create a replicable engagement model: The way UT-Labs integrate into KPI monitoring in Madrid and Dresden will serve as a template for the five replication cities and beyond.

In short, UT-Labs are the human face of MOBILITIES for EU's monitoring programme. They bridge the gap between technical data and social reality, ensuring that when success is measured, what truly matters to the people living in these cities is also captured. The specified monitoring programme for Social Acceptance and Social Readiness in Madrid and Dresden is described in detail in chapter 5.4 of this document.

## 3.5 Data Collection Principles and Standards

The success of MOBILITIES FOR EU depends on collecting a rich and diverse set of data from the pilots in Madrid and Dresden, but also on ensuring this data is managed ethically, securely, and in line with EU law. This section explains how the project approaches data collection, and how privacy and GDPR compliance are built into every step of the monitoring process.

### 3.5.1 DATA COLLECTION PRINCIPLES

The monitoring programme is designed to gather data that is accurate, consistent, and comparable across pilots, while respecting the rights of individuals. To achieve this, MOBILITIES FOR EU follows several guiding principles based on FAIR (Findable, Accessible, Interoperable, and Reusable) ones:

- A) **Standardisation and Harmonisation** – All data from Madrid and Dresden follows uniform formats, units, and definitions, so that comparisons can be made across pilots (e.g., CO<sub>2</sub> reductions in one city vs. another, or user acceptance trends). This ensures replication cities can later adopt the same indicators with minimal adaptation.
- B) **Before-and-After Approach** – Baseline data is collected before each solution is implemented, so impacts can be measured against a clear reference point. For instance, noise levels, energy use, and user perceptions are measured both before and after electric or autonomous vehicles are deployed.
- C) **Multiple Data Sources** – Data will come from sensors and IoT devices (e.g., air quality monitors, charging stations), operator logs (e.g., bus mileage, number of trips), and citizen input via Urban Transport Labs (UT-Labs). This triangulation makes findings more robust and avoids reliance on a single type of evidence.
- D) **Open and Transparent Practices** – Feasible, aggregated, and anonymised datasets will be shared openly with researchers, city administrations, and the public, supporting EU goals for transparency and knowledge sharing. All collected data undergoes pseudonymization and other privacy protection techniques and only those collecting the information have access to citizens' data. Furthermore, it is

guaranteed that no personally identifiable information, such as names, is requested, and that all collected information is protected by appropriate security measures.

- E) **Continuous Quality Control** – Regular data checks will be performed by CARNET (as WP3 lead) and the local evaluation managers in Madrid and Dresden. These will spot inconsistencies, validate measurements, and correct errors to maintain data integrity.
- F) **Future Proofing for Replication** – The monitoring structure is designed so that the same KPIs and data collection methods can be replicated in the five replication cities (Ioannina, Trenčín, Espoo, Gdańsk, Sarajevo) and later in other European cities.

### 3.5.2 PRIVACY AND GDPR COMPLIANCE

Because MOBILITIES FOR EU collects data from vehicles, infrastructure, and people, privacy protection is not just a legal formality — it is central to the project’s legitimacy and citizen trust.

The General Data Protection Regulation (GDPR) is the EU’s gold standard for data privacy. It sets strict rules for how personal data is collected, stored, processed, and shared. Under GDPR, personal data includes any information that can identify an individual — even indirectly — such as GPS traces linked to a person’s commute, survey responses about travel habits, or video images from pilot areas.

To fully comply with GDPR, MOBILITIES FOR EU follows several key measures:

- **Data Minimisation:** Only data that is strictly necessary for the monitoring programme is collected. For example, a survey might ask about perception of security on an autonomous bus but not request identifiable personal details unless essential.
- **Anonymisation and Pseudonymisation:** Any personal data that is gathered is anonymised (irreversibly stripped of identifiers) or pseudonymised (identifiers replaced with codes). This ensures that even if data is leaked or mishandled, individuals cannot easily be identified.
- **Informed Consent:** All participants in UT-Labs, surveys, or pilot feedback activities are clearly informed what data is collected, how it will be used, and how long it will be stored. They can opt out at any time.
- **Secure Storage and Access Control:** All data will be stored on secure servers within the EU, following strict IT security protocols. Only authorised project partners will have access, and access logs will be maintained for accountability.

### 3.5.3 IMPACT ON MONITORING AND COMPARISON OF PILOTS

GDPR has a direct impact on how MOBILITIES FOR EU monitors and compares pilots:

- **Comparability vs. Privacy Balance:** Because pilots in Madrid and Dresden will collect distinct types of data (e.g., an autonomous bus service in Madrid vs. a freight robot in Dresden), GDPR compliance requires careful alignment of data categories. Indicators must be standardised without collecting unnecessary personal details.
- **Aggregation for EU-wide Use:** GDPR means that most personal-level data cannot leave the local systems in identifiable form. This requires MOBILITIES FOR EU to use aggregated, anonymised datasets for cross-city comparisons and for reporting to the European Commission.
- **Trust Building for Participation:** Monitoring relies heavily on citizen feedback (for social KPIs like acceptance, awareness, and customer satisfaction). GDPR compliance, and clear communication of it,

reassures citizens that their privacy is protected, making them more willing to share feedback through UT-Labs.

- Replication Model: By embedding GDPR-compliant methods from the start, MOBILITIES FOR EU creates a template for safe and legal data handling that replication cities can adopt, reducing the burden of setting up their own systems.

In summary, data in MOBILITIES FOR EU is collected responsibly and lawfully. The monitoring framework does not just gather numbers; it safeguards the rights of the people behind the data. GDPR compliance is what makes the project's findings credible, trustworthy, and replicable, ensuring that future cities can scale these solutions without compromising privacy or public confidence.

## 4. Monitoring Programmes per Action

The MOBILITIES FOR EU project applies a comprehensive evaluation methodology to ensure that the KPIs defined in D3.1 -Evaluation framework- are effectively monitored, analysed, and scaled across the diverse pilot measures in Madrid and Dresden. This chapter explains how the methodology is put into practice, from data collection to simulation and modelling, and from urban metabolism analysis to citizen-driven insights via UT-Labs. The approach reflects the project's ambition to provide robust, scalable, and actionable evidence for Europe's transition to climate-neutral cities. First, the starting point of developing the programme is summarized. Then, the monitoring programme per action framework is described in more detail. Finally, the practical implementation in the cities is outlined.

### 4.1 Starting Point

The pilots in Madrid and Dresden involve a range of technologies — from autonomous vehicles and hydrogen buses to smart grids, V2G charging, and renewable energy integration. Monitoring their impact requires therefore a multi-modal monitoring methodology that combines:

- Real-time data collection from sensors and detectors,
- Simulation models to scale and estimate impacts beyond the immediate pilot sites,
- Qualitative data from surveys and Urban Transport Labs (UT-Labs) to capture social dimensions, and
- Tracking of real costs, investments, and economic gains to evaluate the economic footprint.

This approach ensures that different types of information: both hard data (e.g., emissions, mileage, charging times) and soft data (e.g., acceptance, satisfaction, awareness) are gathered, analysed, and contextualised.

Each project partner is responsible for implementing and monitoring KPIs for the pilots under their remit, as outlined in Deliverable 2.1. They bring advanced technological capabilities, including sensors, detectors, and IoT tools, to capture:

- **Environmental data:** Emissions detectors measure CO<sub>2</sub>, NO<sub>x</sub>, and particulate matter (PM) at strategic locations (e.g., Mercamadrid in Madrid, bus depots in Dresden). These sensors provide real-time insights into the environmental effects of electrified fleets, hydrogen buses, and freight robots.
- **Energy data:** Smart meters and monitoring devices track energy consumption, charging events, and the share of renewable energy powering the pilots. In Madrid, for example, energy meters linked to the 700

kWp photovoltaic plant at Mercamadrid record how much solar energy flows into EV charging infrastructure.

- **Mobility data:** Mobility detectors log mileage, number of trips per day, charging times, and commercial speed for e-buses and autonomous vehicles, allowing for a detailed analysis of transport performance.

As introduced in D3.1 -Evaluation framework-, the project and the pilots are structured around three stages from the perspective of the actions to be implemented: the definition of baselines and targets at the outset; monitoring during implementation, including the frequency of data collection; and the assessment of final results at the end of the operation.

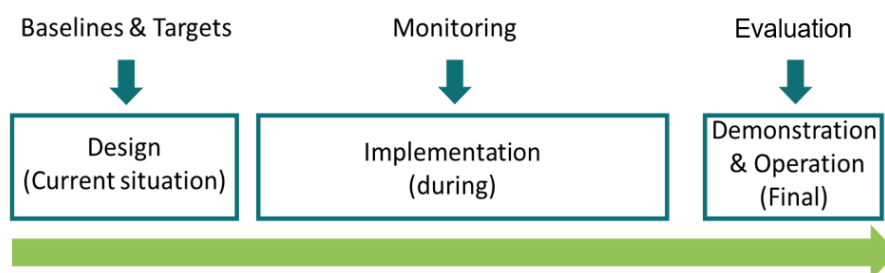


Figure 2 - Project stages from point of view of the actions

Pilots by nature are limited in scope: a single bus depot, a market district, or a few kilometres of autonomous vehicle operation cannot fully represent an entire city. To bridge this gap, MOBILITIES FOR EU relies on simulation and estimation models:

- **Emission Reductions:** Using vehicle specifications and emission factors, models predict reductions in CO<sub>2</sub>, NO<sub>x</sub>, and PM if pilot measures (e.g., e-buses, hydrogen vehicles) are scaled city-wide.
- **Transport Efficiency:** Simulations project the impact of innovations on system-wide indicators like mileage reduction and commercial speed improvements if autonomous delivery vehicles or e-freight solutions are broadly adopted.
- **Energy Usage:** Energy simulations estimate how much total electricity and renewable energy would be consumed or saved if current pilots were expanded — providing a roadmap for grid planning and renewable capacity needs.

By combining real data from pilot sites with modelling projections, the project can provide credible city-level estimates and guide replication in other cities. While sensors and models measure technical performance, societal KPIs require human input. Here, the Urban Transport Labs (UT-Labs – shows in Figure 3 as UM-Labs<sup>1</sup>) play a vital role.

- **Surveys:** Structured surveys in pilot areas measure Acceptance (how ready people are to embrace autonomous shuttles or hydrogen buses), Awareness (how well they understand the pilots and their benefits), and the Customer Satisfaction Index (how users rate their experience).

<sup>1</sup> UM-Lab = UT-Labs. Both terms are used interchangeably in the project for the labs – M standing for mobility while T standing for Transport–

- **UT-Lab workshops:** These are open innovation spaces where citizens, businesses, and civic groups co-create and evaluate solutions. They also feed into the KPI Quality of Cooperation Structures with Stakeholders, revealing how well different actors are collaborating to support the pilots.

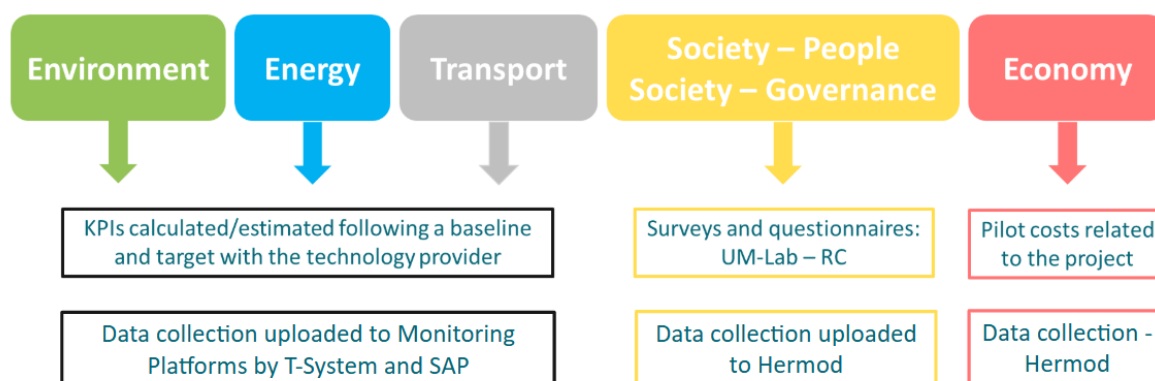


Figure 3 - Overview Monitoring and Data Collection<sup>2</sup>

By integrating citizen insights into the methodology, MOBILITIES FOR EU ensures that monitoring does not just track what is happening, but also how it is experienced, a key factor for scaling and long-term success.

A key innovation in the MOBILITIES FOR EU methodology is the use of urban metabolism to frame monitoring and analysis. Cities are treated like living organisms, with flows of energy, water, waste, goods, and people moving through them. Actions like the Mercamadrid photovoltaic plant, V2G infrastructure, and electric buses close resource loops by generating local energy, reducing fossil fuel reliance, and creating a more circular urban system. Moreover, electrification of public transport and bidirectional charging for EVs in Dresden creates a self-sustaining energy flow, reducing dependence on external non-renewables. Finally, citizen involvement through UT-Labs, citizens are invited to help map their city’s metabolism, identifying gaps and co-designing interventions. This participatory urban metabolism approach ensures the methodology is inclusive and local.

The combination of sensors, models, and qualitative inputs provides a comprehensive view of pilot performance. But the project also recognises potential limitations, from sensor gaps to differences in data quality between pilots. To address these risks:

- **Cross-checking and validation:** Sensor data are compared with operator records and UT-Lab feedback.
- **Estimation techniques:** Where direct data is missing, validated estimation models are used to maintain consistency.
- **Standardised protocols:** Harmonised KPI definitions, data templates, and reporting formats ensure data from Madrid and Dresden is comparable — and replicable in the five replication cities.

The result is a methodology that produces accurate, relevant, and scalable insights — a foundation for evaluating MOBILITIES for EU’s impact and for helping other European cities follow the same path toward climate-neutral mobility.

<sup>2</sup> Hermod (Nextcloud) is a document management and storage service supported by CARTIF for managing information in European projects, used in MOBILITIES FOR EU as the project consortium share-point and to which all project partners have access.

## 4.2 Set up of Monitoring per Action Framework

A robust monitoring framework is key for the MOBILITIES FOR EU project, ensuring that the progress of KPIs is tracked systematically, consistently, and transparently across all actions and pilots. This framework not only provides a clear structure for collecting and interpreting data but also establishes the shared rules and processes that allow twenty-seven pilot measures in Madrid and Dresden to be compared, combined, and scaled to replication cities.

By defining how data is gathered, reported, and validated, the monitoring programme forms the key operational aspect of Task 3.2, Monitoring programmes, and this deliverable (D3.2). It sets the stage for the project's entire evaluation process, from baseline data collection to reporting on impacts, and serves as the foundation for meaningful, evidence-based conclusions about the project's success.

### 4.2.1 MONITORING OBJECTIVE

The monitoring programme is designed to:

- Standardise approaches across all partners and pilots, so that data from Madrid and Dresden is comparable and usable for EU-level reporting.
- Optimise collaboration by creating shared data spaces and structured formats for sharing, storing, and referencing KPI information.
- Capture changes over time by clearly defining and documenting the Before and After stages of each action.
- Ensure quality and reliability by setting data quality standards, reporting frequencies, and verification procedures for every partner involved in KPI collection.

This unified approach ensures that changes in KPI values can be tracked in real time and accurately aligned with project targets, making progress clear and actionable for all stakeholders.

### 4.2.2 ELEMENTS OF FRAMEWORK

The monitoring programme covers the entire lifecycle of data, from collection to analysis, through the following **five structured elements**:

**Evaluation Approach:** A shared conceptual approach ensures that all pilot measures are assessed through the same lens, enabling cross-site comparison and transparency. The programme explicitly defines three stages for each pilot. By documenting all three, the framework ensures accurate attribution of impacts to MOBILITIES FOR EU measures:

- Before – Baseline measurements taken prior to implementation (e.g., current CO<sub>2</sub> emissions at a bus depot).
- Target – The objective of the actions of each pilot and city.
- After – Data collected after deployment, showing measurable impact against both the baseline and target scenario.

**Indicators:** The project uses a standard set of KPIs (environment, energy, transport, society, economy) while allowing each city to introduce context-specific indicators relevant to their urban realities (e.g., waste metrics at Mercamadrid).

**Monitoring Methods:** Agreed measurement methods ensure that data is collected consistently. For example, both cities use similar metrics for CO<sub>2</sub> emissions reductions, even if local technologies (sensors, data systems) differ. The differences will depend on the characteristics of the indicator category, the individual KPI, and the capabilities of the partners. This method includes:

- The methodology used to collect the data.
- Starting date of the action.
- Type of data mainly considered for that indicator, whether it is measured, estimated, or simulated.
- Frequency of the data collection (i.e. daily, weekly, monthly).

**Protocols:** The framework does not just track the measures, it also monitors external factors that might influence outcomes, ensuring results are understood in the right context.

**Monitoring platforms:** A key strength of the monitoring programme is its shared data space architecture through the monitoring platforms. By using structured formats for sharing, storing, and referencing data, all project partners can work with:

- Unified templates for KPI reporting, making outputs from Madrid and Dresden comparable.
- Shared repositories for data storage, ensuring every partner can access the same validated information.
- Version-controlled records, so that updates are tracked, and historic data is never lost.

This structured approach is especially important for shared or similar actions, for example, both cities are deploying electric buses and smart charging infrastructure. The monitoring framework allows direct comparison of results while respecting local variations.

Beyond KPI tracking (impact and performance evaluation), the monitoring programme incorporates a **process evaluation** dimension — a “how and why” lens that explains the implementation journey of each measure. By studying the process, the evaluation can answer fundamental questions such as:

- *Why did certain measures succeed or fail — and how?*
- *What role did supporting activities (e.g., stakeholder engagement, public awareness campaigns) play in shaping their impact?*
- *How did the urban context — regulations, geography, demographics — influence results?*

This process-focused approach ensures that the evaluation does not just present outcomes (e.g., “CO<sub>2</sub> emissions fell by X%”) but also provides a narrative that explains those outcomes. By establishing standard guidelines for all actions and pilots, the monitoring programme ensures consistency by evaluating every measure on the same basis. Furthermore, the programme supports scalability, delivers context, and by pairing KPI data with process analysis, the framework provides actionable lessons for future mobility initiatives.

### 4.3 Practical Implementation of Monitoring Programme per Action

Running twenty-seven pilots in two different cities and providing a monitoring programme that serves all of them is a challenge itself. It is crucial to find a good balance between monitoring as consistent, detailed and target oriented as possible without overburdening the responsible teams in each city with administrative and coordination effort. From a practical perspective it is important to make sure that the who, what, when and how

of the monitoring is defined for each action. But there must also be a process in place which helps the project leaders to stay on track with the monitoring itself and that they get the necessary support in evaluating their pilot properly.

This section provides a detailed description of the practical implementation of the elements introduced in Chapter 5.2 within the monitoring programmes of Madrid and Dresden. First, it outlines the KPI-based tracking framework used for impact and performance evaluation. Second, it presents the components applied to ensure a comprehensive and holistic process evaluation.

#### 4.3.1 IMPACT AND PERFORMANCE EVALUATION

In the MOBILITIES FOR EU evaluation framework, each partner responsible for individual pilots and actions is tasked with providing comprehensive data for each relevant KPI from the described category list. This established data gathering process enables clear, measurable insights which can be directly connected to the impact of each action. This deliverable sets up the monitoring programmes for the pilot actions, detailing which data will be gathered, how often, by whom, and using which tools.

The specific monitoring programs for Madrid and Dresden are compiled in Annex 3 and Annex 4 respectively.

Table 2 - Explanation Monitoring Programme per Action - individual, packaged, city level. Template and filled in.

Pilot	Name of the action	ENVIRONMENTAL KPIs				ENERGY KPIs					TRANSPORT KPIs					SOCIAL KPIs				ECONOMY KPIs				
		Key KPI	Key KPI	Key KPI	KPI	KPI	Key KPI	KPI	Key KPI	KPI	KPI	KPI	KPI	KPI	KPI	Key KPI	Key KPI	Key KPI	KPI	KPI	KPI	KPI	KPI	
		Reduction of CO2 emissions	Reduction of NOX emissions	Reduction of small particle emissions	Reduction of noise level	Energy consumption	Energy savings	Energy delivered	Use of clean energy sources	RES production	Mileage	Quantity of waste collected	Number of trips per day	Charging times	Commercial speed	Perception of security	Acceptance	Awareness	Customer satisfaction index	Quality of cooperation structures with stakeholders	Capital investment	Average operating costs	Pollution cost avoided	Economical impact
Pilot 1	A1.1. Autonomous e-buses in Mercamadrid area for people (ALSA)																							
	A1.2 Automated Guided Vehicle for waste collection at Mercamadrid (PZGR)																							
	A1.3 Last mile autonomous electric transport for food markets (PZGR)																							
	A1.4 Development of 5G Private Mobile Network services in Stand Alone for CCAM connectivity (ORANGE)																							
Pilot 2	<b>Packaged</b> A4-1 Unrestricted smart card for Eco Transportation (FERROVIAL)																							
	A2-2 Digital Twin and power grid management for flexibility (PLEXIGRID, UPM)																							
Pilot 3	A3-1 Electrification of 329 e-buses and full electrification of Carabanchel Bus Depot (EMT)																							
	A3-2 Intelligent sharing of charging infrastructure and energy between vehicles for the transport of people and freight (EMT)																							
Pilot 4	A4-1 Implementation of H2 Refueling Station and 10 H2 fuel cell buses (EMT)																							
Pilot 5	A5-1 Green Energy Data Space in Mobility for the Decarbonization of Madrid and other Cities (TSV)																							

Monitoring Programme per Action (Individual)

City Level

Pilot	Name of the action	ENVIRONMENTAL KPIs				ENERGY KPIs				TRANSPORT KPIs					SOCIAL KPIs				ECONOMY KPIs					
		Key KPI	Key KPI	Key KPI	KPI	KPI	Key KPI	KPI	Key KPI	KPI	KPI	KPI	KPI	KPI	Key KPI	Key KPI	Key KPI	KPI	KPI	KPI	KPI	KPI	KPI	
		Reduction of CO2 emissions	Reduction of NOx emissions	Reduction of small particle emissions	Reduction of noise level	Energy consumption	Energy savings	Energy delivered	Use of clean energy sources	RES production	Mileage	Quantity of waste collected	Number of trips per day	Charging times	Commercial speed	Perception of security	Acceptance	Awareness	Customer satisfaction index	Quality of cooperation structures with stakeholders	Capital investment	Average operating costs	Pollution cost avoided	Economical impact
Pilot 1	A1.1. Autonomous e-buses in Mercamadrid area for people (ALSA)	ALSA	ALSA	ALSA	ALSA	ALSA	ALSA		ALSA		ALSA		ALSA	ALSA	ALSA	R: ALSA C: RC, MM	R: ALSA C: RC, MM	R: ALSA C: RC, MM	R: ALSA C: RC, MM	R: ALSA C: RC, MM	ALSA	ALSA	ALSA	ALSA
	A1-2 Automated Guided Vehicle for waste collection at Mercamadrid (PZGR)	PZGR	PZGR	PZGR		R: PZGR- C: T-SYS	R: PZGR- C: MERCAM, UPM		R: PZGR- C: MERCAM		PZGR	PZGR	PZGR	PZGR	PZGR	R: PZGR C: RC, MM	R: PZGR C: RC, MM	R: PZGR C: RC, MM		<b>Monitoring Programme per Action (Individual)</b>				
	A1-3 Last mile autonomous electric transport for food markets (PZGR)	PZGR	PZGR	PZGR		R: PZGR- C: T-SYS	R: PZGR- C: MERCAM, UPM		R: PZGR- C: MERCAM		PZGR	PZGR	PZGR	PZGR	PZGR	R: PZGR C: RC, MM	R: PZGR C: RC, MM	R: PZGR C: RC, MM	R: PZGR C: RC, MM					
	A1-4 Development of 5G Private Mobile Network services in Stand Alone for CCAM connectivity (ORANGE)	ORANGE							ORANGE											R: ORANGE C: RC, MM	ORANGE			
Pilot 2	<b>Packaged</b> id for (WAL)	R: FRRVL C: MERCAM, UPM				R: FRRVL C: MERCAM, UPM		R: FRRVL C: MERCAM, UPM	MERCAM	R: FRRVL C: MERCAM										R: FRRVL C: RC, MM	C&R FRRVL	C&R FRRVL	R: FRRVL C: MERCAM, UPM	R: FRRVL C: MERCAM
	A2-2 Digital Twin and power grid management for flexibility (PLEXIGRID, UPM)	R: PLEXIG C: MERCAM, UPM				R: PLEXIG C: MERCAM, UPM	R: PLEXIG C: MERCAM, UPM	R: PLEXIG C: MERCAM, UPM	R: PLEXIG C: MERCAM, UPM								R: PLEXIG C: UPM, MERCAM	R: PLEXIG C: UPM, MERCAM		R: PLEXIG C: MERCAM				
Pilot 3	A3-1 Electrification of 329 e-buses and full electrification of Carabanchel Bus Depot (EMT)	EMT			EMT	EMT	EMT	EMT	EMT	EMT	EMT					R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	EMT	EMT	EMT	
	A3-2 Intelligent sharing of charging infrastructure and energy between vehicles for the transport of people and freight (EMT)	EMT				EMT	EMT	EMT	EMT	EMT	EMT					R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	EMT	EMT	EMT	
Pilot 4	A4-1 Implementation of H2 Refueling Station and 10 H2 fuel cell buses (EMT)	EMT			EMT	EMT	EMT	EMT	EMT	EMT	EMT					R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	EMT	EMT	EMT	
Pilot 5	A5-1 Green Energy Data Space in Mobility for the Decarbonization of Madrid and other Cities (TSY)	T-SYS				T-SYS														R: T-SYS C: RC	T-SYS	T-SYS		

City Level

As shown in Table 2, first, for each KPI per action, the responsible partner was identified to monitor (green fields). The sum of all KPIs to track per action creates the monitoring programme per action (red box) and hence focuses on the individual action level monitoring. During the evaluation phase at a later stage, these individual action results can be packaged (blue box) to pilot-level evaluation and city-level evaluation (purple box).

Secondly, for each action a data structure has been provided to be filled out by each city and action responsible. The first elements of each data entry are given, and as already described in the indicators section, include the name, definition, unit, category, and applicable actions for each agreed KPI (Table 3, grey cells).

Table 3 - Format Data Structure per KPI

Name	Definition	Unit	Category	Before	BAU (Business-as-usual)	After	Monitoring System	Monitoring System		Target	
Name of the indicator that will be used to monitor the progress towards the achievement of the measure	Definition of the indicator	Unit measurement	From CIVITAS	Value before the implementation of the measure	Projected value achieved without any measures by the end of the implementation	Value recorded after the implementation of the measures	Method of data collection	Starting Date	Type of Data: Measured, estimated or simulated	Frequency	Expected value after the implementation of the measures

Starting from there, for each KPI, the following key data points are required to be defined by the partner to ensure a robust and consistent evaluation (Table 2, yellow cells):

- 1. Before:** This captures the baseline value of each KPI before the implementation of the action. This initial data serves as the reference point, providing critical context for assessing the actual impact and effectiveness of each action over time.
- 2. BAU (Business-as-Usual):** Each partner is required to estimate the KPI’s projected value at the end of the implementation period, assuming no intervention was made. This business-as-usual projection offers a hypothetical scenario that helps isolate the specific impacts of the implemented actions by contrasting expected natural progress against actual results.
- 3. After:** This value will be recorded following the completion of the action implementation. It reflects the KPI’s actual outcome post-intervention, allowing for direct comparison with both the baseline and business-as-usual projections.
- 4. Method:** To understand data sources available, each partner documents the methods used for data collection, aspects already described in section 2.3.5 of deliverable D3.1 - Evaluation framework. The analysis of this methods and the data quality assessment will be determined and computed during Task 3.3.
- 5. Monitoring System:** The monitoring system variables describe three aspects: the starting point to keep an overview of when the action is implemented the type of data collected (measured, estimated, simulated), and the monitoring frequency. This transparency in methodology ensures that data collected across different pilots and actions are consistent and can be confidently interpreted within the whole project evaluation.
- 6. Target:** Each partner defines an expected target value for the KPI post-implementation, indicating the desired outcome or improvement anticipated from the intervention. This target provides a measurable goal against which actual outcomes can be assessed. It supports the evaluation of each action’s effectiveness.

This structured approach for KPI data reporting for each action, which can be observed in Table 3, allows for a detailed standardized assessment across the MOBILITIES FOR EU project. This provides a clear before and after comparison and promotes a consistent tracking and reporting of action impacts. Furthermore, it allows to sustainably track all details over twenty-seven pilots and actions without missing on essential information. By comparing those values, along with detailed monitoring methodologies, MOBILITIES FOR EU partners can accurately evaluate each action's effectiveness, adapt processes as needed, and generate insights for future mobility improvements.

#### 4.3.2 PROCESS EVALUATION

Process evaluation examines *how* a pilot or intervention is implemented, providing insights into the mechanisms, conditions, and decisions that shape its outcomes. Rather than focusing solely on results, it looks at the quality and fidelity of implementation, the roles of stakeholders, and the contextual factors that enable or hinder progress. By identifying both barriers and facilitators, process evaluation helps explain *why* certain impacts occur, supports continuous improvement during the project, and strengthens the evidence base for scaling and replication.

As elaborated in D3.1 - Evaluation framework - chapter 2.5.2, effective monitoring during all three stages is essential for understanding how and why various actions occurred and there are different techniques that can be employed to monitor the implementation process, ensuring comprehensive tracking and evaluation of activities. For MOBILITIES FOR EU it was decided to use the following three tools to enhance learning and information collection of each action in an effective and time-sensitive way.

##### *Event and Issue Log*

To ensure transparency and traceability throughout the monitoring process, each pilot city will maintain one Event and Issue Log. This log will record all significant occurrences and challenges affecting pilot implementation, offering a clear overview of how contextual factors and operational issues influence progress and results.

Events will capture external developments (e.g. policy changes, extreme weather, or major public happenings) that may impact pilot performance or user behaviour. Issues will document internal or external challenges, including data collection errors, delays, or technical malfunctions, together with their severity, status, and mitigation measures.

Namely, the event and issue logbook document the following specific information (as seen in Table 4 below):

1. **Issue No.** to identify
2. **Date of the Event/Issue**
3. **Pilot No.** – each logged event/issue links to the respective pilot and action
4. **Phase** – Design, implementation, or evaluation phase
5. **Brief description** of what happened for more context
6. **Type of issue / event:** technical, bureaucratic, environmental, other
7. **Description of impact** to better understand its effect on the action
8. **Impact level** estimation (high, medium, low)
9. **Action** taken to resolve or deal with the event / issue
10. **Status of the event / issue:** Open, on track, resolved
11. **Learning** – description of the learning of the event/issue
12. **Responsible** project partner

Table 4 - Template of the Event and Issue Log provided to each city

Issue No.	Date	Pilot No. <i>Pilot [P..]- Measure [A..]</i>	Phase <i>(Design, Implementation, Evaluation)</i>	Event or Issue?	Description of what happened?	Type <i>(Technical, bureaucratic, environmental, other)</i>	Description Effect / Impact	Impact Level <i>(High, medium, low)</i>	Action
1	25.01.2026	[P1] - A1 - Charging robots	Implementation	Issue	Charging stations not ready at launch	Technical	Delayed launch by 2 weeks	High	Supplier expedited setup
<b>Status</b> <i>(Open, on track, resolved)</i>		<b>Learning</b>		<b>Resp.</b>					
Resolved		Align infrastructure timeline with pilot start		VW					

Pilot coordinators will update the log regularly, while the Monitoring Work Package will review entries to ensure quality assurance, enable timely corrective actions, and foster shared learning across all twenty-seven pilot actions.

There will be one logbook per city which is stored in the working folder of WP3 in the consortium working space Hermod (NextCloud). The logbooks will be updated directly in the working space (live document). The review of the logbook will be done **quarterly** during the WP3 monthly meetings. To ensure consistent tracking and uploading, each ecosystem has bi-weekly follow up meetings with the responsible partners to update the logbooks. The bi-weekly meetings are led by the Madrid and Dresden project leaders who will remind all responsible action partners in time to fill in the issue logbook every time an issue or event is happening.

### Periodic Milestone Tracker

The Periodic Milestone Tracker is a management and monitoring tool designed to systematically record and assess progress against predefined project milestones. It provides a clear overview of the implementation status of key activities, deliverables, and pilot actions, supporting early detection of delays or deviations from the planned schedule.

Each city will complete the tracker on a quarterly basis, using it as a practical check-in tool to monitor pilot progress, data collection efforts, and any emerging challenges. The tracker integrates the Event and Issue Log information, ensuring that contextual factors and operational issues are linked to milestone assessment.

More specifically, the periodic milestone tracker (see Table 5 below) functions as checklist where each action responsible must document the status of their pilot regarding monitoring. This helps not only to identify challenges early on but serves as a steering and controlling tool for the monitoring coordinator to make sure that the monitoring is done properly and on time.

The first part of the checklist is to document if the pilot action is on track:

- The pilot has started – yes / no
- When the expected starting time is
- If the pilot is on track (according to their plan) – yes / no
- If not, reasons.

The second part is specifically to have check-in regarding the monitoring of the necessary KPIs per action. The action leader checks here for their pilot for which KPIs they need to collect data, if they have collected the data, what the data quality is and if the data is stored correctly.

If there are issues occurring, the Issue Log number (from the Issue Log) can be added in the comment section, completing the full chronological picture for each action.

Table 5 - Periodic Milestone Tracker Template

Periodic Milestone Tracking										
Q1 - 2026				to be filled out by 31.03.2026			Filled out:			
		Yes	No	Date						
Has the Pilot started?		<input type="checkbox"/>	<input type="checkbox"/>	By whom:						
If not, estimated starting date:										
		Yes	No							
Is the Pilot on track?		<input type="checkbox"/>	<input type="checkbox"/>							
If not, why not (add issue no. from log):										
Please fill out for each KPI:		Did you collect the data?			How is the quality of the data?			Is the data uploaded in the data space?		
ENVIRONMENTAL		Yes	No	Not necessary	High	Medium	Low	Yes	No	Any comments:
Reduction of CO2 emissions		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Reduction of NOX emission		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
ENERGY		Yes	No	Not necessary	High	Medium	Low	Yes	No	Any comments:
Energy Consumption		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Energy Savings		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Energy Delivered		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Use of clean energy sources		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
TRANSPORT		Yes	No	Not necessary	High	Medium	Low	Yes	No	Any comments:
Mileage		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Number of trips per day		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Charging times		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
SOCIAL		Yes	No	Not necessary	High	Medium	Low	Yes	No	Any comments:
Acceptance		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Awareness		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Customer Satisfaction Index		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Quality of cooperation structures with stakeholders		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
ECONOMY		Yes	No	Not necessary	High	Medium	Low	Yes	No	Any comments:
Capital investment		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Average operating costs		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Economical impact		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

**Format:** The periodic milestone trackers are stored in the WP3 work folder of the consortium working space. There is one milestone tracker per action. For each city, Madrid and Dresden, a specific folder is created which contains all trackers. The action responsible will update the trackers directly on the working space (live documentation).

**Frequency & timing:** The milestone trackers must be filled out every 3 months (quarterly), starting from 1<sup>st</sup> of January 2026, by the respective action responsible. The trackers will be reviewed in the WP3 monthly meetings, in a quarterly rhythm to ensure consistency, accountability, and timely corrective action across all pilots and work streams.

Each ecosystem has a bi-weekly follow up meeting in which the responsible parties are reminded about the quarterly milestone to fill it in.

### Process Evaluation Surveys

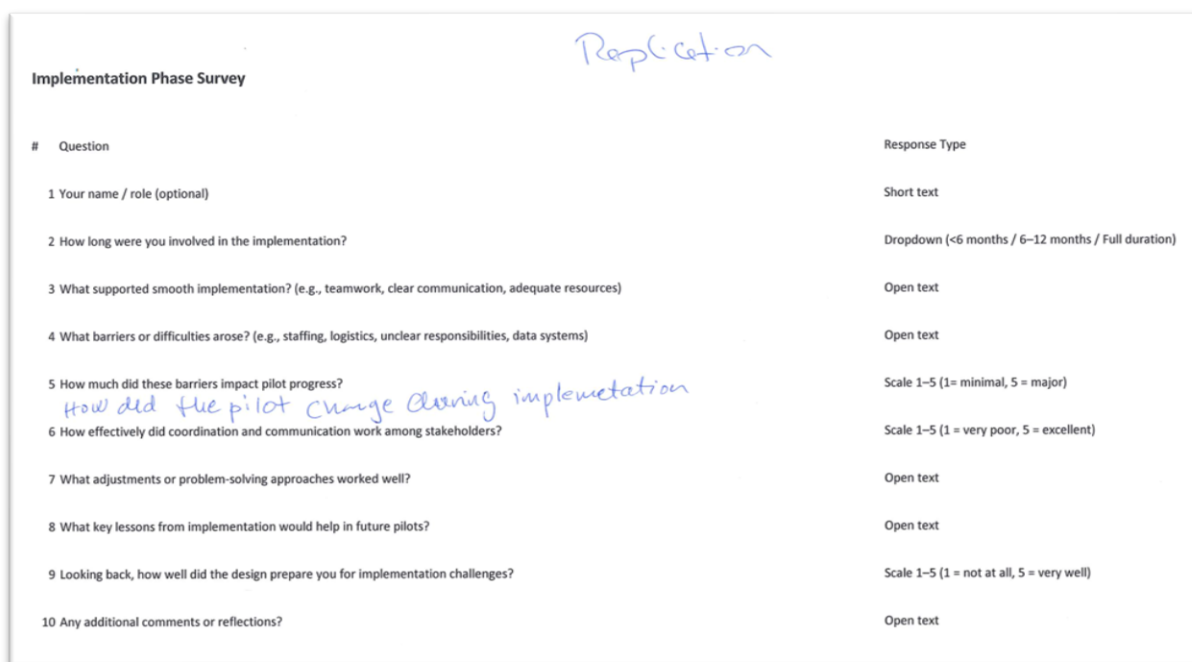
A Process Evaluation Survey is a structured instrument designed to assess the implementation, functioning, and quality of project activities from the perspective of stakeholders, participants, and implementers. Its purpose is to capture feedback on how the pilot interventions are delivered, identify operational strengths and weaknesses, and understand contextual factors affecting outcomes. The survey typically covers dimensions such as adherence to planned procedures, participant engagement, resource utilisation, collaboration among partners, and perceived effectiveness. Collected periodically, the results inform continuous improvement, support monitoring of fidelity to the project plan, and provide qualitative evidence to complement quantitative performance indicators.

In MOBILITIES for EU, process evaluation surveys are run for all three project stages: Design, implementation, and Operation/evaluation. The survey results help to collect valuable information about the practical

implementation of pilots in each phase and provide crucial information for the replicating cities to improve and make future piloting a success. They therefore function as knowledge transfer survey.

To ensure highest usability and effectiveness, the design of the project evaluation surveys was conducted in a collaborative manner together with Madrid, Dresden, and the replicating cities.

A workshop was held during the Madrid general assembly, to gather feedback from Madrid, Dresden and the replication cities on what questions were important to ask in the surveys to collect the most valuable information. Key focus was given on the feedback of the follower cities to make sure that the information documented will serve the needs of the future replication in a practical way.



#	Question	Response Type
1	Your name / role (optional)	Short text
2	How long were you involved in the implementation?	Dropdown (<6 months / 6–12 months / Full duration)
3	What supported smooth implementation? (e.g., teamwork, clear communication, adequate resources)	Open text
4	What barriers or difficulties arose? (e.g., staffing, logistics, unclear responsibilities, data systems)	Open text
5	How much did these barriers impact pilot progress? <i>How did the pilot change during implementation</i>	Scale 1–5 (1= minimal, 5 = major)
6	How effectively did coordination and communication work among stakeholders? <i>How effectively did coordination and communication work among stakeholders?</i>	Scale 1–5 (1 = very poor, 5 = excellent)
7	What adjustments or problem-solving approaches worked well?	Open text
8	What key lessons from implementation would help in future pilots?	Open text
9	Looking back, how well did the design prepare you for implementation challenges?	Scale 1–5 (1 = not at all, 5 = very well)
10	Any additional comments or reflections?	Open text

Figure 4 - Example of Workshop Exercise to define Survey Questions at Madrid General Assembly

Based on the feedback given during the workshop, the final versions of the surveys<sup>3</sup> were agreed on and created. The complete surveys can be found in the Annex 2.

**Format:** The process evaluation surveys will be sent out by Google Forms. Results are documented and stored in the folder of WP3 in the consortium workspace.

**Recipients:** The surveys will be sent to all involved project partners, not only the action responsible. This ensures the accumulation of various perspectives of involved parties (e.g. city perspective, admin, tech, project leaders) and contributes to a more complete picture.

**Frequency and timing:** The surveys will be sent out at the end of each stage. During the implementation stage, there are two surveys sent out. Hence, the first survey for the Design phase will be sent out by the end of 2025. The surveys for the implementation phase will be sent out at the end of 2026 and end of 2027. Operation/Evaluation survey will be sent out during 2028.

<sup>3</sup> Links to: [Design Phase Survey](#) ; [Implementation Phase Survey](#) ; [Evaluation Phase Survey](#)

Table 6 - Overview Timing Process Evaluation Surveys

	Send out to respondents (by CARNET)	Deadline to respond
Design Phase Survey	December 2025	15 <sup>th</sup> of February 2026
Implementation Phase Survey I	December 2026	15 <sup>th</sup> of February 2027
Implementation Phase Survey II	December 2027	15 <sup>th</sup> of February 2028
Evaluation Phase Survey	September 2028	15 <sup>th</sup> of October 2028

## 4.4 Monitoring Programme for Social Acceptance and Social Readiness in Madrid and Dresden

This monitoring programme defines how MOBILITIES FOR EU will measure social acceptance and social readiness of the actions in Madrid and Dresden. It ensures a common framework across both cities, action-specific KPIs, methods, timing, target groups, and governance processes.

### 4.4.1 SCOPE OF PILOTS

The pilots in Madrid and Dresden where social acceptance and readiness will be monitored have been selected based on their level of interaction with end-users. Actions under these pilots involve direct engagement with passengers, operators, businesses, and citizens, making them ideal for assessing perceptions, trust, and adoption readiness. Pilots with higher user interaction—such as autonomous transport services, charging solutions, and digital mobility tools—are prioritized to capture meaningful insights into social acceptance.

#### Madrid

- **A1.1 Autonomous e-buses** – passenger trust, safety perception, willingness to ride.
- **A1.2 Automated Guided Vehicle for waste collection** – employee acceptance, workflow impact.
- **A1.3 Last-mile autonomous electric transport for food markets** – vendor satisfaction, reliability.
- **A2.2 V2G chargers** – trust in bidirectional charging, perceived value.
- **A3.1 Efficient charging and electrification of fleets** – operator readiness, training adequacy.

#### Dresden (Two Stages)

##### Stage 1

- **A1 Charging robots** – trust in automation, perceived convenience.
- **A4 Autonomous e-vehicles for maintenance services** – worker readiness, safety culture.
- **A8 Bidirectional charging for cars** – household willingness-to-enrol, perceived benefits.

##### Stage 2

- **A6 District mobility concept** – modal-shift intentions, infrastructure adequacy.
- **A10.1 Sportpark services app** – digital readiness, usability, willingness to adopt.

#### 4.4.2 OBJECTIVES

1. **Assess Awareness & Acceptance** before, during and after deployment.
2. **Measure Social Readiness** (willingness to adopt, trust, accessibility).
3. Identify **Adoption Barriers**.
4. Evaluate **Governance & Cooperation**.
5. Ensure **Equity & Inclusion**.

#### 4.4.3 FRAMEWORK & PHASING

The monitoring methodology follows a structured **three-phase approach** to capture social acceptance and readiness at different stages of pilot implementation. Each phase includes specific KPIs, evaluation methods, and target groups to ensure comprehensive assessment and comparability across Madrid and Dresden.

Table 7 - Overview three-phase approach

Phase	KPI	Objectives	Evaluation Method	Target Group	Timing
Pre-Testing (Before Deployment)	<b>Awareness &amp; Acceptance</b>	Baseline understanding and attitudes; ensure stakeholders know pilot goals and impacts	UT-LAB Open Day Online/in-person Initial Awareness Survey via UT-LAB.	Local authorities, logistics operators, Mercamadrid businesses, employees, VRUs, citizens.	1–2 months before launch
	<b>Governance Readiness</b>	Understand governance structures and expectations	Survey	Pilot leads and other Project partners,	Every six months
Testing Phase (During Deployment)	<b>Acceptance</b>	Measure user perceptions, awareness, acceptance, and early user experience	On-site User Surveys using QR codes or micro-interviews in public spaces.	Early adopters, passengers, logistics operators, Mercamadrid employees, VRUs.	Start of testing phase (first 2–4 weeks)
	<b>User Satisfaction Index</b>	Assess usability, comfort, safety, willingness to continue.	Passenger Feedback Surveys (QR, onboard, or digital forms).	Bus passengers and early users, VRUs.	Midway & end of testing phase
	<b>Awareness (Adoption Barriers)</b>	Identify obstacles and information gaps.	Direct observation and short intercept	Pilot operators, public interaction points, VRUs.	Continuous during testing

			interviews at pilot sites.		
	<b>Quality of Cooperation Structures</b>	Assess quality of cooperation and communication among stakeholders.	Stakeholder interviews and feedback sessions.	Pilot leads and other Project partners,	Every six months
	<b>Governance &amp; Acceptance</b>	Track operational, safety, and communication challenges.	Operational observation and incident tracking logs.	Pilot operators, safety monitors, project team.	Throughout testing phase
<b>Post-Testing (After Deployment)</b>	<b>Awareness, Acceptance &amp; Satisfaction</b>	Compare pre/post perceptions and social impact.	Final impact assessment survey (digital + in-person).	All pilot users, including non-users for comparison.	1–2 months after pilot implementation ends
	<b>Customer Satisfaction &amp; Governance</b>	Assess long-term adoption and lessons learned.	Focus groups and in-depth interviews.	Selected users, business operators, local authorities.	1–2 months after pilot implementation ends
	<b>Governance Effectiveness</b>	Identify best practices and improvement areas.	Governance review workshop with key partners.	Project partners, policymakers.	End of pilot phase

#### 4.4.4 PILOT-SPECIFIC KPIS

To complement the general monitoring framework, pilot-specific KPIS have been defined for Madrid and Dresden. These KPIS focus on aspects most relevant to social acceptance and readiness, such as trust, perceived safety, usability, and willingness to adopt. Each KPI is linked to an evaluation method tailored to the pilot context (e.g., onboard surveys for passenger services, focus groups for maintenance staff, app-embedded questionnaires for digital tools). This approach ensures that monitoring captures both quantitative and qualitative dimensions of user experience and governance effectiveness.

##### Madrid

Table 8 - Overview pilot-specific KPIS Madrid

Pilot	Key Social KPIS	Evaluation Method	Target Group
<b>A1.1 Autonomous e-buses</b>	Trust, safety perception, willingness to ride	Onboard QR surveys, passenger feedback forms	Passengers, Mercamadrid employees

<b>A1.2 AGV for waste collection</b>	Employee acceptance, workflow impact	Worker interviews, observation checklists	Logistics staff, operators
<b>A1.3 Last-mile autonomous transport</b>	Vendor satisfaction, reliability perception	Vendor panels, service reliability logs	Market vendors
<b>A2.2 V2G chargers</b>	Trust in bidirectional charging, perceived value	Surveys for fleet managers, info sessions	Fleet operators, employees
<b>A3.1 Fleet electrification</b>	Acceptance of charging schedules, training adequacy	Operator diaries, training evaluation forms	Fleet operators

### Dresden

Table 9 - Overview pilot-specific KPIs Dresden

Pilot	Key Social KPIs	Evaluation Method	Target Group
<b>A1 Charging robots</b>	Trust in automation, perceived convenience	On-site demos, intercept surveys	Charging station users
<b>A4 Autonomous maintenance vehicles</b>	Worker readiness, safety culture	Focus groups, near-miss reporting	Maintenance staff
<b>A8 Bidirectional charging for cars</b>	Willingness-to-enrol, perceived benefits	Mixed-mode surveys, choice-based questions	Car owners, households
<b>A6 District mobility concept</b>	Intermodal readiness, bike acceptance	Ward-level surveys, pop-up counts	District residents
<b>A10.1 Sportpark services app</b>	Digital readiness, usability, willingness to adopt	App-embedded surveys, SUS score	Sportpark visitors

#### 4.4.5 BRIEF SYNTHESIS

The monitoring programme for social acceptance and readiness in Madrid and Dresden combines a structured methodology, pilot-specific KPIs, and participatory engagement through UT-Labs. This integrated approach ensures that technical performance is complemented by social insights, fostering trust, inclusiveness, and adoption. The results will feed into the overall impact assessment and provide guidelines for replication in the five follower cities and beyond.

## 4.5 Monitoring of Economic Footprint

As with the KPIs in the Environment, Energy, and Transport categories, economic KPIs are monitored in line with the pillars described in chapter 5.3.1. Annual financial reporting per pilot action ensures consistent tracking of economic performance and enables a structured assessment of the financial footprint associated with the implementation of innovative mobility solutions in cities.

### *Capital Investment*

The Capital Investment KPI captures the total capital expenditure required for the purchase of infrastructure, equipment, and vehicles, as well as the costs associated with preparing and setting up each measure. This includes expenses incurred from the initiation of measure preparation up to the start of implementation. For the MOBILITIES FOR EU pilots, capital investments are tracked throughout the year and documented annually through financial reporting. Budgeted costs defined in the Grant Agreement serve as the baseline against which actual expenditures are compared. Deviations from planned costs provide valuable insights into real-world cost structures, investment needs, and financial risks, supporting comparability with similar projects across Europe.

### *Average operating costs*

The average operating costs include all recurring expenses required to operate the implemented solutions, such as personnel, energy (fuel or electricity), maintenance, and operational services. As with capital investment, the budgeted operating costs defined in the Grant Agreement are used as baseline values and compared with actual operating expenses incurred during the piloting phase. Monitoring these costs supports the assessment of cost efficiency relative to conventional transport systems and provides evidence on the affordability and scalability of the solutions.

### *Pollution cost avoided*

The Pollution Cost Avoided KPI estimates the financial benefits resulting from reduced emissions and energy consumption achieved through the implemented measures. Depending on the characteristics of each pilot, different calculation approaches are applied. For example, in pilots leading to energy savings, pre-implementation energy consumption and electricity costs are used as the baseline and compared with values observed during operation. The resulting differences allow environmental benefits to be translated into monetary terms, contributing to a more comprehensive assessment of the societal value generated by emission reductions.

### *Economic impact*

The Economic Impact KPI captures the broader economic effects associated with the transition to clean mobility solutions, including benefits for end users, operators, and local economies. This includes direct and indirect impacts such as reduced energy expenditure, operational savings, and potential economic benefits linked to new technologies (e.g. clean vehicles or bidirectional charging systems). By quantifying changes in energy consumption and related costs, this KPI supports an assessment of the wider economic value generated by the pilots beyond direct project expenditures.

The annual financial reporting across all four economic KPIs provides a robust evidence base for decision-makers, ensuring that the 27 MOBILITIES FOR EU pilot measures are assessed not only from an environmental and social perspective but also in terms of long-term financial viability. This comprehensive view of the economic footprint supports informed decisions on future funding, scaling up successful solutions, and replication in other European cities. All details about the economic monitoring per pilot action are found in the Annex in the Monitoring Programmes for each city.

## 4.6 Life Cycle Costing (LCC) and Life Cycle Assessment (LCA)

Beyond day-to-day monitoring, MOBILITIES FOR EU embeds LCC and LCA methodologies, which complement for various actions some of the evaluation areas:

- Life Cycle Costing (LCC): LCC calculates the total cost of ownership of each solution — from initial investment to long-term maintenance, energy costs, and disposal. This helps identify if a pilot may become financially unsustainable. For example, if an autonomous vehicle system proves too costly to maintain, this would be flagged early through LCC, allowing for adjustments (e.g., alternative technologies or operational models).
- Life Cycle Assessment (LCA): LCA assesses the full environmental impact of solutions, from production to end of life. For instance, an electric bus may reduce emissions in use, but its battery production and disposal also have environmental footprints. LCA ensures no “hidden” environmental costs are ignored and helps avoid burden shifting (reducing emissions in one stage but increasing them elsewhere).

By integrating LCC and LCA into monitoring financial risks (e.g., unexpectedly high maintenance costs) are spotted early, and environmental trade-offs are identified and managed, ensuring the project’s measures truly support climate neutrality.

Based on the project’s LCC and LCA guidelines, this section presents an illustrative application of these methodologies to two representative pilot actions in Madrid (see also D3.1 - Evaluation framework for more details): the electric bus charging infrastructure and the green hydrogen fuelling station. The analysis follows a full life-cycle perspective, assessing each system from resource extraction and production to operation, maintenance, and end-of-life. For the charging infrastructure, the assessment covers the environmental impacts associated with the manufacturing and installation of charging points, operational electricity demand and its energy mix, system efficiency, required maintenance and component replacement, and the recyclability and disposal of materials such as copper at end-of-life. The evaluation also considers energy losses within the distribution grid and the supporting infrastructure required for grid integration.

The LCA of the green hydrogen fuelling station applies a similarly comprehensive scope, addressing the production of electrolysis equipment, storage tanks, compressors, and associated renewable energy installations. Operational impacts include electricity consumption for hydrogen production, the potential for hydrogen leakage, storage requirements, and routine maintenance, particularly for components such as electrolyser membranes. End-of-life processes assess dismantling requirements, material disposal, and opportunities to recover valuable resources, including platinum. Hydrogen distribution impacts were excluded due to the localised configuration of this pilot.

Across both actions, the evaluation incorporates key technical, environmental, and socio-economic dimensions. These include the renewable energy sources powering the installations, potential synergies with new solar or wind generation, and impacts linked to the lifecycle of the associated vehicle fleets (electric and hydrogen buses). Broader societal and economic aspects—such as total cost of ownership, tariff implications, job creation, emission reduction benefits, and contributions to public health—are also taken into account to ensure alignment with Madrid’s long-term sustainability objectives.

The analyses follow, where applicable, the ISO 14040/14044 standards for LCA and ISO 15686 for LCC, ensuring methodological robustness and comparability. Impact categories extend beyond carbon footprint to include water consumption, resource depletion (with emphasis on critical raw materials), air quality, and biodiversity. Data reliability is supported using recognised datasets and tools (e.g., Ecoinvent, SimaPro, OpenLCA). Through scenario analysis, upscaling methodologies, and integration with MOBILITIES FOR EU KPIs, these LCC/LCA findings will inform future decision-making, support long-term urban mobility planning, and contribute to the development of scalable and sustainable mobility solutions within the project framework.

## 5. Monitoring Platforms

A robust monitoring framework is essential to systematically track and evaluate the progress of KPIs in the MOBILITIES FOR EU project. This framework guarantees consistency, transparency, and accuracy in data collection and interpretation across all actions and pilots, while creating a unified approach to manage the diverse inputs from project partners.

At its core, the monitoring programme uses centralized data spaces and standardized formats for sharing, storing, and referencing information. These shared structures allow Madrid and Dresden to exchange insights, particularly for transversal actions like electric vehicle infrastructure deployment and public transport optimisation. By organising information by city, action, and KPI, the monitoring framework helps partners access, compare, and learn from each other's results, reinforcing a continuous cycle of learning and innovation across the project. Moreover, the information presented in the platforms can be presented in the form of dashboards to show the public the benefits and improvements of the actions, while helping city and institution representatives explore current and new measures for their cities.

The monitoring framework defines clear rules for data quality standards (how accuracy is maintained and verified), frequency of reporting (to ensure timely tracking of KPI progress), and verification procedures (so all partners work under a cohesive approach). It also incorporates timelines for every action, documenting baselines, and targets for each KPI and ensuring that performance can be measured against both initial conditions and compared with expected results.

Data hubs act as the repository for all project data, functioning as structured, living libraries where all information is stored, catalogued, and made accessible to project stakeholders. Two partners are leading the development of these monitoring platforms:

- T-Systems (Madrid, Pilot 5) is developing a Data Intelligent Hub (DIH), a secure, cloud-agnostic, GAIA-X-compliant data space designed for data accessibility, control, and analysis. The DIH is a marketplace for data exchange, enabling partners to share project datasets safely while maintaining data sovereignty. This hub-based structure also creates a foundation for future smart city services in Madrid, promoting data harmonisation and the integration of analytics and AI for advanced insights.
- SAP (Dresden, Pilot 5) is building the monitoring environment on its Business Technology Platform (BTP), combining SAP Analytics Cloud (SAC), which provides dynamic dashboards for KPI tracking, enabling partners to view progress in real time, run trend analyses, and project future impacts, and SAP Datasphere, which consolidates diverse data sources into a single, structured environment, ensuring consistency and quality across environmental, economic, and transport KPIs, even when some rely on simulation models or estimation techniques.

Both platforms share similar requirements (data management, integration, privacy, and user access design) but are tailored to the specific needs and partners of each city. By collaborating, T-Systems and SAP are creating a coherent and complementary monitoring architecture that supports mutual learning and paves the way for a replicable framework for the replication cities. To fully design and operate these platforms, MOBILITIES FOR EU partners are contributing information on:

- Data Sources – what sensors, logs, and manual inputs will feed the platforms,
- Data Types – including emissions, energy, mobility, and qualitative survey data,
- Calculation Logic – how raw inputs will be processed to produce KPI values,
- Update Frequencies – from real-time feeds to monthly or quarterly reporting, and
- User Roles – defining who can access the dashboards, from technical teams to city decision-makers.

This ensures that the monitoring platforms are not just technically sound, but also usable and accessible for everyone who needs to interact with them. The monitoring platforms enable consistent KPI tracking, secure and structured data sharing between Madrid and Dresden, and cross-city comparison of results for shared actions. By combining centralized data spaces, harmonised standards, and powerful analytical tools, the monitoring platforms support the project’s KPI evaluation and create a scalable infrastructure for future smart city initiatives across Europe.

## 5.1 Madrid Monitoring Platform (T-Systems)

In the following section, the Monitoring Platform from T-System for Madrid is presented.

### 5.1.1 TECHNICAL ARCHITECTURE

The AERO platform complies with UNE standards 178104 and 178502.

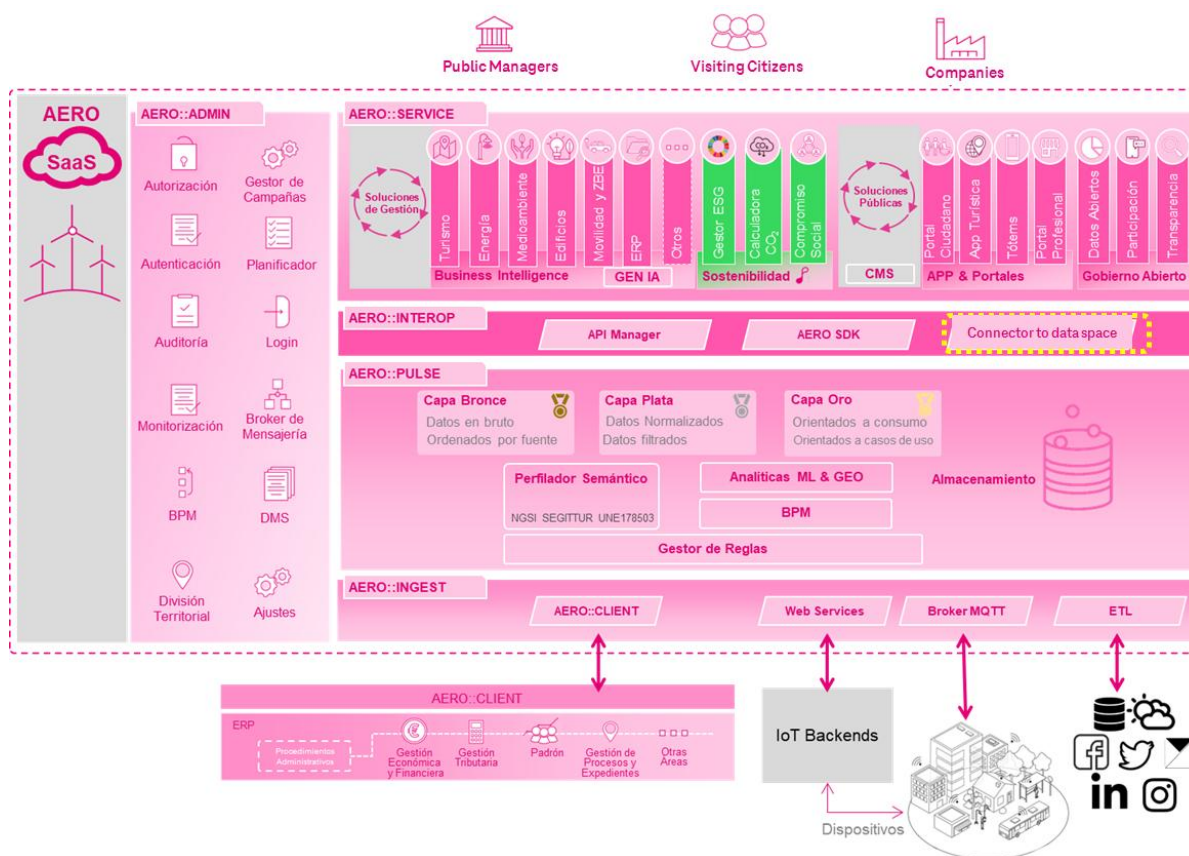


Figure 5 - Layered architecture Data Lake

AERO, a cross-cutting intelligent service platform provided by T-Systems, will integrate the different data systems of the MOBILITIES FOR EU project actions in Madrid, through the integration capabilities provided by a Smart platform based on the UNE 178104 standard, both for the operations it must develop and for enhancing integrations with other systems.

As can be seen, AERO maps its components to the model proposed by CTN 178, with the aim of providing the capabilities required for an intelligent management platform: collecting information about the territory, its

citizens, and businesses; providing cross-functionality for current and future systems; analysing the collected information; facilitating decision-making by public managers; and facilitating the creation of an application ecosystem on the platform that generates added value for citizens.

In T-Systems' implementation of the UNE standard in AERO, the following tools are identified as offering the required functionalities, through the following correspondence:

- Support Layer: Thanks to the BUROWEB tool's technology, support functionalities are offered to the other layers of the solution in a cross-functional manner, providing services such as auditing, monitoring, and security, among others. The AERO:ADMIN tool provides platform operators with the administration and configuration capabilities for the different platform components through a unified interface.
- Acquisition/Interconnection Layer: AERO:CLIENT is the AERO component responsible for providing the necessary mechanisms for interconnection and data acquisition from different external systems and sensors.
- Knowledge/Tourism Intelligence Layer: AERO:PULSE is the AERO module that enables the abstraction of information using a standard semantic approach, allowing for its homogeneous storage, processing, management, and analysis.
- It includes tools for processing information in real time and in batch processes, applying various analytical tools. It also includes the AERO:MAPS component, which provides support for georeferenced data.
- Interoperability Layer: AERO:INTEROP is the AERO component that facilitates the delivery of services to the various users of the smart tourism platform. It provides secure access to platform information through the API manager, as well as other integrated functionalities such as the Development Kit and the Open Data connector to facilitate integration with this type of portal.
- Intelligent Services Layer: AERO:SERVICE is the AERO service that enables the provision of business applications to clients, thanks to interaction with the platform through the interoperability layer. The main services provided are customized dashboards and the web and mobile applications that will be made available for the project.

AERO meets the general requirements that this type of platform provides, such as:

- Horizontal capability, understood as both multi-service capacity and cross-functionality, by supporting different verticals and services and making the information from each of them available for use by others.
- Interoperability and openness, as it is built on open technologies and provides interconnection standards at both the acquisition layer and the interoperability layer itself. This capability is a dynamic element that adapts to the different systems that may arise.
- High performance, robustness, resilience, and scalability. Cloud availability, as will be discussed later, ensures the platform's performance and high availability for each client, utilizing scalability mechanisms as needed.
- Evolvability and security: the AERO platform is an essential element within T-Systems' portfolio of solutions for the more than 430 public sector clients it serves. Being part of the TAO product suite, T-Systems can offer the same experience and guarantee of security and product evolution capabilities that they have been providing to their clients for over 30 years.

- Flexible and modular, AERO delivers its capabilities in both SaaS and on-premises environments, allowing for the dynamic deployment and activation of its various modules based on each client's needs, using containers with specific capabilities.
- Easy to operate and highly usable, thanks to the work of the T-Systems UX/UI team and interaction with their clients, AERO offers exceptional usability, as it can be seen in the examples that are included later.
- Big Data capabilities: one of the key elements in the platform's knowledge layer is its big data analytics engine.

The AERO platform has been designed to be offered to clients from a multi-entity cloud environment (1 instance, n clients) using a SaaS (Software as a Service) model.

For MOBILITIES for EU, it was opted for a private cloud deployment (dedicated resources) instead of a public/shared cloud, based on the following points:

- Adaptation of systems and services to the client's specific needs.
- No competition for resources (infrastructure and communications).
- Sized based on expected demand with a degree of elasticity.
- Aimed at complex environments with stable and predictable loads, or critical databases with guaranteed performance and high load capacity.

The proposed services are offered from T-Systems' data centers in Cerdanyola and 22@, which together form a Twin Data Center. This means they are tightly integrated and can be configured in different disaster recovery models (active-active or primary-secondary) to ensure the continuity of clients' information systems in the event of a contingency.

For the provision of information system hosting services, the computing resources of two of T-Systems' own Tier III Data Processing Centers (DPCs) are available.

Both of T-Systems' own Data Processing Centers (DPCs) are classified as Tier III - Concurrently Maintainable according to the Uptime Institute standard for design and construction. This certification can be verified at any time on the Uptime Institute website. Specifically, the certifications for T-Systems Iberia's Data Processing Centers

Both are infrastructures designed, built, and operated by T-Systems exclusively for its clients.

The primary data center will be the facility located in the Cerdanyola Science and Technology Park (Barcelona); a state-of-the-art facility inaugurated in early 2014. T-Systems has implemented the results of several research projects at this location.

The secondary data center will be the facility located in the 22@ technology district of Barcelona, situated at the company's corporate headquarters, which was modernized in 2017.

### 5.1.2 DATA INTEGRATION MECHANISM

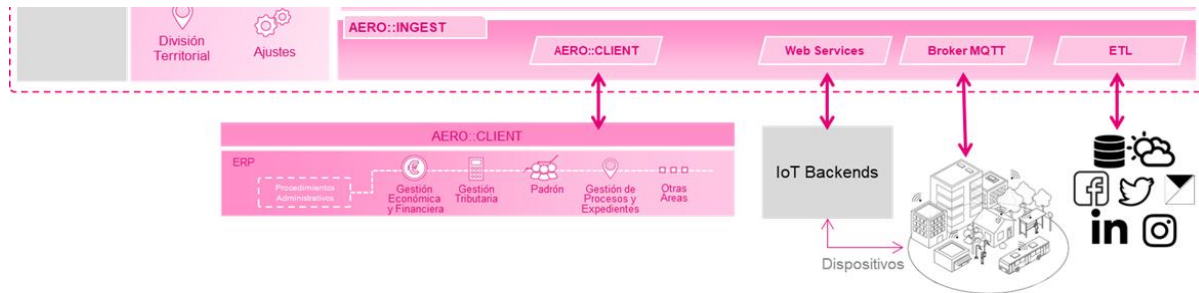


Figure 6 - Acquisition Layer Mechanisms

The AERO:INGEST layer is responsible for acquiring information from the sensors and systems of interest, whose data will be integrated into the platform. To do this, it will use numerous services:

- **MQTT Message Broker**
  - The AERO message broker provides the ability to operate both synchronously and asynchronously, using different services and protocols adapted for communication with the devices and systems from which information is to be integrated.
  - For communication with devices and systems that use asynchronous communication, AERO uses MQTT, although it can also function as a device communication interface.
  - As an MQTT server, it manages the publications generated on the platform, and as a client, it acts as a subscriber to devices and systems.
- **Web Services**
  - Regarding communication with systems, AERO provides the capabilities based on Web Services offered by the REST protocol, both for reading data and sending commands to systems. For each system to be connected, a connector will be implemented using the API capabilities of the system to be integrated. For each of the elements that need to be interconnected in the project, REST communication will be preferred, since each element will manage its own devices and send the processed information to the platform.
- **ETLs**
  - The Extract, Transform, and Load mechanisms used by the platform are Node-RED and N8N.
- **Rules Manager**
  - Although a typical element of the knowledge layer, the AERO acquisition layer allows for the implementation of certain simple processes that will serve to discard invalid readings or to identify potential alerts that require real-time action. This capability allows for optimizing both the quality of the data sent to the Knowledge Layer and the platform's responsiveness when taking action based on specific values configured in the manager, such as managing alerts based on certain input values.

### 5.1.3 VISUALISATION AND REPORTING TOOLS

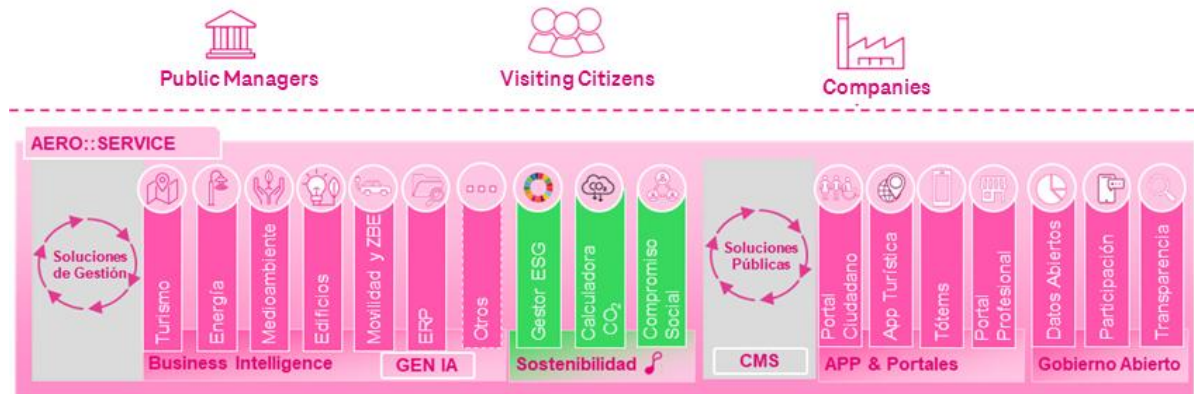


Figure 7 - Data Lake visualization and reporting verticals

To create the various platform dashboards, a tool will be used that will allow managers to control each of the services within the MOBILITIES FOR EU project, specifically Mobility and Energy. This tool is called AERO:SERVICE.

AERO:SERVICE is based on Kibana, a Big Data dashboard creation tool integrated into the platform. Thanks to the versatility of this tool, it will be possible to create customized dashboards adapted to the needs of different managers. However, as an initial proposal, the following dashboards have been proposed to be created:

- Energy Management Dashboard
- Mobility Management Dashboard
- General Indicators Dashboard for the MOBILITIES FOR EU project

The platform's versatility will allow for the creation of additional dashboards as new services are added.

Access to each dashboard by the different project managers or technicians will be regulated by the relevant access policies, as defined in the Architecture Support Layer, and based on the information security and integrity policies that govern the currently implemented systems.

Figure 8 below shows an example dashboard of general indicators for the MOBILITIES FOR EU project:

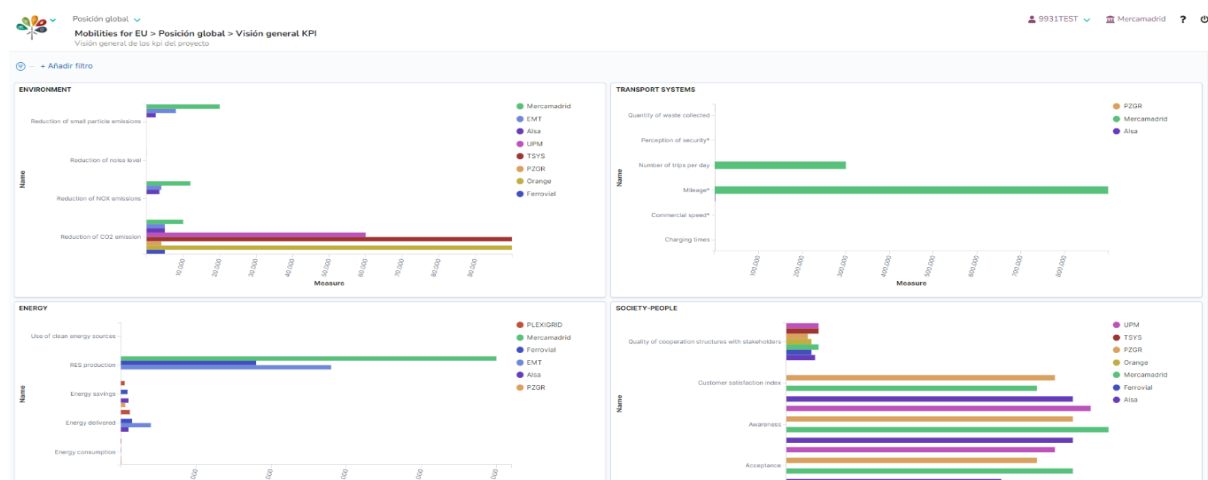


Figure 8 - Example dashboard visualizing project KPIs

## 5.2 Dresden Monitoring Platform (SAP)

In the following section, the Monitoring Platform from SAP for Dresden is presented.

### 5.2.1 TECHNICAL ARCHITECTURE

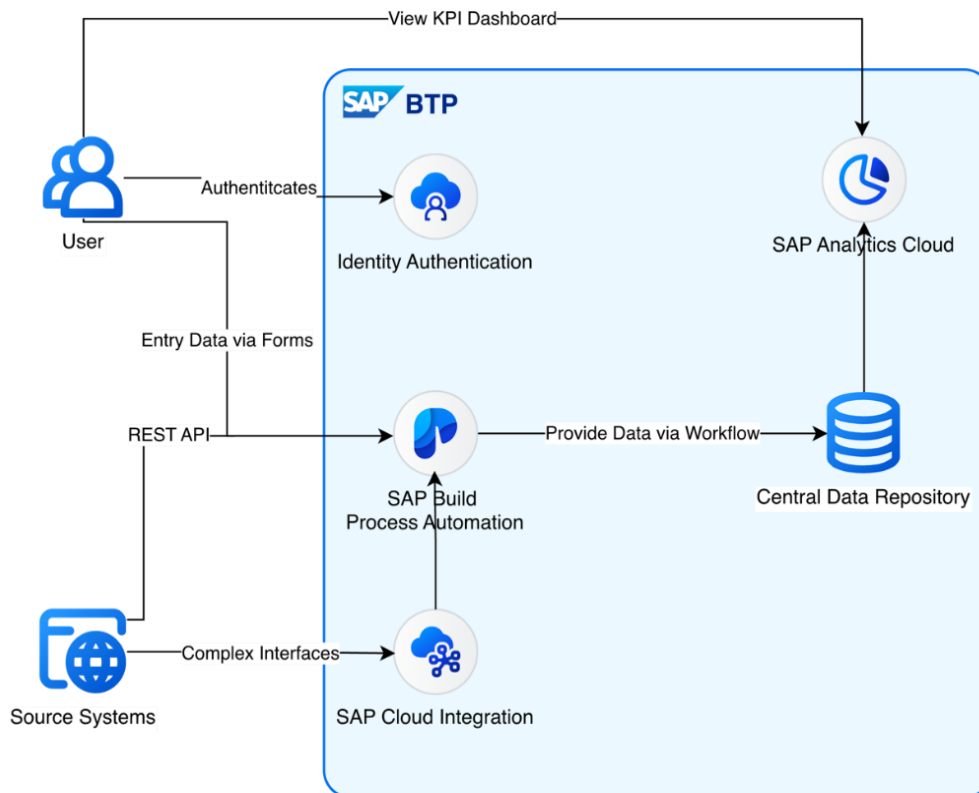


Figure 9 - Architecture Diagram of the Monitoring System

The Dresden Monitoring Platform is built on the **SAP Business Technology Platform (BTP)**, providing an integrated cloud solution for tracking the project KPIs. The architecture combines several key SAP technologies to create a robust and scalable environment for data management, process automation, and analytics.

The core of the platform is a **central data repository**, which consolidates data from diverse sources and manual submissions. This unified data layer ensures consistency and quality for all project data.

For data collection and workflow management, the platform uses **SAP Build Process Automation**. This component provides digital forms for KPI submissions and automates the entire process, from sending reminders to data validation and provisioning of data to the data repository.

Interactive visualizations and reporting are managed by **SAP Analytics Cloud (SAC)**. SAC delivers dynamic, real-time dashboards tailored to different user roles as so-called User Stories.

**SAP Integration Suite** enables seamless, automated data collection from external systems. It supports various integration patterns and a wide range of adapters for different interface technologies, ensuring that data is collected efficiently and reliably. It also holds dataspace components to facilitate cross company data exchange if required.

The platform is designed with security, interoperability, and scalability as core principles, ensuring it can support the project's needs and future expansion. Several components of this platform will also be reused during the creation of the WP2 pilots.

### 5.2.2 DATA INTEGRATION MECHANISM

The platform supports a hybrid data integration approach, combining manual and automated methods to accommodate the variety of data sources in a smart city environment.

Manual data collection is managed through user-friendly digital forms and automated workflows (see Figure 10 below). The forms are used for quarterly KPI submissions, with features like pre-filled fields and validation. The workflows manage the entire process, from submission reminders and quality assurance approvals to data persistence.

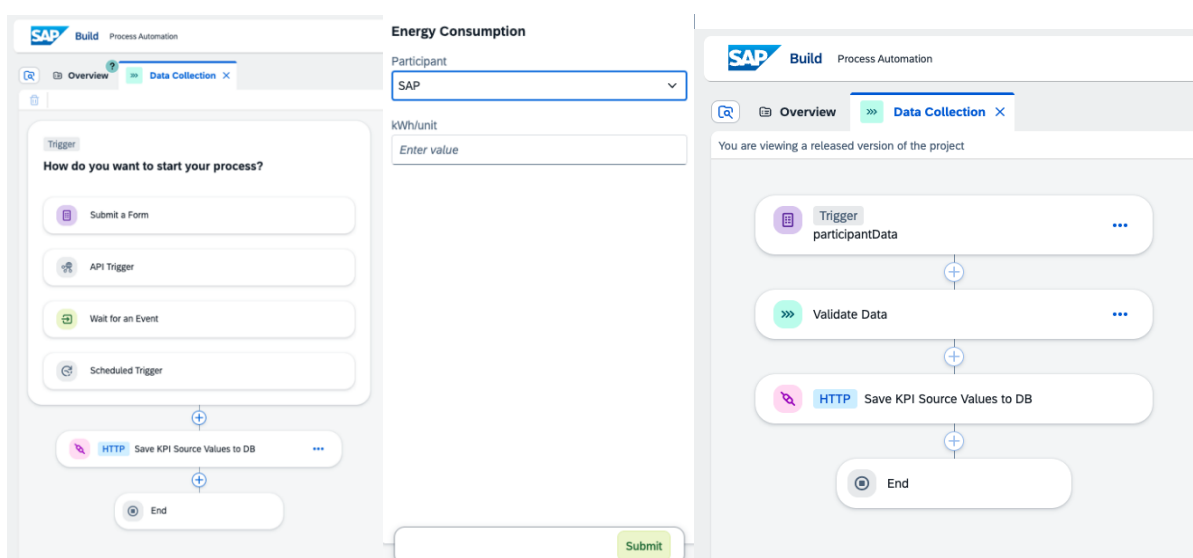


Figure 10 - Screenshots of the Workflow Automation Part for the Data Collection

Automated data collection is handled by SAP Integration Suite, which supports different integration patterns and interface technologies. Data quality is ensured through validation and continuous monitoring of integrations. This ensures that the data is accurate, reliable, and trustworthy.

### 5.2.3 VISUALISATION AND REPORTING TOOLS

The platform provides tailored dashboard experiences through SAC to meet the needs of different stakeholders. The platform's reporting capabilities include both standard automated reports and a flexible ad-hoc report builder. The basis for these reports is a central data repository structuring the base and master data and making it available to SAC. Collaboration is supported through features like commenting, dashboard sharing, and scheduled distribution, ensuring all stakeholders remain informed and aligned.

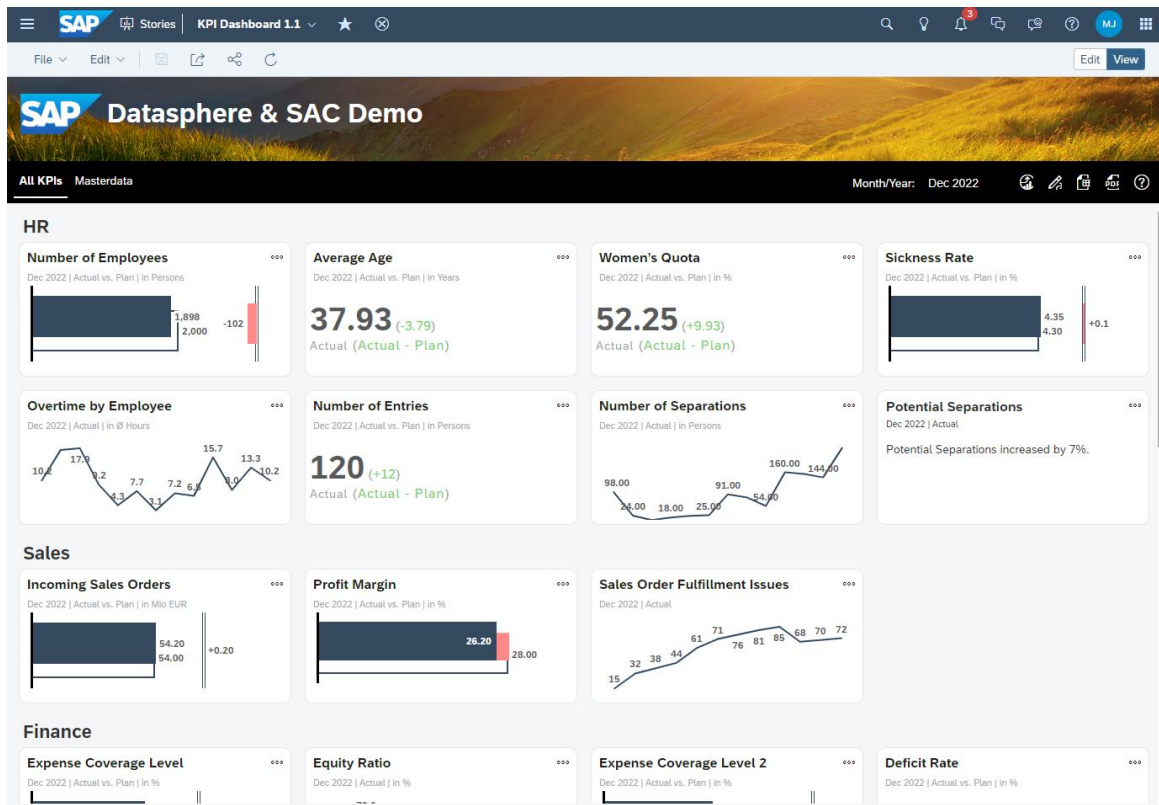


Figure 11 - Example Picture of a KPI Dashboard Created with SAP Analytics Cloud

## 6. Expected Challenges and Management Approach

As MOBILITIES FOR EU moves from the design phase into active monitoring and evaluation, it faces a complex landscape of technical, operational, and contextual challenges. This chapter outlines the main ones identified for the KPI monitoring programme and the wider performance assessment work and explains the mitigation strategies built into the project. It also describes how methodologies such as Life Cycle Costing (LCC) and Life Cycle Assessment (LCA) will support risk management and how the monitoring activities will connect to broader city-level climate neutrality goals.

### 6.1 Technical, Operational and Data Challenges

Implementing a harmonised monitoring programme across two lead cities, Madrid and Dresden, with different infrastructures, policies, and mobility solutions is inherently complex. Some relevant challenges have been identified and mitigation strategies are consistently discussed with the technical partners:

#### Technical Challenges

- **System Interoperability:** Madrid and Dresden use different technologies (e.g., charging infrastructure, telematics, autonomous vehicle systems). Ensuring data compatibility between systems, and also thinking of other possible future uses like upscaling or replication in other cities, requires standardised common data formats, and robust integration monitoring platforms.
- **Sensor and Device Reliability:** Many KPIs depend on sensor data (e.g., charging times, emissions, or energy use). Sensors can fail, be vandalised, or drift in calibration, which could compromise data accuracy. Regular calibration schedules and backup data collection sources will mitigate this.
- **Technological Readiness Gaps:** Some pilots, like charging robots or autonomous delivery vehicles, are at lower TRL levels. Unforeseen malfunctions or delays could disrupt data collection timelines. Mitigation involves staggered deployment, technical redundancies, and realistic scheduling buffers.

#### Operational Challenges

- **Coordination Between Partners:** Monitoring requires close collaboration among municipalities, transport operators, technology providers, and researchers. Misalignment in responsibilities could cause delays or inconsistencies. Clear role definitions and regular coordination meetings reduce this risk.
- **Pilot Scope Adjustments:** Urban pilots may evolve in response to real-world conditions (e.g., changes to routes, vehicle numbers, or regulatory permissions). This could alter KPI baselines or invalidate some assumptions. The monitoring framework is therefore designed to be adaptive, with mechanisms for updating KPIs or data collection protocols if pilots change.

#### Data Challenges

- **Data Gaps and Inconsistencies:** Not all data will be available at the same level of detail from each pilot. Some measures might underdeliver data, or report in incompatible formats. The project has adopted harmonised data templates and will use cross-checking and triangulation (e.g., combining operational logs with UT-Lab surveys, estimation or calculation) to fill gaps.
- **GDPR Constraints on Comparability:** Privacy rules may limit sharing of individual-level data across cities. To ensure comparability without violating GDPR, MOBILITIES FOR EU will work with aggregated, anonymised datasets and develop city-level summaries that can be safely exchanged.

## 6.2 Contribution to Project Impact Assessment

The monitoring challenges described above directly influence the project’s ability to deliver a credible and comprehensive impact assessment. The MOBILITIES FOR EU evaluation framework (from D3.1 - Evaluation framework) links KPI monitoring to three levels of assessment (see chapter 5.3.1):

- Measure-level performance: Does each bus, shuttle, or charging station do what it is supposed to?
- Pilot-level performance: How well do all measures in Madrid or Dresden function together?
- Project-wide impact: What is the total effect across cities, and what can be replicated?

Challenges such as inconsistent data or scope changes could create “gaps” in this chain. The mitigation approach is to:

- Use cross-verification (e.g., comparing UT-Lab surveys with operational data) to validate results.
- Build redundancies into data collection (e.g., backup data sources for key KPIs).
- Keep a flexible evaluation design, so that unexpected findings or pilot changes can be integrated rather than disrupt the entire impact assessment.

This resilience means MOBILITIES FOR EU will still deliver robust insights, even if individual pilots have some delays or issues with their individual actions, we can make sure pilots provide important insights of the innovation involved in this project.

## 6.3 Integration with City-Level Climate Objectives

One of MOBILITIES for EU’s unique strengths is its alignment with city-level climate neutrality objectives, especially through the NetZero Cities platform and the Climate City Contracts (CCCs) of Madrid and Dresden.

However, this integration also presents challenges:

- Policy and Target Shifts: Cities may revise their climate neutrality targets or mobility strategies during the project (e.g., introducing new low-emission zones or changing energy sourcing policies). Monitoring must adapt KPIs and reporting to stay relevant.
- Different Baselines and Ambitions: Madrid and Dresden start from different levels of electrification, grid capacity, and modal split. Comparing their progress requires context-sensitive interpretation, a success metric in Dresden might look different in Madrid, and vice versa.

To mitigate these challenges:

- KPIs are aligned with the Cities Mission emission scopes, so that results can plug directly into CCC reporting and wider EU frameworks.
- Monitoring includes qualitative notes to explain contextual factors behind results, preventing misinterpretation of raw numbers.
- UT-Labs provide a feedback channel between monitoring teams and city decision-makers, ensuring monitoring findings are fed into real policy decisions (e.g., how to scale electric fleets or where to expand charging infrastructure).

Ultimately, integrating monitoring with city objectives means MOBILITIES FOR EU is not just reporting what happened, but directly supporting how cities will move forward.

## 7. Conclusion

In conclusion, this deliverable establishes the comprehensive monitoring architecture required to assess the environmental, energy, transport, social, and economic impacts of the MOBILITIES FOR EU pilot actions in Madrid and Dresden.

Building on the methodological foundations laid in D3.1 (Evaluation framework), it translates high-level indicators into operational monitoring programmes, clarifies responsibilities across partners, and introduces harmonised data collection and reporting principles aligned with NetZeroCities, CIVITAS, and SUMI. The monitoring platforms developed by T-Systems and SAP, complemented by the ongoing work of the Urban Transport Labs, provide the digital and organisational infrastructure needed to ensure that high-quality, GDPR-compliant data can be collected, integrated, visualised, and used to support both performance and process evaluations.

By anticipating technical, operational, and data-related challenges and by incorporating Life Cycle Costing and Life Cycle Assessment into the analytical framework, the deliverable strengthens the project's ability to detect risks early, understand trade-offs, and track whether the innovative mobility solutions deployed remain both economically viable and environmentally sound. Beyond its technical outputs, the monitoring programme serves as a strategic framework that aligns diverse project partners under a shared methodology, ensures transparency and comparability across pilots, and combines quantitative indicators with contextual analysis tools that explain not only what changes occur, but why.

Overall, this document, D3.2, lays the operational and methodological groundwork for a robust, consistent, and scalable impact assessment approach. It equips MOBILITIES FOR EU with the tools needed to generate credible and meaningful insights, support informed decision-making in Madrid and Dresden, and provide a replicable model for future deployment in replication cities and across Europe.

Thanks to the process already defined in this deliverable, the final objective of WP3 is tackled and the path to success is paved. Project implementation's data will be collected, data quality will be analysed and KPIs will be calculated and the results analysed as part of T3.3 (Data collection and KPI calculation) and T3.4 (Evaluation and contribution to City-wide Climate Neutrality objectives, 2Zero and CCAM partnerships), and the results will be reported in D3.3 (Data collection & automatic KPI calculation procedures) and D3.4 (Performance Evaluation: viability and limitations of 2ZERO and CCAM solutions in Madrid and Dresden) respectively.

## Annexes

### Annex 1: Template Event Issue Logbook

Event & Issue Logbook												
Dresden												
TEMPLATE												
Issue No.	Date	Pilot No. <i>Pilot [P..] - Measure [A..]</i>	Phase <i>(Design, Implementation, Evaluation)</i>	Event or Issue?	Description of what happened?	Type <i>(Technical, bureaucratic, environmental, other)</i>	Description Effect / Impact	Impact Level <i>(High, medium, low)</i>	Action	Status <i>(Open, on track, resolved)</i>	Learning	Resp.
1	25.01.2026	[P1] - A1 - Charging robots	Implementation	Issue	Charging stations not ready at launch	Technical	Delayed launch by 2 weeks	High	Supplier expedited setup	Resolved	Align infrastructure timeline with pilot start	VW
2												
3												
4												
5												
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7												
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9												
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12												
13												
14												

## Annex 2: Process Evaluation Surveys

### Design Phase Survey

#	Question	Response Type
1	Your name / role (optional)	Short text
2	Team or department	Short text
3	How clear were the pilot’s goals and expected outcomes during design?	Scale 1–5 (1 = not clear, 5 = very clear)
4	Did you need to change the scope of the pilot? How?	Open text
5	What worked well in the design phase? (e.g., collaboration, clarity, leadership, stakeholder input)	Open text
6	What barriers or challenges did you encounter?	Open text
7	How much did these barriers impact readiness for implementation?	Scale 1–5 (1 = minimal, 5 = major)
8	How did you solve these barriers?	Open text
9	What helped or supported the process? (e.g., leadership support, good communication, tools)	Open text
10	What key lessons or recommendations would you take forward to future pilot designs?	Open text
11	Overall, how well did the design phase prepare the project for implementation?	Scale 1–5 (1 = very poor, 5 = excellent)

## Implementation Phase Survey

#	Question	Response Type
1	Your name / role (optional)	Short text
2	How long were you involved in the implementation?	Dropdown (<6 months / 6–12 months / Full duration)
3	What supported smooth implementation? (e.g., teamwork, clear communication, adequate resources)	Add categories (teamwork, clear communication, adequate resource, other) and scale each category
4	What else supported smooth implementation that is specific from your pilot?	Open text
5	What barriers or difficulties arose? (e.g., staffing, logistics, unclear responsibilities, data systems)	Open text
6	How much did these barriers impact pilot progress?	Scale 1–5 (1= minimal, 5 = major)
7	How effectively did coordination and communication work among stakeholders?	Scale 1–5 (1 = very poor, 5 = excellent)
8	If Q6 is answer 1 or 2 explain why	Open text
9	What adjustments or problem-solving approaches worked well?	Open text
10	What key lessons from implementation would help in future pilots?	Open text
11	Looking back, how well did the design prepare you for implementation challenges?	Scale 1–5 (1 = not at all, 5 = very well)
12	Any additional comments or reflections?	Open text

### Evaluation Phase Survey

#	Question	Response Type
1	Your name / role (optional)	Short text
2	How clear were the evaluation objectives and criteria?	Scale 1–5 (1 = not clear, 5 = very clear)
3	What supported the evaluation process? (e.g., data access, tools, stakeholder engagement)	Open text
4	What barriers made the evaluation challenging? (e.g., limited time, unclear data, lack of coordination)	Open text
5	How much did these barriers affect the ability to draw meaningful conclusions?	Scale 1–5 (1 = minimal, 5 = major)
6	What were the most valuable insights gained from the evaluation?	Open text
7	How useful do you find the evaluation results for improving future projects?	Scale 1–5 (1 = not useful, 5 = very useful)
8	How well were learnings from earlier phases (design, implementation) integrated into this phase?	Scale 1–5 (1 = not at all, 5 = very well)
9	What would you recommend changing or improving in future evaluations?	Open text
10	Final reflection: If you could share one piece of advice with a future evaluation team, what would it be?	Open text

### Annex 3: Monitoring Programmes Madrid

#### Overview Responsibilities - Monitoring Programmes per Action Madrid

Pilot	Name of the action	ENVIRONMENTAL KPIs				ENERGY KPIs					TRANSPORT KPIs						SOCIAL KPIs			ECONOMY KPIs							
		Key KPI	Key KPI	Key KPI	KPI	KPI	Key KPI	KPI	Key KPI	KPI	KPI	KPI	KPI	KPI	KPI	KPI	Key KPI	Key KPI	Key KPI	KPI	KPI	KPI	KPI	KPI	KPI		
		Reduction of CO2 emissions	Reduction of NOX emissions	Reduction of small particle emissions	Reduction of noise level	Energy consumption	Energy savings	Energy delivered	Use of clean energy sources	RES production	Mileage	Quantity of waste collected	Number of trips per day	Charging times	Commercial speed	Perception of security	Acceptance	Awareness	Customer satisfaction index	Quality of cooperation structures with stakeholders	Capital investment	Average operating costs	Pollution cost avoided	Economical impact			
Pilot 1	A1.1. Autonomous e-buses in Mercamadrid area for people (ALSA)	ALSA	ALSA	ALSA	ALSA	ALSA	ALSA		ALSA		ALSA		ALSA	ALSA	ALSA	R: ALSA C: RC, MM	R: ALSA C: RC, MM	R: ALSA C: RC, MM	R: ALSA C: RC, MM	R: ALSA C: RC, MM	ALSA	ALSA	ALSA	ALSA			
	A1-2 Automated Guided Vehicle for waste collection at Mercamadrid (PZGR)	PZGR	PZGR	PZGR		R: PZGR- C: T-SYS	R: PZGR- C: MERCAM, UPM		R: PZGR- C: MERCAM		PZGR	PZGR	PZGR	PZGR	PZGR	R: PZGR C: RC, MM	R: PZGR C: RC, MM	R: PZGR C: RC, MM	R: PZGR C: RC, MM	R: PZGR C: RC	PZGR	PZGR					
	A1-3 Last mile autonomous electric transport for food markets (PZGR)	PZGR	PZGR	PZGR		R: PZGR- C: T-SYS	R: PZGR- C: MERCAM, UPM		R: PZGR- C: MERCAM		PZGR	PZGR	PZGR	PZGR	PZGR	R: PZGR C: RC, MM	R: PZGR C: RC, MM	R: PZGR C: RC, MM	R: PZGR C: RC, MM	R: PZGR C: RC, MM	PZGR	PZGR					
	A1-4 Development of 5G Private Mobile Network services in Stand Alone for CCAM connectivity (ORANGE)	ORANGE							ORANGE												R: ORANGE C: RC, MM	ORANGE					
Pilot 2	A2-1 Distributed Smart Grid for Eco Transportation (FERROVIAL)	R: FRRVL C: MERCAM, UPM				R: FRRVL C: MERCAM, UPM		R: FRRVL C: MERCAM, UPM	MERCAM	R: FRRVL C: MERCAM													R: FRRVL C: RC, MM	C&R FRRVL	C&R FRRVL	R: FRRVL C: MERCAM, UPM	R: FRRVL C: MERCAM
	A2-2 Digital Twin and power grid management for flexibility (PLEXIGRID, UPM)	R: PLEXIG C: MERCAM, UPM				R: PLEXIG C: MERCAM, UPM	R: PLEXIG C: MERCAM, UPM	R: PLEXIG C: MERCAM, UPM	R: PLEXIG C: MERCAM, UPM									R: PLEXIG C: UPM, MERCAM	R: PLEXIG C: UPM, MERCAM		R: PLEXIG C: MERCAM						
Pilot 3	A3-1 Electrification of 329 e-buses and full electrification of Carabanchel Bus Depot (EMT)	EMT			EMT	EMT	EMT	EMT	EMT	EMT	EMT					R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	EMT	EMT	EMT				
	A3-2 Intelligent sharing of charging infrastructure and energy between vehicles for the transport of people and freight (EMT)	EMT				EMT	EMT	EMT	EMT	EMT	EMT					R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	EMT	EMT	EMT				
Pilot 4	A4-1 Implementation of H2 Refueling Station and 10 H2 fuel cell buses (EMT)	EMT			EMT	EMT	EMT	EMT	EMT	EMT	EMT					R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	R: EMT C: RC	EMT	EMT	EMT				
Pilot 5	A5-1 Green Energy Data Space in Mobility for the Decarbonization of Madrid and other Cities (TSY)	T-SYS				T-SYS														R: T-SYS C: RC	T-SYS	T-SYS					

## D3.2 – Monitoring Programmes for 2ZERO, CCAM and power grid actions in Madrid and Dresden

### Monitoring Programme per Pilot 1 – ALSA

Name	Definition	Unit	Category	Measures	Comments	BAU (Business-as-usual)	After	Method	Monitoring System			Target
Name of the indicator that will be used to monitor the progress towards the achievement of the measure	Definition of the indicator	Unit measurement	From CIVITAS	Related to measure:		Projected value achieved without any measures by the end of the implementation	Value recorded after the implementation of the measures	Method of data collection	Starting Date	Type of Data: Measured, estimated or simulated	Frequency	Expected value after the implementation of the measures
Reduction of CO2 emissions	The average CO2 emissions per unit reduced as a result of the measures package implementation. This value takes into account SCOPE 1, 2 and 3 emissions.	TnCO2eq	ENVIRONMENT	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people	Estimated diesel bus calculation	60,78 kg CO2eq/100km		n/a	July 2025	Estimated	Annually	0
Reduction of NOX emissions	Average NOX emissions per unit reduced as a result of the implementation of the package of measures.	ppb	ENVIRONMENT	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people	Estimated diesel bus calculation	0,62 kg NOx/100km		n/a	July 2025	Estimated	Annually	0
Reduction of small particle emissions	Average small particle emissions per unit reduced as a result of the implementation of the package of measures.	microg/m3	ENVIRONMENT	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people	Estimated diesel bus calculation	0,01 kg/100km		n/a	July 2025	Estimated	Annually (natural year)	0
Reduction of noise level	Noise level (dB(A)) measured on-site in the area or corridor under study.	dB(A)	ENVIRONMENT	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people		82 dB(A)		Periodical technical inspections (ITV)	July 2025	Certificate		0
Energy consumption	The energy consumption per unit of activity.	kWh/unit	ENERGY	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people	Bus and route equivalencies and fuel consumption	70kWh/100km	70kWh/100km	Chargers monitoring system & on-board telematics	July 2025	Measured (plexigrid)	Monthly	70kWh/100km
Energy savings	Reduction in energy consumption (per distance, per trip, per passenger transported)	kWh/unit	ENERGY	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people	Bus and route equivalencies and fuel consumption	-175.59 kWh/100km	75.59 kWh/100km	Chargers monitoring system & on-board telematics	July 2025	Measured (plexigrid)	Monthly	-175.59 kWh/100km
Use of clean energy sources	The total volume of non-conventional energy resources. It can also be measured as a percentage of the total energy used.	%	ENERGY	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people	100% clean	100%	100%	Certificate of the origin of the energy used	July 2025			100%
Mileage	Total distances driven in an area during a day.	km/unit	TRANSPORT SYSTEM	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people		TBD	TBD	Tachograph, onboard telematics, GPS	December 2025	Measured	Monthly	TBD
Number of trips per day	Vehicle frequency	n° trips/day	TRANSPORT SYSTEM	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people		TBD	TBD	Tachograph, onboard telematics, GPS	December 2026	Measured	Monthly	TBD
Charging times	Time needed to charge a vehicle	hours/unit	TRANSPORT SYSTEM	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people		TBD	TBD	Chargers monitoring system & on-board telematics	December 2027	Measured	Monthly	TBD
Commercial speed	The average journey speed of public transport services between two points, including any delay at stops	km/h	TRANSPORT SYSTEM	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people		TBD	TBD	Tachograph, onboard telematics, GPS	December 2028	Measured	Monthly	TBD
Perception of security	Qualitative perception of security	Qualitative score	TRANSPORT SYSTEM	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people		> 7 out of 10	> 7 out of 10	Periodical survey	July 2025			> 7 out of 10
Acceptance	The percentage of the population who favourably receive or approve the measures.	% or Qualitative score	SOCIETY-PEOPLE	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people		>60%	>60%	Periodical survey	July 2025			>60%
Awareness	The percentage of the target population with knowledge of the measures implemented in the testing area on account of provided information.	(% or Qualitative score	SOCIETY-PEOPLE	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people		>60%	>60%	Periodical survey	July 2025			>60%
Customer satisfaction index	The reported satisfaction of the quality of the specific services deployed.	%	SOCIETY-PEOPLE	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people		> 7 out of 10	> 7 out of 10	Periodical survey	July 2025			> 7 out of 10
Quality of cooperation structures with stakeholders	Level of quality of cooperation structures between all public and private stakeholders to develop and implement innovative mobility solutions.	Qualitative score	SOCIETY-GOVERNANCE	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people	Bi-annual survey to project partners (From 1 to 5)	3		Periodical survey	December 2024			5
Capital investment	The total capital costs for purchase of infrastructure, equipment and vehicles. It can also include the total costs expended in setting up the measure and cover a period from the initiative of the measure preparation until the start of the measure implementation.	€	ECONOMY	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people	Review together with cost reportings	1.561.200 €	1.561.200 €	Financial and Interim reportings	January 2024	Measured	Annually	1.561.200 €
Average operating costs	Operating costs including for example, the personnel costs, fuel, electricity and maintenance costs for the vehicle(s) involved.	€	ECONOMY	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people		TBD	TBD	Financial and Interim reportings	July 2025	Measured	Semester	TBD
Pollution cost avoided	The estimated financial savings resulting from the reduction of pollution due to implemented measures.	€	ECONOMY	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people		TBD	TBD	KPI #6 multiplied by the average cost of CO2 emission rights in this period	July 2025	Estimated	Semester	TBD
Economical impact	Financial benefits to end users and to entities from the transition from petrol to clean energy vehicles, the adoption of bidirectional charging, etc.	€	ECONOMY	1) A1.1 - Madrid Autonomous e-buses in Mercamadrid area for people		TBD	TBD	KPI #5 multiplied by the average cost of diesel in this period, or the average price of electricity	July 2025	Estimated	Semester	TBD

## D3.2 – Monitoring Programmes for 2ZERO, CCAM and power grid actions in Madrid and Dresden

### Monitoring Programme per Pilot 1 – PZG

Name	Definition	Unit	Category	Measures	Comments	BAU (Business-as-usual)	After	Method	Monitoring System		Target	
<i>Name of the indicator that will be used to monitor the progress towards the achievement of the measure</i>	<i>Definition of the indicator</i>	<i>Unit measurement</i>	<i>From CIVITAS</i>	<i>Related to measure:</i>	<i>Minutes</i>	<i>Projected value achieved without any measures by the end of the implementation</i>	<i>Value recorded after the implementation of the measures</i>	<i>Method of data collection</i>	<i>Starting Date</i>	<i>Type of Data: Measured, estimated or simulated</i>	<i>Frequency</i>	<i>Expected value after the implementation of the measures</i>
Reduction of CO2 emissions	The average CO2 emissions per unit reduced as a result of the measures package implementation. This value takes into account SCOPE 1, 2 and 3 emissions.	TnCO2eq	ENVIRONMENT	1) A1.2 Madrid -Automated Guided Vehicle for waste collection at Mercamadrid		n/a	0	Estimation from diesel avoidance	Pilot starting date	Estimated		0
Reduction of NOX emissions	Average NOX emissions per unit reduced as a result of the implementation of the package of measures.	ppb	ENVIRONMENT	1) A1.2 Madrid -Automated Guided Vehicle for waste collection at Mercamadrid		n/a	0	Estimation from diesel avoidance	Pilot starting date	Estimated		0
Reduction of small particle emissions	Average small particle emissions per unit reduced as a result of the implementation of the package of measures.	microg/m3	ENVIRONMENT	1) A1.2 Madrid -Automated Guided Vehicle for waste collection at Mercamadrid		n/a	0	Estimation from diesel avoidance	Pilot starting date	Estimated		0
Energy consumption	The energy consumption per unit of activity.	kWh/unit	ENERGY	1) A1.2 Madrid -Automated Guided Vehicle for waste collection at Mercamadrid		n/a			Pilot starting date	Measured		TBD
Energy savings	Reduction in energy consumption (per distance, per trip, per passenger transported)	kWh/unit	ENERGY	1) A1.2 Madrid -Automated Guided Vehicle for waste collection at Mercamadrid		n/a	108,62	Calculation (theoretical diesel consumption - vehicle electricity consumption)	Pilot starting date	Measured		108,62
Mileage	Total distances driven in an area during a day.	km/unit	TRANSPORT SYSTEM	1) A1.2 Madrid -Automated Guided Vehicle for waste collection at Mercamadrid		n/a	10-15	Vehicle distance driven extracted from the forklift software	Pilot starting date	Measured	Weekly	10-15
Quantity of waste collected	Waste collected by vehicle, trip, etc.	weight/unit	TRANSPORT SYSTEM	1) A1.2 Madrid -Automated Guided Vehicle for waste collection at Mercamadrid		30-40		Data collected by operator at the collection point	Pilot starting date	Measured	Weekly	60-80
Number of trips per day	Vehicle frequency	n° trips/day	TRANSPORT SYSTEM	1) A1.2 Madrid -Automated Guided Vehicle for waste collection at Mercamadrid	Number of cages collected per day	n/a	40	Numer of trips (1 cage per trip) extracted from the forklift software	Pilot starting date	Measured	Weekly	40
Charging times	Time needed to charge a vehicle	hours/unit	TRANSPORT SYSTEM	1) A1.2 Madrid -Automated Guided Vehicle for waste collection at Mercamadrid		n/a		Charging time given by the forklift software	Pilot starting date	Measured	Weekly	TBD
Commercial speed	The average journey speed of public transport services between two points, including any delay at stops	km/h	TRANSPORT SYSTEM	1) A1.2 Madrid -Automated Guided Vehicle for waste collection at Mercamadrid		n/a	> 7 out of 10	Speed given by the forklift software	Pilot starting date	Measured	Weekly	> 7 out of 10
Perception of security	Qualitative perception of security	Qualitative score	TRANSPORT SYSTEM	1) A1.2 Madrid -Automated Guided Vehicle for waste collection at Mercamadrid	Both baselines and targets will be gathered through surveys conducted at Madrid Urban Mobility Lab with the	to be defined	>70%	Surveys	Pilot starting date	Measured	td	>70%
Acceptance	The percentage of the population who favourably receive or approve the measures.	% or Qualitative score	SOCIETY-PEOPLE	1) A1.2 Madrid -Automated Guided Vehicle for waste collection at Mercamadrid	Both baselines and targets will be gathered through surveys conducted at Madrid Urban Mobility Lab with the	to be defined	>60%	Surveys	Pilot starting date	Measured	td	>60%
Awareness	The percentage of the target population with knowledge of the measures implemented in the testing area on account of provided information.	(% or Qualitative score	SOCIETY-PEOPLE	1) A1.2 Madrid -Automated Guided Vehicle for waste collection at Mercamadrid	Both baselines and targets will be gathered through surveys conducted at Madrid Urban Mobility Lab with the	to be defined	> 7 out of 10	Surveys	Pilot starting date	Measured	td	> 7 out of 10
Customer satisfaction index	The reported satisfaction of the quality of the specific services deployed.	%	SOCIETY-PEOPLE	1) A1.2 Madrid -Automated Guided Vehicle for waste collection at Mercamadrid	Both baselines and targets will be gathered through surveys conducted at Madrid Urban Mobility Lab with the	not available		Surveys	Pilot starting date	Measured	td	5
Quality of cooperation structures with stakeholders	Level of quality of cooperation structures between all public and private stakeholders to develop and implement innovative mobility solutions.	Qualitative score	SOCIETY-GOVERNANCE	1) A1.2 Madrid -Automated Guided Vehicle for waste collection at Mercamadrid	Bi-annual survey to project partners (From 1 to 5)	3		Project Financial data	December 2024	Measured	td	5
Capital investment	The total capital costs for purchase of infrastructure, equipment and vehicles. It can also include the total costs expended in setting up the measure and cover a period from the initiative of the measure preparation until the start of the measure implementation.	€	ECONOMY	1) A1.2 Madrid -Automated Guided Vehicle for waste collection at Mercamadrid	Review together with cost reportings	to be defined	745000	Project Financial data	Beginning of the project	Measured	Annually	745.000,00
Average operating costs	Operating costs including for example, the personnel costs, fuel, electricity and maintenance costs for the vehicle(s) involved.	€	ECONOMY	1) A1.2 Madrid -Automated Guided Vehicle for waste collection at Mercamadrid	Review together with cost reportings	to be defined	29165,7	Operating cost estimation	Start of the pilot	Estimation	Monthly	29.165,70

## D3.2 – Monitoring Programmes for 2ZERO, CCAM and power grid actions in Madrid and Dresden

### Monitoring Programme per Pilot 1 – ORANGE

Name	Definition	Unit	Category	Measures	Comments	Before	BAU (Business-as-usual)	After	Monitoring System	Monitoring System	Target		
<i>Name of the indicator that will be used to monitor the progress towards the achievement of the measure</i>	<i>Definition of the indicator</i>	<i>Unit measurement</i>	<i>From CIVITAS</i>	<i>Related to measure:</i>	<i>Comments</i>		<i>Projected value achieved without any measures by the end of the implementation</i>	<i>Value recorded after the implementation of the measures</i>	<i>Method of data collection</i>	<i>Starting Date</i>	<i>Type of Data: Measured, estimated or simulated</i>	<i>Frequency</i>	<i>Expected value after the implementation of the measures</i>
Reduction of CO2 emissions	The average CO2 emissions per unit reduced as a result of the measures package implementation. This value takes into account SCOPE 1, 2 and 3 emissions.	TnCO2eq	ENVIRONMENT	A1-4 Development of 5G Private Mobile Network services in Stand Alone for CCAM connectivity	At Orange (now MASORANGE), we work with PPAs (Power Purchase Agreements). These are clean energy contracts, meaning 100% of the energy we use must be renewable; consequently, our emissions are 0 tons of SCO_25. In 2023, we renewed our ISO 50001 (Energy Management Systems), ISO 14001 (Environmental Management Systems), and ISO 14064 (Greenhouse Gas Accounting and Verification) certifications. Regarding our 5G+ SA (Stand Alone) rollout, we have deployed next-generation networks that are highly energy-efficient. These networks act directly on greenhouse gas emissions, mitigating their impact as much as possible—as seen in the nodes we have deployed at Mercamadrid. Furthermore, these systems have been implemented with intelligent configurations from the outset, allowing equipment to be partially or fully powered down when not in use, thereby optimizing energy consumption. We also work closely with our equipment suppliers to design eco-friendly, high-efficiency products, such as batteries and solar panels.	0 TnCO2	0 TnCO2	0 TnCO2	Tender up to 2030 with PPA: Power Purchase Agreement	Pilot starting date	Measured	Annually	0 TnCO2
Use of clean energy sources	The total volume of non-conventional energy resources. It can also be measured as a percentage of the total energy used.	%	ENERGY	A1-4 Development of 5G Private Mobile Network services in Stand Alone for CCAM connectivity	At Orange (now MASORANGE), we work with PPAs (Power Purchase Agreements). These are clean energy contracts, meaning 100% of the energy we use must be renewable; consequently, our emissions are 0 tons of SCO_25. In 2023, we renewed our ISO 50001 (Energy Management Systems), ISO 14001 (Environmental Management Systems), and ISO 14064 (Greenhouse Gas Accounting and Verification) certifications. Regarding our 5G+ SA (Stand Alone) rollout, we have deployed next-generation networks that are highly energy-efficient. These networks act directly on greenhouse gas emissions, mitigating their impact as much as possible—as seen in the nodes we have deployed at Mercamadrid. Furthermore, these systems have been implemented with intelligent configurations from the outset, allowing equipment to be partially or fully powered down when not in use, thereby optimizing energy consumption. We also work closely with our equipment suppliers to design eco-friendly, high-efficiency products, such as batteries and solar panels.	100%	n/a	100%	Tender up to 2030 with PPA: Power Purchase Agreement	Pilot starting date	Measured	Annually	100%
Quality of cooperation structures with stakeholders	Level of quality of cooperation structures between all public and private stakeholders to develop and implement innovative mobility solutions.	Qualitative score	SOCIETY-GOVERNANCE	A1-4 Development of 5G Private Mobile Network services in Stand Alone for CCAM connectivity	Bi-annual survey to project partners (From 1 to 5)	3	3			December 2024	Measured	Semester	5
Capital investment	The total capital costs for purchase of infrastructure, equipment and vehicles. It can also include the total costs expended in setting up the measure and cover a period from the initiative of the measure preparation until the start of the measure implementation.	€	ECONOMY	A1-4 Development of 5G Private Mobile Network services in Stand Alone for CCAM connectivity		TBD	TBD	TBD	SAP/R3	Beginning of the project			TBD

## D3.2 – Monitoring Programmes for 2ZERO, CCAM and power grid actions in Madrid and Dresden

### Monitoring Programme per Pilot 2 – FERROVIAL

Name	Definition	Unit	Category	Measures	BAU (Business-as-usual)	After	Monitoring System	Monitoring System	Monitoring System	Target	
Name of the indicator that will be used to monitor the progress towards the achievement of the measure	Definition of the indicator	Unit measurement	From CIVITAS	Related to measure:	Projected value achieved without any measures by the end of the implementation	Value recorded after the implementation of the measures	Method of data collection	Starting Date	Type of Data: Measured, estimated or simulated	Frequency	Expected value after the implementation of the measures
Reduction of CO2 emissions	The average CO2 emissions per unit reduced as a result of the measures package implementation. This value takes into account SCOPE 1, 2 and 3 emissions.	TnCO2eq	ENVIRONMENT	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID	TBD		Electricity bills from the supplier company Report Frequency Quarterly	January 2026	measure	quarterly	0
Energy consumption	The energy consumption per unit of activity. (vehicle consumption)	kWh/unit	ENERGY	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID	TBD		Meters & Telemetry system data Report Frequency Quarterly	January 2026	measured	quarterly	Tbd
Energy delivered		kWh/unit	ENERGY	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID	TBD		Meters & Telemetry system data Report Frequency Quarterly	January 2026	measured	quarterly	TBD
Use of clean energy sources	The total volume of non-conventional energy resources. It can also be measured as a percentage of the total energy used.	%	ENERGY	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID	Current Energy consumption from de grid (kwh)		Meters & Telemetry system data Report Frequency Quarterly	January 2026	measured	quarterly	100%
RES production	RES production per activity.	kWh	ENERGY	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID	Current Energy consumption from de grid (kwh)		Meters & Telemetry system data Report Frequency Quarterly	January 2026	measured	quarterly	TBD
Quality of cooperation structures with stakeholders	Level of quality of cooperation structures between all public and private stakeholders to develop and implement innovative mobility solutions.	Qualitative score	SOCIETY-GOVERNANCE	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID	3		Survey	December 2024	measured	semester	5
Capital investment	The total capital costs for purchase of infrastructure, equipment and vehicles. It can also include the total costs expended in setting up the measure and cover a period from the initiative of the measure preparation until the start of the measure implementation.	€	ECONOMY	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID	TBD		Project costs	January 2024	measured	Annually	TBD
Average operating costs	Operating costs including for example, the personnel costs, fuel, electricity and maintenance costs for the vehicle(s) involved.	€	ECONOMY	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID	TBD		Project costs	January 2026	measured	Annually	TBD
Pollution cost avoided	The estimated financial savings resulting from the reduction of emissions due to implemented measures.	€	ECONOMY	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID	Emissions from the current electricity consumption (TnCO2eq)* conversion factor from the costs compensation of CO2 emissions (€/TneqCO2) 2023: 25.295€	Emissions from the current no renewable electricity consumption (TnCO2eq)* conversion factor from the costs compensation of CO2 emissions (€/tCO2eq) € = emissions from No renewable electricity consumption (tCO2eq) * Conversion factor (€/tCO2eq)	Electricity bills from the supplier company	January 2026	measured	Annually	Emissions from the current no renewable electricity consumption (TnCO2eq)* conversion factor from the costs compensation of CO2 emissions (€/tCO2eq) € = emissions from No renewable electricity consumption (tCO2eq) * Conversion factor (€/tCO2eq)
Economical impact	Financial benefits to end users and to entities from the transition from petrol to clean energy vehicles, the adoption of bidirectional charging, etc.	€	ECONOMY	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID	TBD		Electricity bills from the supplier company	January 2026	measured	Annually	TBD

### Monitoring Programme per Pilot 2 – PLEXIGRID

Name	Definition	Unit	Category	Measures	Comments	BAU (Business-as-usual)	After	Method	Monitoring System		Target	
<i>Name of the indicator that will be used to monitor the progress towards the achievement of the measure</i>	<i>Definition of the indicator</i>	<i>Unit measurement</i>	<i>From CIVITAS</i>	<i>Related to measure:</i>		<i>Projected value achieved without any measures by the end of the implementation</i>	<i>Value recorded after the implementation of the measures</i>	<i>Method of data collection</i>	<i>Starting Date</i>	<i>Type of Data: Measured, estimated or simulated</i>	<i>Frequency</i>	<i>Expected value after the implementation of the measures</i>
Reduction of CO2 emissions	The average CO2 emissions per unit reduced as a result of the measures package implementation. This value takes into account SCOPE 1, 2 and 3 emissions.		ENVIRONMENT	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID		TBD	-	Electrical energy consumption (smart meters), distance covered by electric means by ALSA and PZGR vehicles (Tachograph, onboard telematics, GPS)	TBD: Once A2-1 and A2-2 metering system are deployed	Measured	Hourly electrical energy timestamps Daily/Monthly distance covered by EVs	TBD
Energy consumption	The energy consumption per unit of activity.	kWh/unit	ENERGY	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID	Target depends also on MercaMadrid y Ferrovial Lighting depends on UPM.	2.850.550,91 kWh		Electrical energy consumption (smart meters)	TBD: Once A2-1 and A2-2 metering system are deployed	Measured	Hourly electrical energy timestamps	2.841.927,91 kWh
Energy savings	Reduction in energy consumption (per distance, per trip, per passenger transported)	kWh/unit	ENERGY	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID	Target depends also on ALSA and PZGR	N/A		distance covered by electric means by ALSA and PZGR vehicles (Tachograph, onboard telematics, GPS)	TBD: Once Pilot 1 is deployed	Measured	Daily/Monthly distance covered by EVs	8623 kWh
Energy delivered	Energy delivered from charging infrastructure to clean vehicle Energy delivered from the grid to the vehicle Energy delivered from the vehicle to the grid Energy delivered from RES facilities to the smart grid Energy delivered from RES facilities to the battery Energy delivered from RES facilities to the vehicle	kWh/unit	ENERGY	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID		41.595,09 kWh		Electrical energy consumption (smart meters)	TBD: Once A2-1 and A2-2 metering system are deployed	Measured	Hourly electrical energy timestamps	Unknown yet
Use of clean energy sources	The total volume of non-conventional energy resources. It can also be measured as a percentage of the total energy used.	%	ENERGY	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID		3,1%		Electrical energy consumption (smart meters)	TBD: Once A2-1 and A2-2 metering system are deployed	Measured	Hourly electrical energy timestamps	35,08%
Quality of cooperation structures with stakeholders	Level of quality of cooperation structures between all public and private stakeholders to develop and implement innovative mobility solutions.	Qualitative score	SOCIETY-GOVERNANCE	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID	Surveys to project partners	3		Survey	December 2024	Measured	Semester	5

### Monitoring Programme per Pilot 2 – UPM

Name	Definition	Unit	Category	Measures	Comments	BAU (Business-as-usual)	After	Method	Monitoring System			Target
<i>Name of the indicator that will be used to monitor the progress towards the achievement of the measure</i>	<i>Definition of the indicator</i>	<i>Unit measurement</i>	<i>From CIVITAS</i>	<i>Related to measure:</i>	<i>Minutes</i>	<i>Projected value achieved without any measures by the end of the implementation</i>	<i>Value recorded after the implementation of the measures</i>	<i>Method of data collection</i>	<i>Starting Date</i>	<i>Type of Data: Measured, estimated or simulated</i>	<i>Frequency</i>	<i>Expected value after the implementation of the measures</i>
Reduction of CO2 emissions	The average CO2 emissions per unit reduced as a result of the measures package implementation. This value takes into account SCOPE 1, 2 and 3 emissions.	TnCO2eq	ENVIRONMENT	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID		22.665 Tn		Data from power usage	Pilot starting date	Measured	Semester	0 Tn
Quality of cooperation structures with stakeholders	Level of quality of cooperation structures between all public and private stakeholders to develop and implement innovative mobility solutions.	Qualitative score	SOCIETY-GOVERNANCE	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID		3		Survey	December 2024	Measured	Semester	5/5
Acceptance	The percentage of the population who favourably receive or approve the measures.	% or Qualitative score	SOCIETY-PEOPLE	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID		not available		Survey	Pilot starting date	Measured	Semester	70,00%
Awareness	The percentage of the target population with knowledge of the measures implemented in the testing area on account of provided information.	(% or Qualitative score	SOCIETY-PEOPLE	1) A2 MADRID - RES-BASED POWER GRID AND V2G CHARGERS IN MERCAMADRID		not available		Survey	Pilot starting date	Measured	Semester	90,00%

## D3.2 – Monitoring Programmes for 2ZERO, CCAM and power grid actions in Madrid and Dresden

### Monitoring Programme per Pilot 3 – EMT (first part)

Name	Definition	Unit	Category	Measures	Comments	BAU (Business-as-usual)	After	Method	Monitoring System		Target	
<i>Name of the indicator that will be used to monitor the progress towards the achievement of the measure</i>	<i>Definition of the indicator</i>	<i>Unit measurement</i>	<i>From CIVITAS</i>	<i>Related to measure:</i>	<i>Minutes</i>	<i>Projected value achieved without any measures by the end of the implementation</i>	<i>Value recorded after the implementation of the measures</i>	<i>Method of data collection</i>	<i>Starting Date</i>	<i>Type of Data: Measured, estimated or simulated</i>	<i>Frequency</i>	<i>Expected value after the implementation of the measures</i>
Reduction of CO2 emissions	The average CO2 emissions per unit reduced as a result of the measures package implementation. This value takes into account SCOPE 1, 2 and 3 emissions.	TnCO2eq	ENVIRONMENT	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	harán propuesta con medio ambiente	TBD		EMT own data	2024	estimated	semester	TBD
Reduction of noise level	Noise level (dB(A)) measured on-site in the area or corridor under study.	dB(A)	ENVIRONMENT	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Baseline form project LEAD	urban pass-by 72 dB(A)		Noise data form Madrid sensors and from vehicle specifications	2024	estimated	annually	-4 dB(A)
Energy consumption	The energy consumption per unit of activity.	kWh/unit	ENERGY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)		38,376.88 kWh/pantograph		Daily consumption data form energy records	2024	Measured	semester	3% decrease of energy consumption per unit
Energy savings	Reduction in energy consumption (per distance, per trip, per passenger transported)	kWh/unit	ENERGY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	from charging structure	not available yet			2025	Measured	semester	
Energy delivered	Energy delivered from charging infrastructure to clean vehicle; Energy delivered from the grid to the vehicle; Energy delivered from the vehicle to the grid; Energy delivered from RES facilities to the smart grid; Energy delivered from RES facilities to the battery; Energy delivered from RES facilities to the vehicle	kWh/unit	ENERGY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	from charging structure	not available yet			2025	Measured	semester	
Use of clean energy sources	The total volume of non-conventional energy resources. It can also be measured as a percentage of the total energy used.	%	ENERGY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	from charging structure	not available yet		from charging structure	2025	Measured	semester	100%
RES production	RES production per activity.	kWh	ENERGY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid)	from charging structure	not available yet			2025	Measured source of energy	semester	
Mileage	Total distances driven in an area during a day.	km/unit	TRANSPORT SYSTEM	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)		not available yet		From EMT transport data	2025	Measured	semester	
Perception of security	Qualitative perception of security	Qualitative score	TRANSPORT SYSTEM	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Surveys at Urban Transport Lab	not available		Surveys	2026	Measured	semester	>70%
Acceptance	The percentage of the population who favourably receive or approve the measures.	% or Qualitative score	SOCIETY-PEOPLE	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Surveys at Urban Transport Lab	not available		Surveys	2026	Measured	semester	>70%
Awareness	The percentage of the target population with knowledge of the measures implemented in the testing area on account of provided information.	(% or Qualitative score	SOCIETY-PEOPLE	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Surveys at Urban Transport Lab	not available		Surveys	2026	Measured	semester	>70%
Customer satisfaction index	The reported satisfaction of the quality of the specific services deployed.	%	SOCIETY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Surveys at Urban Transport Lab	not available		Surveys	2026	Measured	semester	>70%

## D3.2 – Monitoring Programmes for 2ZERO, CCAM and power grid actions in Madrid and Dresden

### Monitoring Programme per Pilot 3 – EMT (second part)

Name	Definition	Unit	Category	Measures	Comments	BAU (Business-as-usual)	After	Method	Monitoring System			Target
<i>Name of the indicator that will be used to monitor the progress towards the achievement of the measure</i>	<i>Definition of the indicator</i>	<i>Unit measurement</i>	<i>From CIVITAS</i>	<i>Related to measure:</i>	<i>Minutes</i>	<i>Projected value achieved without any measures by the end of the implementation</i>	<i>Value recorded after the implementation of the measures</i>	<i>Method of data collection</i>	<i>Starting Date</i>	<i>Type of Data: Measured, estimated or simulated</i>	<i>Frequency</i>	<i>Expected value after the implementation of the measures</i>
Customer satisfaction index	The reported satisfaction of the quality of the specific services deployed.	%	SOCIETY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Surveys at Urban Transport Lab	not available		Surveys	2026	Measured	semester	>70%
Quality of cooperation structures with stakeholders	Level of quality of cooperation structures between all public and private stakeholders to develop and implement innovative mobility solutions.	Qualitative score	SOCIETY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Among project partners	3		Surveys	December 2024	Measured	semester	4/5, 5/5
Capital investment	The total capital costs for purchase of infrastructure, equipment and vehicles. It can also include the total costs expended in setting up the measure and cover a period from the initiative of the measure preparation until the start of the measure implementation.	€	ECONOMY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid) 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Item Description (Technical) Investment (€) Infrastructure for 170 pantographs 12,633,512.75 € Infrastructure for 50 plug-in charging points 2,401,667.01 € Infrastructure for 13 plug-in charging points 309,433.60 € Acquisition of 50 electric vehicles (12m) 35,029,500.00 € Acquisition of 200 vehicles 120,838,140.00 € Acquisition of 200 chargers 36,043,480.00 € Acquisition of 13 plug-in chargers 404,701.03 € Acquisition of 170 pantographs 2,766,665.00 € Pantograph retrofitting/adaptation for buses 1,922,327.00 € Grand Total 212,349,426.39 €	212.349.426,39 €		EMT Financial data	January 2024	Measured	Semester	212.349.426,39 €
Average operating costs	Operating costs including for example, the personnel costs, fuel, electricity and maintenance costs for the vehicle(s) involved.	€	ECONOMY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Since there are no moving parts, Photovoltaic (PV) maintenance is estimated at 10% (*) of the total investment for preventive and corrective maintenance. Photovoltaic: €36,919.97 (*) Vehicle Maintenance: No documentation was provided by the manufacturer regarding approximate vehicle maintenance costs; the provided data only indicates potential man-hours for corrective and preventive maintenance. Estimating a maintenance cost over the vehicle's useful life (15 years) at 150% of the bus's value—i.e., €960,000 per vehicle—the total would be €9,600,000 for the 10-bus fleet. This represents an annual maintenance cost of €640,000 for the 10 units. (*) Charger Maintenance: €12,500 per year for the 10 chargers.	€36,919.97		EMT Financial data	December 2025	Measured	Semester	< €36,919.97
Pollution cost avoided	The estimated financial savings resulting from the reduction of pollution due to implemented measures.	€	ECONOMY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Data gathered together with Sustainability Department	not available		EMT Financial data	December 2025	Measured	Semester	tbd

## D3.2 – Monitoring Programmes for 2ZERO, CCAM and power grid actions in Madrid and Dresden

### Monitoring Programme per Pilot 4 – EMT (first part)

Name	Definition	Unit	Category	Measures	Comments	BAU (Business-as-usual)	After	Method	Monitoring System			Target
<i>Name of the indicator that will be used to monitor the progress towards the achievement of the measure</i>	<i>Definition of the indicator</i>	<i>Unit measurement</i>	<i>From CIVITAS</i>	<i>Related to measure:</i>	<i>Minutes</i>	<i>Projected value achieved without any measures by the end of the implementation</i>	<i>Value recorded after the implementation of the measures</i>	<i>Method of data collection</i>	<i>Starting Date</i>	<i>Type of Data: Measured, estimated or simulated</i>	<i>Frequency</i>	<i>Expected value after the implementation of the measures</i>
Reduction of CO2 emissions	The average CO2 emissions per unit reduced as a result of the measures package implementation. This value takes into account SCOPE 1, 2 and 3 emissions.	TnCO2eq	ENVIRONMENT	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	tbd	tbd		Data from EMT environmental department	2025	Estimated	semester	tbd
Energy consumption	The energy consumption per unit of activity.	kWh/unit	ENERGY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	for 10 vehicles: The electrical consumption of the hydrogen station equipment is estimated at 1,322 kW	1,322 kW		from charging infrastructure	2025	Measured	semester	< 1,322 kW
Energy delivered	Energy delivered from charging infrastructure to clean vehicle; Energy delivered from the grid to the vehicle; Energy delivered from the vehicle to the grid; Energy delivered from RES facilities to the smart grid; Energy delivered from RES facilities to the battery; Energy delivered from RES facilities to the vehicle	kWh/unit	ENERGY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Solar PV Generation 2,029 MWh/year Hydrogen Station Consumption 5,790 MWh/year	Solar PV Generation 2,029 MWh/year Hydrogen Station Consumption 5,790 MWh/year		from charging infrastructure	2025	Measured	semester	TBD
Use of clean energy sources	The total volume of non-conventional energy resources. It can also be measured as a percentage of the total energy used.	%	ENERGY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	The solar installation covers 35.1% of the total energy required for hydrogen production, meaning the remaining 64.9% must be sourced from the grid or other external energy providers.	35.1%		from charging infrastructure	2025	Measured	semester	100%
RES production	RES production per activity.	kWh	ENERGY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid)	Regarding hydrogen production (18 kg/h), we must account for the facility's total consumption, stemming from both the electrical components and the electrolyzer's water requirements.	18 kg/h		from charging infrastructure	2025	Measured source of energy	semester	18 kg/h
Mileage	Total distances driven in an area during a day.	km/unit	TRANSPORT SYSTEM	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Service data form EMT	n/a		From bus service	2025	Measured	semester	TBD
Perception of security	Qualitative perception of security	Qualitative score	TRANSPORT SYSTEM	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Surveys at Urban Mobility Lab in Mercamadrid	n/a		Surveys	2026	Measured	Annually	>70%
Acceptance	The percentage of the population who favourably receive or approve the measures.	% or Qualitative score	SOCIETY-PEOPLE	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Surveys at Urban Mobility Lab in Mercamadrid	n/a		Surveys	2026	Measured	Annually	>70%
Awareness	The percentage of the target population with knowledge of the measures implemented in the testing area on account of provided information.	(% or Qualitative score	SOCIETY-PEOPLE	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Surveys at Urban Mobility Lab in Mercamadrid	n/a		Surveys	2026	Measured	Annually	>70%

### Monitoring Programme per Pilot 4 – EMT (second part)

Name	Definition	Unit	Category	Measures	Comments	BAU (Business-as-usual)	After	Method	Monitoring System			Target
<i>Name of the indicator that will be used to monitor the progress towards the achievement of the measure</i>	<i>Definition of the indicator</i>	<i>Unit measurement</i>	<i>From CIVITAS</i>	<i>Related to measure:</i>	<i>Minutes</i>	<i>Projected value achieved without any measures by the end of the implementation</i>	<i>Value recorded after the implementation of the measures</i>	<i>Method of data collection</i>	<i>Starting Date</i>	<i>Type of Data: Measured, estimated or simulated</i>	<i>Frequency</i>	<i>Expected value after the implementation of the measures</i>
Customer satisfaction index	The reported satisfaction of the quality of the specific services deployed.	%	SOCIETY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Surveys at Urban Mobility Lab in Mercamadrid	n/a		Surveys	2026	Measured	Annually	>70%
Quality of cooperation structures with stakeholders	Level of quality of cooperation structures between all public and private stakeholders to develop and implement innovative mobility solutions.	Qualitative score	SOCIETY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Surveys to project partners	3		Surveys	December 2024	Measured	Semester	4/5, 5/5
Capital investment	The total capital costs for purchase of infrastructure, equipment and vehicles. It can also include the total costs expended in setting up the measure and cover a period from the initiative of the measure preparation until the start of the measure implementation.	€	ECONOMY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Hydrogen Refueling Station: €4,818,065.72 Photovoltaic System: €5,728,902.29 TOTAL: €10,546,968.01	€10,546,968.01		Financial data	2025	Measured	Semestral	€10,546,968.01
Average operating costs	Operating costs including for example, the personnel costs, fuel, electricity and maintenance costs for the vehicle(s) involved.	€	ECONOMY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Since there are no moving parts, Photovoltaic (PV) maintenance is estimated at 10% (*) of the total investment for preventive and corrective maintenance. Hydrogen: €332,279.63 (*) Vehicle Maintenance: No documentation was provided by the manufacturer regarding approximate vehicle maintenance costs; the provided data only indicates potential man-hours for corrective and preventive maintenance. Estimating a maintenance cost over the vehicle's useful life (15 years) at 150% of the bus's value—i.e., €960,000 per vehicle—the total would be €9,600,000 for the 10-bus fleet. This represents an annual maintenance cost of €640,000 for the 10 units. (*) Charger Maintenance: €12,500 per year for the 10 chargers.	€332,279.63		financial data	2025	Measured	Semestral	< €332,279.63
Pollution cost avoided	The estimated financial savings resulting from the reduction of pollution due to implemented measures.	€	ECONOMY	1) A3 Madrid - Efficient charging and electrification of fleets (EMT, Mercamadrid); 2) A4 Madrid - H2 fuel cell buses and H2 refueling station (EMT)	Data gathered together with Sustainability Department. To calculate the pilot total pollution cost avoided	not applicable		financial data from sustainability department	2025	Measured	Annually	TBD

### Monitoring Programme per Pilot 5 – TSYS

Name	Definition	Unit	Category	Measures	Comments	BAU (Business-as-usual)	After	Method	Monitoring System		Target	
<i>Name of the indicator that will be used to monitor the progress towards the achievement of the measure</i>	<i>Definition of the indicator</i>	<i>Unit measurement</i>	<i>From CIVITAS</i>	<i>Related to measure:</i>	<i>Minutes</i>	<i>Projected value achieved without any measures by the end of the implementation</i>	<i>Value recorded after the implementation of the measures</i>	<i>Method of data collection</i>	<i>Starting Date</i>	<i>Type of Data: Measured, estimated or simulated</i>	<i>Frequency</i>	<i>Expected value after the implementation of the measures</i>
Reduction of CO2 emissions	The average CO2 emissions per unit reduced as a result of the measures package implementation. This value takes into account SCOPE 1, 2 and 3 emissions.	TnCO2eq	ENVIRONMENT	1) A5 - Madrid. IMPLEMENTATION HIGH VALUE SERVICES	Data center – Certification-> estimation (yearly static data)	0.00%		GREEN ENERGY CERTIFICATION FOR CPDS		measured	semester	0.00%
Energy consumption	The energy consumption per unit of activity.	kWh/unit	ENERGY	1) A5 - Madrid. IMPLEMENTATION HIGH VALUE SERVICES		not available		form		Measured	semester	TBC
Quality of cooperation structures with stakeholders	Level of quality of cooperation structures between all public and private stakeholders to develop and implement innovative mobility solutions.	Qualitative score	SOCIETY-GOVERNANCE	1) A5 - Madrid. IMPLEMENTATION HIGH VALUE SERVICES	Maybe some small external stakeholder. Survey.	3		Survey	December 2024	Measured	semester	5
Capital investment	The total capital costs for purchase of infrastructure, equipment and vehicles. It can also include the total costs expended in setting up the measure and cover a period from the initiative of the measure preparation until the start of the measure implementation.	€	ECONOMY	1) A5 - Madrid. IMPLEMENTATION HIGH VALUE SERVICES	Licenses, and software development. Estimation until identify the use cases.	PURCHASES(licenses, HW...): 287.500€ SOFTWARE DEVELOPMENT: 350.000€		ECONOMICAL REPORT	December 2025	Measured	annually	637.500,00 €
Average operating costs	Operating costs including for example, the personnel costs, fuel, electricity and maintenance costs for the vehicle(s) involved.	€	ECONOMY	1) A5 - Madrid. IMPLEMENTATION HIGH VALUE SERVICES	Running costs (licenses, cloud fees...) and maintenance of the software. Estimation.	<15.000€/month		ECONOMICAL REPORT	December 2025	Measured	annually	<15.000€/month

## Annex 4: Monitoring Programmes Dresden

### Overview Responsibilities - Monitoring Programmes per Action Dresden

Pilot	New Action	Partner	ENVIRONMENTAL KPIs		ENERGY KPIs				TRANSPORT KPIs			SOCIAL KPIs				ECONOMY KPIs		
			Key KPI	Key KPI	Key KPI	KPI	KPI	Key KPI	KPI	KPI	KPI	Key KPI	Key KPI	Key KPI	KPI	KPI	KPI	KPI
	New Actions	Responsible of Pilot	Reduction of CO2 emissions	Reduction of NOX emissions	Energy Consumption	Energy Savings	Energy delivered	Use of clean energy sources	Mileage	Number of trips per day	Charging times	Acceptance	Awareness	Customer satisfaction index	Quality of cooperation structures with stakeholders	Capital investment	Average operating costs	Economical impact
Pilot 1	A1 Charging robots	VW	R: DRE C: VW	R: DRE C: VW	R: VW C: DRE	R: DRE C: VW	VW		VW	VW	VW	R: VW C: RC	R: VW C: RC	R: VW C: RC	R: VW C: RC	VW		
Pilot 2	A2.1 Infrastructure assistance Automated Connected Driving (Control Center)	FHG	R: FHG C: DRE	R: FHG C: DRE	FHG	R: DRE C: FHG		R: DRE C: FHG							R: FHG C: RC	FHG	FHG	
	A4 Autonomous e-vehicles for maintenance services with charging infrastructure	DRE	DRE	DRE	DRE	DRE	DRE	DRE	DRE	DRE	DRE	R: DRE C: RC	R: DRE C: RC	R: DRE C: RC	R: DRE C: RC	DRE	DRE	DRE
Pilot 4	A7 Data analysis of public e-bus fleet	DRE	DRE	DRE	DRE	DRE	DRE	DRE	DRE	DRE	DRE	R: DRE C: RC	R: DRE C: RC	R: DRE C: RC	R: DRE C: RC	DRE	DRE	DRE
	A8 One tuneable/configurable e-car with bi-directional charging	TUD	R: TUD C: DRE		TUD	TUD		TUD			TUD				R: TUD C: RC	TUD	TUD	TUD
	A14 Small-scale bidirectional charging system	TUD	TUD		TUD										R: TUD C: RC	TUD	TUD	
Pilot 5	A2.2 Mobility Data Space for Automated Connected Driving	FHG			R: FHG C: SAP	R: FHG C: CARNET									R: FHG C: RC	FHG	FHG	
	A9 Unified Platform for Data Integration and Management	SAP			SAP										R: SAP C: RC	SAP	SAP	
	A10.1 App for Sportpark Services	SAP			SAP										R: SAP C: RC	SAP	SAP	
	A10.2 App for Sportpark Mobility and Traffic Flow Management	SAP			SAP										R: SAP C: RC	SAP	SAP	
	A11 Parking Space Monitoring and Data Integration	SAP			SAP										R: SAP C: RC	SAP	SAP	
Pilot 6	A12 5G private communication network	TUD	TUD												R: TUD C: RC	TUD	TUD	
	A13 5G network slicing	TUD													R: TUD C: RC	TUD	TUD	

## Monitoring Programme per Action: (1) City Public Transport - E-Bus Fleet

### Scenario Explanation

DVB: Dresden Transport Company („Dresdner Verkehrsbetriebe“)

MAchUP: previous EU project during which the e-buses had been deployed and KPIs had been monitored and evaluated à MOBILITIES will continue this data tracking

The actual deployed DVB fleet of e-buses (short: e-fleet) consists of 20 e-buses, comprising two solo/standard e-buses (12 m) and 18 articulated e-buses (18 m). Successive deployment started in Q2/2022; by Q3/2022 eight e-buses (2/2 standard, 6/18 articulated) had been deployed; the entire e-fleet in full operation since Q1/2023. This e-fleet, we intend to monitor and evaluate during and for MOBILITIES.

### For the D3.2 relevant input for the KPIs:

- We have taken the measurements (driven distance, trips, energy consumption) for of the e-buses which have been in operation since Q3/2022 (both standard and the “sample” of 8 articulated e-buses) for a 12 months interval (June 2022 – May2023) to capture seasonal effects but disregard low-frequency summer vacation time.
- The sample of articulated buses has been scaled up to 18 (factor 3) to complete the statistical population fleet of 20 buses, comprising of 2 standard buses and 18 articulated buses (= same size as actual fleet).
- Based on this statistical population, the KPI numbers for a reference diesel fleet have been computed by applying respective reference values for the diesel equivalents to the standard and articulated e-buses. These reference values (energy density, CO<sub>2</sub> and NO<sub>x</sub> emissions, diesel consumption) have already been provided by the DVB during the MAchUP project, hence, we use the same.

### D3.2 – Monitoring Programmes for 2ZERO, CCAM and power grid actions in Madrid and Dresden

Name	Definition	Unit	Category	Measures	BAU (Business-as-usual)	After	Monitoring System	Monitoring System	Monitoring System	Target		
Name of the indicator that will be used to monitor the progress towards the achievement of the measure	Definition of the indicator	Unit measurement	From CIVITAS	COMMENT DRE	Related to measure:	Projected value achieved without any measures by the end of the implementation	Value recorded after the implementation of the measures	Method of data collection	Starting Date	Type of Data: Measured, estimated or simulated	Frequency	Expected value after the implementation of the measures
Reduction of CO2 emissions	Average CO2 emissions reduction per month	t/month	ENVIRONMENT	unit of reference factor provided by DVB as g/km and only for CO2; therefore co conversion to CO2eq necessary	A7	155.5		comparison with reference diesel fleet + emission factors	Q3/2022	estimated	quarterly check; (numbers are actually provided on a monthly basis)	20%
Reduction of NOx emissions	Average NOx emissions reduction per month	kg/month	ENVIRONMENT	unit of reference factor provided by DVB (Dresden Transportation Company) as g/km; cannot be converted to ppb due to lack of reference volume	A7	100.2		comparison with reference diesel fleet + emission factors	Q3/2022	estimated	quarterly check; (numbers are actually provided on a monthly basis)	20%
Energy consumption	Energy consumption per 100 km	kWh/100 km	ENERGY	none	A7	588518.9		battery management system + logger installed in bus	Q3/2022	measured	quarterly check; (numbers are actually provided on a monthly basis)	30% reduction
Energy savings	Reduction in energy consumption per 100 km	kWh/100 km	ENERGY	none	A7	not applicable		comparison with reference diesel fleet	Q3/2022	estimated	quarterly check; (numbers are actually provided on a monthly basis)	30%
Energy delivered	Energy delivered from charging infrastructure to clean fleet	kWh/month	ENERGY	data not (yet) evaluated/only indirectly monitored; might be available after additional contractual agreement with data tracing institute	A7	x	x	x	x	x	x	x
Use of clean energy sources	The total volume of non-conventional energy resources. It can also be measured as a percentage of the total energy used.	%	ENERGY	DVB uses clean energy mix to charge e-buses	A7	0		info on energy mix used by DVB	Q3/2022	measured	quarterly check; (numbers are actually provided on a monthly basis)	100%
Mileage	Total distances driven in a month.	km/month	TRANSPORT SYSTEM	due to the financial restrictions on the city (and by proxy DVB) budget, a stable service as TARGET would already be a success	A7	125497.5		battery management system + logger installed in bus	Q3/2022	measured	quarterly check; (numbers are actually provided on a monthly basis)	stable
Number of trips per month	The total number of trips in a month. A trip is defined as the single way (no round trip!) between the start and the last stop of a route/line.	number of trips/month	TRANSPORT SYSTEM	due to the financial restrictions on the city (and by proxy DVB) budget, a stable service as TARGET would already be a success	A7	8367.9		battery management system + logger installed in bus	Q3/2022	measured	quarterly check; (numbers are actually provided on a monthly basis)	stable
Charging times	Time spent to charge fleet	hours/month	TRANSPORT SYSTEM	data not (yet) evaluated/only indirectly monitored; might be available after additional contractual agreement with data tracing institute	A7	x	x	x	x	x	x	x
Acceptance	The percentage of citizens encountered during public-engagement project activities who approve the e-fleet.	%	SOCIETY-PEOPLE	SOCIETY-PEOPLE KPIs could not be collected before the implementation because the e-fleet had already been deployed before the start of the project	A7	not applicable		questionnaires + interviews	Q1/2026	measured	quarterly	10% increase
Awareness	The percentage of the citizens encountered during public-engagement project activities with knowledge of the e-fleet.	%	SOCIETY-PEOPLE	SOCIETY-PEOPLE KPIs could not be collected before the implementation because the e-fleet had already been deployed before the start of the project	A7	not applicable		questionnaires + interviews	Q1/2026	measured	quarterly	10% increase
Customer satisfaction index	The satisfaction of the citizens encountered during public-engagement project activities with the quality of the e-fleet operation.	%	SOCIETY-PEOPLE	SOCIETY-PEOPLE KPIs could not be collected before the implementation because the e-fleet had already been deployed before the start of the project	A7	not applicable		questionnaires + interviews	Q1/2026	measured	quarterly	stable
Quality of cooperation structures with stakeholders	Level of quality of cooperation structures between all public and private stakeholders to develop and implement innovative mobility solutions.	Qualitative score	SOCIETY-GOVERNANCE	handled by WRC, Steinbeis?, CARNET	A7	3/4?		surveys	start of project	measured	quarterly	4/5?
Capital investment	The total capital costs for purchase of infrastructure, equipment and vehicles.	€	ECONOMY	none; see "Before" and "BAU"	A7	ca. 6.3 Mio for diesel fleet; infrastructure already implemented	ca. 17.4 Mio. for e-fleet + 5.7 Mio for infrastructure	publicly available information	Q3/2022	BAU: estimated; After: measured	once	not applicable
Average operating costs	Operating costs including for example, the personnel costs, fuel, electricity and maintenance costs for the vehicle(s) involved.	€	ECONOMY	data not available on necessary and sufficient disaggregation level/unit/period	A7	x	x	x	x	x	x	x
Economical impact	Financial benefits to end users and to entities from the transition from petrol to clean energy vehicles, the adoption of bidirectional charging, etc.	€	ECONOMY	data not available on necessary and sufficient disaggregation level/unit/period	A7	x	x	x	x	x	x	x

## D3.2 – Monitoring Programmes for 2ZERO, CCAM and power grid actions in Madrid and Dresden

### Monitoring Programme per Action: (2) City Sports - Maintenance Robot

Name	Definition	Unit	Category		Measures	BAU (Business-as-usual)	After	Monitoring System	Monitoring System	Monitoring System	Target	
<i>Name of the indicator that will be used to monitor the progress towards the achievement of the measure</i>	<i>Definition of the Indicator</i>	<i>Unit measurement</i>	<i>From CIVITAS</i>	<i>COMMENT DRE</i>	<i>Related to measure:</i>	<i>Projected value achieved without any measures by the end of the implementation</i>	<i>Value recorded after the implementation of the measures</i>	<i>Method of data collection</i>	<i>Starting Date</i>	<i>Type of Data: Measured, estimated or simulated</i>	<i>Frequency</i>	<i>Expected value after the implementation of the measures</i>
Reduction of CO2 emissions	The average CO2 emissions per unit reduced as a result of the measures package implementation. This value takes into account SCOPE 1, 2 and 3 emissions.	TnCO2eq	ENVIRONMENT			High value of CO2 emissions because of fuel-driven equipment that is in use every day	Significant reduction of the CO2 emissions with the use of electrical service robots	statistics and logged data of the fuel consumption and operational times to calculate	01.01.26	measured, estimated	quarterly check; (numbers are actually provided on a monthly basis)	expected reduction to zero after implementation of the electrical solution
Reduction of NOX emissions	Average NOX emissions per unit reduced as a result of the implementation of the package of measures.	ppb	ENVIRONMENT			High value of NOX emissions because of fuel-driven equipment that is in use every day	Significant reduction of the NOX emissions with the use of electrical service robots	statistics and logged data of the fuel consumption and operational times to calculate the value of before	01.01.26	measured, estimated	quarterly check; (numbers are actually provided on a monthly basis)	expected reduction to zero after implementation of the electrical solution
Energy consumption	The energy consumption per unit of activity.	kWh/unit	ENERGY			no value since the fuel-driven equipment doesn't use electrical energy	At the beginning: Increasing value of electrical energy with start of operation; During project period: potential reduction of energy consumption through an adapted and more efficient operational concept	monitoring of the charging cycles; Electricity meter on the charging station or via software of the manufacturer	01.01.26	measured: charging cycles	quarterly check; (numbers will be provided per use)	At the beginning: increasing energy consumption since there were none before; During project period: potential reduction of energy consumption through an adapted and more efficient operational concept
Energy savings	Reduction in energy consumption (per distance, per trip, per passenger transported)	kWh/unit	ENERGY			no value since the fuel-driven equipment doesn't use electrical energy	no value since the fuel-driven equipment doesn't use electrical energy	monitoring of the charging cycles; Electricity meter on the charging station or via software of the manufacturer	01.01.26	measured: charging cycles	quarterly check; (numbers will be provided per use)	At the beginning: no energy savings, starting the operation; During project period: potential energy savings through an adapted and more efficient operational concept
Energy delivered	Energy delivered from charging infrastructure to clean vehicle; Energy delivered from the grid to the vehicle; Energy delivered from RES facilities to the smart grid; Energy delivered from RES facilities to the battery; Energy delivered from RES facilities to the vehicle	kWh/unit	ENERGY	theoretically possible - when the charging station is part of a monitoring system		no value since the fuel-driven equipment doesn't use electrical energy	At the beginning: Increasing value of energy delivered with start of operation; During project period: potential reduction of delivered energy through an adapted and more efficient operational concept	monitoring of the charging cycles; Electricity meter on the charging station or via software of the manufacturer	01.01.26	measured: charging cycles	quarterly check; (numbers will be provided per use)	value depends on the use rate which will be determined after the test period and creation of the operational schedule
Use of clean energy sources	The total volume of non-conventional energy resources. It can also be measured as a percentage of the total energy used.	%	ENERGY	possible (unclear location of the charging station)		estimated energy mix at the location	estimated value depends on the energy mix at the location and the usage	estimated energy mix at the location	01.01.26	estimated energy mix at the location	Once (Based on an annual balance)	estimated energy mix at the location
Mileage	Total distances driven in an area during a day.	km/unit	TRANSPORT SYSTEM			no significant change since the dimensions of the pitches remain constant	no significant change since the dimensions of the pitches remain constant	monitoring of the covered distances through the software (logged data) of the equipment	01.01.26	measured	quarterly check; (numbers will be provided per use)	no significant change since the dimensions of the pitches remain constant
Number of trips per day	Vehicle frequency	n° trips/day	TRANSPORT SYSTEM			Value is explored and references the number of operations of the fuel-driven equipment	expected higher frequency of number of trips compared to the fuel-driven process	Software tracks the number of trips (usage times)	01.01.26	measured	quarterly check; (numbers will be provided per use)	expected higher frequency of number of trips compared to the fuel-driven process
Charging times	Time needed to charge a vehicle	hours/unit	TRANSPORT SYSTEM			no value since the fuel-driven equipment doesn't use any electrical energy	increased value since there was no charging before	monitoring of the charging cycles; Electricity meter on the charging station or via software of the manufacturer	01.01.26	measured	quarterly check; (numbers will be provided per use)	value depends on the use rate which will be determined after the test period and creation of the operational schedule
Acceptance	The percentage of the population who favourably receive or approve the measures.	% or Qualitative	SOCIETY-PEOPLE			subjective	subjective	questionnaires + interviews	01.01.26	measured	once/twice a year	subjective
Awareness	The percentage of the target population with knowledge of the measures implemented in the testing area on account of provided information.	% or Qualitative score	SOCIETY-PEOPLE			subjective	subjective	questionnaires + interviews	01.01.26	measured	once/twice a year	subjective
Customer satisfaction index	The satisfaction of the quality of the specific services deployed reported by the employees that use the solution.	%	SOCIETY-PEOPLE	questionnaire possible		high workload, high personnel costs	higher satisfaction compared to the start of the project because of the workload reduction	questionnaires + interviews	01.01.26	measured	once/twice a year	higher satisfaction compared to the start of the project because of the workload reduction
Quality of cooperation structures with stakeholders	Level of quality of cooperation structures between all public and private stakeholders to develop and implement innovative mobility solutions.	Qualitative score	SOCIETY-GOVERNANCE	handled by WRC, Steinbeis?, CARNET	A7	3/4?		surveys	start of project	measured	quarterly	4/5?
Capital investment	The total capital costs for purchase of infrastructure, equipment and vehicles. It can also include the total costs expended in setting up the measure and cover a period from the initiative of the measure preparation until the start of the measure implementation.	€	ECONOMY			- cost for procurement of the maintenance vehicles - cost for fuel consumption of the maintenance vehicles - Personnel cost for staff	36'000.00 €	not applicable	December 2025 (estimated date of delivery)	measured	once	not applicable
Range operating costs	Operating costs including for example, the personnel costs, fuel, electricity and maintenance costs for the vehicle(s) involved.	€	ECONOMY	possible		increasing costs through inflation, political pay rise, price rises for fuel/maintenance etc.	reduced operational costs through higher efficiency, less maintenance time, lower personnel costs	monitoring, measuring, estimation	01.01.26	measured and estimated	per use	reduced operational costs through higher efficiency, less maintenance time, lower personnel costs
Economic impact	Financial benefits to end users and to entities from the transition from petrol to clean energy vehicles, the adoption of bidirectional charging, etc.	€	ECONOMY	benefits could be for example the reduction of personnel costs for the cleaning staff		increasing costs through inflation, political pay rise, price rises for fuel/maintenance etc.	reduced operational costs through higher efficiency, less maintenance time, lower personnel costs	monitoring, measuring, estimation	01.01.26	measured and estimated	per use	reduced operational costs through higher efficiency, less maintenance time, lower personnel costs

## D3.2 – Monitoring Programmes for 2ZERO, CCAM and power grid actions in Madrid and Dresden

### Monitoring Programme per Action: (3) City Sports - Cleaning Robot

Name	Definition	Unit	Category		Measures	BAU (Business-as-usual)	After	Monitoring System	Monitoring System	Monitoring System	Target	
<i>Name of the indicator that will be used to monitor the progress towards the achievement of the measure</i>	<i>Definition of the indicator</i>	<i>Unit measurement</i>	<i>From CIVITAS</i>	<i>COMMENT DRE</i>	<i>Related to measure:</i>	<i>Projected value achieved without any measures by the end of the implementation</i>	<i>Value recorded after the implementation of the measures</i>	<i>Method of data collection</i>	<i>Starting Date</i>	<i>Type of Data: Measured, estimated or simulated</i>	<i>Frequency</i>	<i>Expected value after the implementation of the measures</i>
Reduction of CO2 emissions	The average CO2 emissions per unit reduced as a result of the measures package implementation. This value takes into account SCOPE 1, 2 and 3 emissions.	TnCO2eq	ENVIRONMENT	budget closure of the municipality could lead to job cuts that would lead to a procurement of a low-cost, fuel-driven solution that has a lot of ecological downsides (example: Nilfisk Kehrmachine SW900 P)		no value since the cleaning staff doesn't cause any CO2	value depends on the use rate which will be determined after the test period and creation of the operational schedule	monitoring of the charging cycles and estimation of the CO2 load	01.01.26	Measured: charging cycles Estimated: CO2 load	quarterly check; (numbers will be provided per use)	At the beginning: increasing CO2 emissions since there were none before; During project period: potential reduction of CO2 emissions through an adapted and more efficient operational concept
Reduction of NOX emissions	Average NOX emissions per unit reduced as a result of the implementation of the package of measures.	ppb	ENVIRONMENT	budget closure of the municipality could lead to job cuts that would lead to a procurement of a low-cost, fuel-driven solution that has a lot of ecological downsides (example: Nilfisk Kehrmachine SW900 P)		no value since the cleaning staff doesn't cause any NOX	no value since electrical devices doesn't cause any NOX	No Data Collection	No Data Collection	No Data Collection	No Data Collection	no value since electrical devices doesn't cause any NOX
Energy consumption	The energy consumption per unit of activity.	kWh/unit	ENERGY			no value since the cleaning staff itself doesn't use any electrical energy	value depends on the use rate which will be determined after the test period and creation of the operational schedule	monitoring of the charging cycles; Electricity meter on the charging station or via software of the manufacturer	01.01.26	measured: charging cycles	quarterly check; (numbers will be provided per use)	At the beginning: increasing energy consumption since there were none before; During project period: potential reduction of energy consumption through an adapted and more efficient operational concept
Energy savings	Reduction in energy consumption (per distance, per trip, per passenger transported)	kWh/unit	ENERGY			no value since the cleaning staff itself doesn't use any electrical energy	value depends on the use rate which will be determined after the test period and creation of the operational schedule	monitoring of the charging cycles; Electricity meter on the charging station or via software of the manufacturer	01.01.26	measured: charging cycles	quarterly check; (numbers will be provided per use)	At the beginning: no energy savings, starting the operation; During project period: potential energy savings through an adapted and more efficient operational concept
Energy delivered	Energy delivered from charging infrastructure to clean vehicle; Energy delivered from the grid to the vehicle Energy delivered from RES facilities to the smart grid Energy delivered from RES facilities to the battery Energy delivered from RES facilities to the vehicle	kWh/unit	ENERGY	theoretically possible - when the charging station is part of a monitoring system		no value since the cleaning staff itself doesn't use any electrical energy	value depends on the use rate which will be determined after the test period and creation of the operational schedule	monitoring of the charging cycles; Electricity meter on the charging station or via software of the manufacturer	01.01.26	measured: charging cycles	quarterly check; (numbers will be provided per use)	value depends on the use rate which will be determined after the test period and creation of the operational schedule
Use of clean energy sources	The total volume of non-conventional energy resources. It can also be measured as a percentage of the total energy used.	%	ENERGY	possible (unclear location of the charging station)		estimated energy mix at the location	estimated value depends on the energy mix at the location and the usage	estimated energy mix at the location	01.01.26	estimated energy mix at the location	Once (Based on an annual balance)	estimated energy mix at the location
Mileage	Total distances driven in an area during a day.	km/unit	TRANSPORT SYSTEM			calculation based on the floor plan	calculation based on the floor plan	calculation based on the floor plan	01.01.26	estimated	once (at the implementation)	no change through the pilot
Number of trips per day	Vehicle frequency	n° trips/day	TRANSPORT SYSTEM			Value is explored and references the number of operations of the cleaning staff	expected reduction of number of trips compared to the cleaning process of the staff	Software tracks the number of trips (usage times)	01.01.26	measured	quarterly check; (numbers will be provided per use)	expected reduction of number of trips compared to the cleaning process of the staff
Charging times	Time needed to charge a vehicle	hours/unit	TRANSPORT SYSTEM			no value since the cleaning staff itself doesn't use any electrical energy	increased value since there was no charging before	monitoring of the charging cycles; Electricity meter on the charging station or via software of the manufacturer	01.01.26	measured	quarterly check; (numbers will be provided per use)	value depends on the use rate which will be determined after the test period and creation of the operational schedule
Acceptance	The percentage of the population who favourably receive or approve the measures.	% or Qualitative score	SOCIETY-PEOPLE			subjective	subjective	poll	01.01.26	measured	once/twice a year	subjective
Awareness	The percentage of the target population with knowledge of the measures implemented in the testing area on account of provided information.	(% or Qualitative score	SOCIETY-PEOPLE			subjective	subjective	poll	01.01.26	measured	once/twice a year	subjective
Customer satisfaction index	The satisfaction of the quality of the specific services deployed reported by the employees that use the solution.	%	SOCIETY-PEOPLE	questionnaire possible		high workload, high personnel costs	higher satisfaction compared to the start of the project because of the workload reduction	surveys, etc (other UML activities)	01.01.26	measured	once/twice a year	higher satisfaction compared to the start of the project because of the workload reduction
Quality of cooperation structures with stakeholders	Level of quality of cooperation structures between all public and private stakeholders to develop and implement innovative mobility solutions.	Qualitative score	SOCIETY-GOVERNANCE	handled by WRC, Steinbeis?, CARNET	A7	3/47		surveys	start of project	measured	quarterly	4/57
Capital investment	The total capital costs for purchase of infrastructure, equipment and vehicles. It can also include the total costs expended in setting up the measure and cover a period from the initiative of the measure preparation until the start of the measure implementation.	€	ECONOMY			Personnel cost for cleaning staff	36'126.00 €	not applicable	10.09.2025 (date of delivery)	measured	once	not applicable
Range operating costs	Operating costs including for example, the personnel costs, fuel, electricity and maintenance costs for the vehicle(s) involved.	€	ECONOMY	possible		increasing costs through inflation, political pay rise, price rises for electricity/water etc.	reduced operational costs through higher efficiency, less cleaning time, lower personnel costs	monitoring, measuring, estimation	01.01.26	measured and estimated	quarterly check; (numbers will be provided per use)	reduced operational costs through higher efficiency, less cleaning time, lower personnel costs
Economic impact	Financial benefits to end users and to entities from the transition from petrol to clean energy vehicles, the adoption of bidirectional charging, etc.	€	ECONOMY	benefits could be for example the reduction of personnel costs for the cleaning staff		increasing costs through inflation, political pay rise, price rises for electricity/water etc.	reduced operational costs through higher efficiency, less cleaning time, lower personnel costs	monitoring, measuring, estimation	01.01.26	measured and estimated	quarterly check; (numbers will be provided per use)	reduced operational costs through higher efficiency, less cleaning time, lower personnel costs

### Monitoring Programme per Action: (4) SAP Data Integration

Name	Definition	Unit	Category	Measures	Comments	BAU (Business-as-usual)	After	Monitoring System	Monitoring System			Target
<i>Name of the indicator that will be used to monitor the progress towards the achievement of the measure</i>	<i>Definition of the indicator</i>	<i>Unit measurement</i>	<i>From CIVITAS</i>	<i>Related to measure:</i>	<i>Word</i>	<i>Projected value achieved without any measures by the end of the implementation</i>	<i>Value recorded after the implementation of the measures</i>	<i>Method of data collection</i>	<i>Starting Date</i>	<i>Type of Data: Measured, estimated or simulated</i>	<i>Frequency</i>	<i>Expected value after the implementation of the measures</i>
Reduction of CO2 emissions	The average CO2 emissions	TnCO2eq	ENVIRONMENT		Derived from energy consumption	use baseline	to be discussed (maybe considering the use of renewable energy the reduction can be noted)	NA				NA
Energy consumption	The energy consumption per unit of activity.	kWh/unit	ENERGY		As adoption and usage is the goal we would actually expect an increase and not a reduction	same as baseline	10% increase from first estimation with increased adoption	Cost/Revenue of Supplier ratio applied against total energy consumption of supplier	with platform usage	estimated	quarterly	Up to 2300 kwh /year
Quality of cooperation structures with stakeholders	Level of quality of cooperation structures between all public and private stakeholders to develop and implement innovative mobility solutions.	Qualitative score	SOCIETY-GOVERNANCE		A composite score on a likert scale derived from qualitative feedback provided by stakeholders, reflecting their perceptions of the quality and effectiveness of collaboration.	NA	4/5	Derived from project documentation or interviews with the project leader/participants	start of monitoring	measured	quarterly	4 out of 5 points on average
Capital investment	The total capital costs for purchase of infrastructure, equipment and vehicles. It can also include the total costs expended in setting up the measure and cover a period from the initiative of the measure preparation until the start of the measure implementation.	€	ECONOMY		Only cap investment personnel – budget	NA	real financial costs related to the pilot	Equal to project cost monitoring	start of monitoring	measured	quarterly	994125 EUR according to GAP Annex 2
Average operating costs	Operating costs including for example, the personnel costs, fuel, electricity and maintenance costs for the vehicle(s) involved.	€	ECONOMY		Clearer targets and baselines will follow financial planning in Q1/Q2 2026; As adoption and usage is the goal we would actually expect an increase and not a reduction	NA	10% increase from first estimation with increased adoption	Via Cost and Usage Views in the cockpit of the SAP BTP	with platform usage	measured	quarterly	up to 100000 EUR /year

## D3.2 – Monitoring Programmes for 2ZERO, CCAM and power grid actions in Madrid and Dresden

### Monitoring Programme per Action: (5) FHG

Name	Definition	Unit	Category	Measures	Comments	BAU (Business-as-usual)	After	Monitoring System	Monitoring System	Monitoring System	Target	
<i>Name of the indicator that will be used to monitor the progress towards the achievement of the measure</i>	<i>Definition of the indicator</i>	<i>Unit measurement</i>	<i>From CIVITAS</i>	<i>Related to measure:</i>	<i>Word</i>	<i>Projected value achieved without any measures by the end of the implementation</i>	<i>Value recorded after the implementation of the measures</i>	<i>Method of data collection</i>	<i>Starting Date</i>	<i>Type of Data: Measured, estimated or simulated</i>	<i>Frequency</i>	<i>Expected value after the implementation of the measures</i>
Reduction of CO2 emissions	The average CO2 emissions per unit reduced as a result of the measures package implementation. This value takes into account SCOPE 1, 2 and 3 emissions.	TnCO2eq	ENVIRONMENT		A2.1: Trying to provide information of everything. Scope 1 probably zero. Look into scope 3 comment on timeline (recycling can be out of project)	baseline	use of renewable energy and use electric shuttles instead of conventional benzin fuel	scenario analysis	implementation of infrastructure and remote driving hardware	estimated	quarterly	10 kg CO2eq reduction of 75 kg CO2eq Plus energy for infrastructure systems
Energy consumption	The energy consumption per unit of activity.	kWh/unit	ENERGY		A2.1: Divided into vehicle (V) and infrastructure (I) energy consumption → (V) should decrease with nr. of passengers, (I) will increase with nr. of vehicles	baseline	use of renewable energy and use electric shuttles instead of conventional benzin fuel	scenario analysis	implementation of infrastructure and remote driving hardware	estimated	quarterly	3,34 kWh/person reduction of 32 kWh/h Plus energy for infrastructure systems
Energy consumption	The energy consumption per unit of activity.	kWh/unit	ENERGY		A2.2	same as „before“ or an estimation (will be provided by SAP based on performance of similar SAP platforms)	5-15% reduction from SAP „after“ estimation value	Before and BAU: estimation as Cost/Revenue of Supplier ratio applied against total energy consumption of supplier; After: estimation	Same as the launching date of the SAP platform	Estimated	quarterly	85-95% of SAP value (up to 2300 kWh/year); Equals up to 1955-2185 kWh/year
Energy savings	Reduction in energy consumption (per distance, per trip, per passenger transported)	kWh/passenger transported	ENERGY		A2.1: Divided into vehicle (V) and infrastructure (I) energy consumption → (V) should decrease with nr. of passengers, (I) will increase with nr. of vehicles	baseline	use of renewable energy and use electric shuttles instead of conventional benzin fuel	scenario analysis	implementation of infrastructure and remote driving hardware	Estimated	quarterly	3,34 kWh/person reduction of 32 kWh/h Plus energy for infrastructure systems
Energy savings	Reduction in energy consumption (per distance, per trip, per passenger transported)	kWh/unit	ENERGY		A2.2: The plan is to use the Power Usage Effectiveness (PUE) metric for calculating energy savings by measuring the total power consumed by a data center compared to the power used solely by the IT equipment. A PUE of 1.0 is ideal, indicating no excess energy is used beyond what's needed for the IT equipment itself. A PUE of 1.2 is considered very efficient, with 80% of energy being used by IT equipment and 20% being used for cooling, lighting, and other infrastructure. Higher PUE (>1.5) values reflect lower efficiency, with more energy being consumed by non-IT systems like cooling and power distribution.	to be calculated 100% of the SAP energy consumption „BAU“ value as the Total SAP Centre Consumption value, divided by the Consumption of the IT value (relying on SAP that they are able to measure or estimate energy consumption of their technology → check this with Florian)	here we would use the SAP value „after“ for the total system consumption and an estimation for the reduction in energy consumption after implementing the data space connectors (5-15% reduction of the IT Consumption BAU value)	Calculation of the Power Usage Effectiveness (PUE) metric	Beginning of the pilot	Measured (before and BAU) and estimated (after)	quarterly	5-15%
Use of clean energy sources	The total volume of non-conventional energy resources. It can also be measured as a percentage of the total energy used.	%	ENERGY		A2.1: Only for infrastructure	baseline	use of renewable energy and use electric shuttles instead of conventional benzin fuel	scenario analysis	implementation of infrastructure and remote driving hardware	estimated	quarterly	goal is to use 100% renewable energy
Quality of cooperation structures with stakeholders	Level of quality of cooperation structures between all public and private stakeholders to develop and implement innovative mobility solutions.	Qualitative score	SOCIETY-GOVERNANCE		A2.1	3/5?	4/5?	survey	start of project	Estimated or measured	quarterly	4/5
Quality of cooperation structures with stakeholders	Level of quality of cooperation structures between all public and private stakeholders to develop and implement innovative mobility solutions.	Qualitative score	SOCIETY-GOVERNANCE		A2.2: no MDS available	3/5	4/5	Derived from project documentation or interviews with the project leader/participants	start of project	measured	quarterly	4/5
Capital investment	The total capital costs for purchase of infrastructure, equipment and vehicles. It can also include the total costs expended in setting up the measure and cover a period from the initiative of the measure preparation until the start of the measure implementation.	€	ECONOMY		A2.1: Some questions on financing. Trying to get another vehicles, might give range of costs (1-2 vehicles)	NA		Estimation based on project costs monitoring	End of the project	measured (equipment actually purchased) / estimated (possible costs for expansion, e.g. additional vehicle)	Once at the end of the project	50.000€ + 50.000€/sensor
Capital investment	The total capital costs for purchase of infrastructure, equipment and vehicles. It can also include the total costs expended in setting up the measure and cover a period from the initiative of the measure preparation until the start of the measure implementation.	€	ECONOMY		A2.2: no MDS available	NA		Estimation based on project costs monitoring	start of project	Estimated	related to the project cost reporting activities	100.000€ (1,473,125.00 is a total to FHG according to grant agreement → but this sum is for EVERYTHING. We calculate with 200.000€ investment costs for both pilots)
Age operating costs	Operating costs including for example, the personnel costs, fuel, electricity and maintenance costs for the vehicle(s) involved	€	ECONOMY		A2.1: Some questions on financing. Trying to get another vehicles, might give range of costs (1-2 vehicles)	tdb	tdb	Estimation	End of the project	Estimated	Once at the end of the project	Approx. 1.000€/year for telecommunication
Age operating costs	Operating costs including for example, the personnel costs, fuel, electricity and maintenance costs for the vehicle(s) involved.	€	ECONOMY		A2.2: no MDS available	NA		Estimation	Start of the pilot	Estimated	annually	

## D3.2 – Monitoring Programmes for 2ZERO, CCAM and power grid actions in Madrid and Dresden

### Monitoring Programme per Action: (6) VWG Charging Robots

Name	Definition	Unit	Category	Measures	Comments	BAU (Business-as-usual)	After	Monitoring System	Monitoring System	Monitoring System	Target	
Name of the indicator that will be used to monitor the progress towards the achievement of the measure	Definition of the indicator	Unit measurement	From CIVITAS	Related to measure:	Comments Meeting	Projected value achieved without any measures by the end of the implementation	Value recorded after the implementation of the measures	Method of data collection	Starting Date	Type of Data: Measured, estimated or simulated	Frequency	Expected value after the implementation of the measures
Reduction of CO2 emissions	The average CO2 emissions per unit reduced as a result of the measures package implementation. This value takes into account SCOPE 1, 2 and 3 emissions.	TnCO2eq	ENVIRONMENT		Emission comparison using combustion engine (baseline/before) vs electric vehicles (target and after) If possible comparison of emissions of fixed vs mobile chargers include emissions of battery's manufacturing (Scope 3), maybe more in the future for recycling and LCC			simulation refer to the charged vehicle per day and robot	coming in 2026	estimated		
Reduction of NOX emissions	Average NOX emissions per unit reduced as a result of the implementation of the package of measures.	ppb	ENVIRONMENT			NA	NA	NA	NA	NA		
Energy consumption	The energy consumption per unit of activity.	kWh/unit	ENERGY		Can be provided Very meaningful with real data After value can be higher as it could include A1+3d mapping, which consume more. It also depends on the light concept which we need			Robot Software	coming 2026	measured		Powertrain 1000 Wh, Elektroniks 1000 Wh
Energy savings	Reduction in energy consumption (per distance, per trip, per passenger transported)	kWh/unit	ENERGY									
Energy delivered	Energy delivered from charging infrastructure to clean vehicle Energy delivered from the grid to the vehicle Energy delivered from the vehicle to the grid Energy delivered from RES facilities to the smart grid Energy delivered from RES facilities to the battery Energy delivered from RES facilities to the vehicle	kWh/unit	ENERGY		Can be provided and will depend on how much the vehicle wants/needs to be charged			BMS		measured		
Use of clean energy sources	The total volume of non-conventional energy resources. It can also be measured as a percentage of the total energy used.	%	ENERGY		Information from Dresden Energy supplier					estimated		
Mileage	Total distances driven in an area during a day.	km/unit	TRANSPORT SYSTEM		Can be provided			Robot Software		measured		theoretical 5km
Charging times	Time needed to charge a vehicle	hours/unit	TRANSPORT SYSTEM		Can be provided			Robot Software		measured		theoretical 11 kWh
Acceptance	The percentage of the population who favourably receive or approve the measures.	% or Qualitative score	SOCIETY-PEOPLE		Provide Target: Above 8/10 UT Labs Carnet could also help to create a team for surveys							7
Awareness	The percentage of the target population with knowledge of the measures implemented in the testing area on account of provided information.	(% or Qualitative score)	SOCIETY-PEOPLE		Provide Target: Above 8/10 UT Labs Carnet could also help to create a team for surveys							7
Driver satisfaction index	The reported satisfaction of the quality of the specific services deployed.	%	SOCIETY-PEOPLE		First only open to VW vehicles and with drivers from Dresden Survey to drivers							7
Quality of cooperation structures with stakeholders	Level of quality of cooperation structures between all public and private stakeholders to develop and implement innovative mobility solutions.	Qualitative score	SOCIETY-GOVERNANCE		Qualitative, useful for following cities		4/5, 5/5					
Capital investment	The total capital costs for purchase of infrastructure, equipment and vehicles. It can also include the total costs expended in setting up the measure and cover a period from the initiative of the measure preparation until the start of the measure implementation.	€	ECONOMY		Can provide cost of one robot		cost of the unit with respect to the number of robots	calculation				

### Monitoring Programme per Action: (7) TUD Bi-Directional Charging

Name	Definition	Unit	Category	Measures	Comments	BAU (Business-as-usual)	After	Monitoring System	Monitoring System			Target
Name of the indicator that will be used to monitor the progress towards the achievement of the measure	Definition of the indicator	Unit measurement	From CIVITAS	Related to measure:	Word	Projected value achieved without any measures by the end of the implementation	Value recorded after the implementation of the measures	Method of data collection	Starting Date	Type of Data: Measured, estimated or simulated	Frequency	Expected value after the implementation of the measures
Reduction of CO2 emissions	The average CO2 emissions per unit reduced as a result of the measures package implementation. This value takes into account SCOPE 1, 2 and 3 emissions.	TnCO2eq	ENVIRONMENT			coming	coming	MEF Method	the plan is to simulate 50 EVs and compare uncoordinated charging vs. bidirectional (smart) charging. For monitoring process, there is no need to set a starting date and frequency. However, once the chargers are installed at Ostra, we plan to collect data from the charger and EVs. It depends on when the chargers are in place then we can plan. It is too early right now.			
Energy consumption	The energy consumption per unit of activity.	kWh/unit	ENERGY		based on a simulation of 50 EVs	1510	822	simulation				
Energy savings	Reduction in energy consumption (per distance, per trip, per passenger transported)	kWh/unit	ENERGY									
Use of clean energy sources	The total volume of non-conventional energy resources. It can also be measured as a percentage of the total energy used.	%	ENERGY		based on a simulation of 50 EVs		86% with bidirectional	simulation				
Charging times	Time needed to charge a vehicle	hours/unit	TRANSPORT SYSTEM									
Quality of cooperation structures with stakeholders	Level of quality of cooperation structures between all public and private stakeholders to develop and implement innovative mobility solutions.	Qualitative score	SOCIETY-GOVERNANCE		They are interested in social but they will need help. It will be related with UT Labs.		3/5, 4/5					
Capital investment	The total capital costs for purchase of infrastructure, equipment and vehicles. It can also include the total costs expended in setting up the measure and cover a period from the initiative of the measure preparation until the start of the measure implementation.	€	ECONOMY					check the business model document				
Average operating costs	Operating costs including for example, the personnel costs, fuel, electricity and maintenance costs for the vehicle(s) involved.	€	ECONOMY									
Economical impact	Financial benefits to end users and to entities from the transition from petrol to clean energy vehicles, the adoption of bidirectional charging, etc.	€	ECONOMY		based on a simulation of 50 EVs		43.97	simulation				

### Monitoring Programme per Action (8): TUD Bi-Directional Charging - on Energy Saving Efficiency

Name	Definition	Unit	Category	Measures	Comments	BAU (Business-as-usual)	After	Monitoring System	Monitoring System			Target
<i>Name of the indicator that will be used to monitor the progress towards the achievement of the measure</i>	<i>Definition of the indicator</i>	<i>Unit measurement</i>	<i>From CIVITAS</i>	<i>Related to measure:</i>	<i>Word</i>	<i>Projected value achieved without any measures by the end of the implementation</i>	<i>Value recorded after the implementation of the measures</i>	<i>Method of data collection</i>	<i>Starting Date</i>	<i>Type of Data: Measured, estimated or simulated</i>	<i>Frequency</i>	<i>Expected value after the implementation of the measures</i>
Energy savings	Utilization of Surplus PV Power - Utilization of Surplus PV Power for EV Charging	kWh/unit	ENERGY		Measures how much renewable energy is directly consumed thanks to V2G coordination, reducing wastage and grid import.	0 kWh/unit (surplus PV not stored, as in typical charging)	[Simulated value, e.g.,] 180 kWh/unit (from simulation with 50 EVs using V2G to capture surplus PV)	Simulation	start of pilot	simulated	quarterly	
Energy savings	Improved Charging/Discharging Efficiency (Smart Power Management): The average round-trip efficiency (%) of charging and discharging cycles, weighted for power level, before and after implementing smart V2G control logic.	%	ENERGY		Higher efficiency reflects less energy loss in V2G operation through smart scheduling to avoid low-efficiency (low power) windows – smart logic avoids low-current charging; simulation based	83–87% (reflects real-world average V2G round-trip system efficiency)	86-89% (Target)	Simulation	Start of pilot or simulation	Simulated	Quarterly	