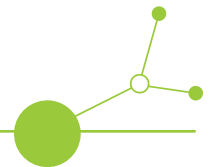


# DELIVERABLE D.2.1.2

## Action Plan Maribor, Slovenia

Action Plan to capture and use waste energy from trains and charge used batteries with renewable energy sources along new life cycle value chains, based on municipal circular economy strategy and urban regeneration plan



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## Abbreviations of partners

Abbreviation	Partner name
LVB	Leipzig Public Transport Company, Germany
PKA	Public Transport Bus Operator in Gdynia, Poland
UG	University of Gdańsk, Poland
SZKT	Szeged Transport Company, Hungary
Kruch	Kruch Railways Innovations, Austria
MOM	Municipality of Maribor, Slovenia
UM	University of Maribor, Slovenia
ATB	ATB Mobility Bergamo, Italy
Redmint	Redmint social enterprise, Italy
Mobilissmus	Mobilissimus Ltd., Hungary
TM	trolley:motion association, Austria

## 1. Executive summary

The CE4CE project empowers circular economy system thinking for actors in public transport from Central European countries to reduce waste and create value along new life cycles of infrastructure and rolling stock. To do so, CE4CE jointly develops solutions that increase knowledge and capacities for the sector, help reduce barriers and costs, and initiate the development of new services and skilled jobs, as well as strategies and action plans that improve policy development, learning and exchange on the regional and transnational level. CE4CE aims at bringing circular economy principles into the public transport sector and, thus, reduce waste, increase efficiency in the sector and improve the ecological footprint of public transport.

Furthermore, stakeholders from the public transport community will cooperate in CE4CE to jointly develop and adapt processes and solutions as key enablers for the integration of circular economy principles, like data sharing concepts, new (innovation) procurement guidance, product and business model designs, extended life-cycle assessment, and cost-benefit analysis methodologies.

CE4CE will jointly develop outputs based on co-creation and peer reviews for take up by the public transport sector, e.g. pilot actions and solutions such as the CE4CE Circularity Compass for public transport, the CE4CE Circularity Knowledge platform, a web-based second-hand marketplace, strategies and pilot actions to increase resource-efficiency and pilots demonstrating use more, reuse and recycle approaches for the public transport sector.

CE4CE’s partnership reflects the whole value chain and transport sector system perspective including 11 project partners from 6 Central European countries, ranging from public transport authorities/operators, industry and research to interest groups. To enlarge this cooperation, associated partners like the



international active networks ICLEI, UITP and EIT Urban Mobility/Raw Materials are strategically involved to maximise communication outreach and knowledge transfer of project results.

This document is the Maribor Action Plan prepared within the Interreg Central Europe project CE4CE. Its aim is to set out measures for capturing and using waste energy from trains, charging used batteries with renewable energy sources, and supporting the transition towards a circular and energy-efficient public transport system in Maribor.

This document is organized as follows:

Chapter 2 is about an introduction to the Maribor Action Plan developed within the CE4CE project.

Chapter 3 explains the strategic background and context for the Action Plan initiation.

Chapter 4 is presenting the Action Plan development and its main features and measures.

Chapter 5 presents the main outcomes, lessons learned and conclusions

Chapter 6 focuses on the next steps beyond the CE4CE project lifetime.

Chapter 7 contains the annexes of the document.

## 2. Introduction to the Maribor Action Plan

The Maribor Action Plan is developed to address key challenges related to energy consumption, emissions, and efficiency in the public transport system. The main needs identified include the transition to low-emission mobility, improved energy management, and better utilisation of existing infrastructure, particularly through the integration of renewable energy sources and circular solutions such as second-life batteries and energy recovery.

The Action Plan focuses on measures that improve operational efficiency, support electrification of public transport, and enable the use of recovered and locally produced energy. Priorities were defined in cooperation with local stakeholders, including the municipality, public transport operator, energy sector and research institutions, ensuring alignment with ongoing projects and strategic development goals.

A key limitation is that the Action Plan is not a legally binding document but provides strategic guidance for future development. However, its measures are aligned with the Sustainable Urban Mobility Plan (SUMP) of Maribor (2026), which defines the long-term direction of transport development in the city and is supported by national and EU funding mechanisms. This significantly increases the feasibility of implementation.



Občinska celostna  
prometna strategija  
Mestne občine Maribor



REPUBLIKA SLOVENIJA  
MINISTRSTVO ZA OKOLJE,  
PROSTOR IN ENERGIJO



Sofinancira  
Evropska unija



Figure 1: Project partners and funding framework of the Maribor SUMP.

## 3. Strategic background and context for the Action Plan development

The Maribor Action Plan is embedded within the broader strategic and regulatory framework at local, national and EU level, supporting the transition towards low-emission and energy-efficient public transport systems. At EU level, it aligns with key policy frameworks such as the European Green Deal and the Circular Economy Action Plan, promoting decarbonisation, energy efficiency and circular use of resources in the transport sector.



At the local level, the Action Plan represents an update of the 2022 strategy “Strategy for environmentally efficient multifunctional charging infrastructure”. The update focuses on refining and upgrading previously defined measures, while placing stronger emphasis on circular economy principles, particularly the transition from linear to circular resource management in public transport systems.

The Action Plan is closely aligned with the Sustainable Urban Mobility Plan (SUMP) of Maribor (2026), which defines the long-term development of the city’s transport system. In this context, the Action Plan acts as an implementation-oriented document, supporting SUMP objectives through concrete energy-related and infrastructure measures.

In addition, the Action Plan takes into account other relevant local strategic documents, including the Circular Economy Transition Strategy of the Municipality of Maribor 2024-2030, ensuring synergies between mobility, energy and circular economy policies. Special emphasis is placed on efficient energy use, which is becoming a critical factor with the increasing electrification of the public transport fleet.



Figure 2: Strategic framework supporting the vision for public transport in Maribor (SUMP).



## 4. Development of the Action Plan to capture and use waste energy from trains, charge used batteries with renewable energy sources

### 4.1. The methodology used in the Action Plan development process

The methodology for the development of the Maribor Action Plan is based on the integration of existing strategic frameworks, technical analyses and project-based findings. It builds upon the previously developed strategy for charging infrastructure (2022), the Sustainable Urban Mobility Plan (SUMP 2026), and the results of the CE4CE project.

Particular emphasis was placed on energy system transformation driven by the electrification of public transport. The analysis considered the transition from a distributed fossil-based system to a concentrated electricity-based system, requiring careful planning of charging infrastructure and energy supply.

The methodology includes:

- assessment of future energy demand and charging needs,
- integration of battery energy storage systems (BESS) to improve flexibility and reduce peak loads,
- gradual integration of renewable energy sources (RES), particularly solar energy,
- evaluation of the potential for capturing and using regenerative braking energy from trains.

A baseline study on railway energy recovery was conducted, identifying both technical potential and system constraints. In addition, the Action Plan considers the development of multimodal energy hubs and the integration of transport and energy systems at key locations.

This approach enables more efficient energy management, reduces pressure on the electricity grid and supports the transition towards a circular and integrated public transport energy system.

### 4.2. Stakeholder engagement process

The stakeholder engagement process was carried out through workshops and expert consultations within the CE4CE project, involving key actors from the public transport, energy and infrastructure sectors

Participating Organizations:

- Municipal level: PTA - MOM, PTO - Marprom, municipal infrastructure and public works company, Local energy and district heating provider, public waste management company
- Regional level: regional development agency, regional energy agency
- Academic and research sector: UM - higher education and research institution
- Technology and private sector stakeholders: fast-charging infrastructure distributor, electric bus distributor



Figure 3: Stakeholder workshop on circular economy and energy in public transport (CE4CE, Maribor).

The process focused on identifying key challenges and needs related to the implementation of circular economy principles in public transport, with a particular emphasis on the energy dimension (energy consumption, renewable energy integration, energy storage and reuse).

Table 1: Overview of key challenges in implementing circular economy principles in public transport (Score: 1 - least challenging, 5 - most challenging).

Area	Key challenges	Score
<b>Energy system (charging, storage, RES)</b>	Renewable energy sources (solar, biomethane, wind) are insufficiently integrated into the public transport energy supply	2.8
	Smart charging and reduction of energy losses are not yet implemented	2.9
	Second-life battery use (BESS) is not systematically integrated into the public transport energy system	3.0
	Regulatory constraints between producers, distributors and consumers hinder public-private cooperation	3.6
	Monitoring of energy consumption and energy efficiency is insufficient	2.9
	Reuse of end-of-life batteries requires specialised handling and implementation procedures	3.4
<b>Charging and spatial infrastructure</b>	Permitting procedures for dedicated infrastructure are complex and time-consuming	2.6
	Weak integration between spatial, transport and energy planning	3.5
	Sustainable materials and eco-design principles are insufficiently applied	3.0
	Spatial integration of infrastructure (charging stations, solar panels) is often inadequate	2.1
	Disassembly and reuse of infrastructure components are not systematically planned	2.8
<b>Vehicles and fleet management</b>	Share of internal combustion engine vehicles remains relatively high	2.7
	Fleet electrification is progressing but requires further system optimisation	2.8



	Procurement must comply with EU and national clean vehicle regulations	3.2
	Systematic monitoring of vehicles and energy consumption is not established	2.9
	Maintenance is predominantly reactive rather than predictive	2.7
	Recycling and reuse of materials (batteries, metals, electronics) are not systematic	3.3
<b>System and governance challenges</b>	Life-cycle assessment (LCA) is not yet standard practice in planning and procurement	2.5
	Lack of transparency in material and component origin	3.2
	Measures for energy and material efficiency are not consistently monitored or optimised	3.0
	Systems for return and reuse of components are insufficiently developed	3.8
	Preventive maintenance is not systematically implemented	2.7
	Systems for handling hazardous waste (batteries, oils, tyres, metals) are insufficiently developed	3.5
	Investment financing depends heavily on EU and municipal funding sources	3.7

### Key challenges

Based on the analysis and stakeholder workshops, the key challenges in implementing circular economy principles in public transport in the Municipality of Maribor are primarily concentrated in the energy system, which represents the foundation for further electrification and optimisation of public transport. The main challenge is to ensure sufficient and reliable energy capacities to support electrification.

This challenge is closely linked to other issues related to the integration of circular economy principles in public transport:

- lack of a systematic approach to the deployment of battery energy storage systems (BESS), which are currently limited to pilot projects,
- insufficient implementation of smart charging solutions, leading to inefficient energy use and increased system loads,
- limited integration of renewable energy sources and strong dependence on the existing electricity grid,
- largely untapped potential of regenerative energy from the railway system,
- insufficient integration between energy, transport and spatial planning,
- administrative and regulatory barriers related to the deployment of charging infrastructure,
- absence of a systematic approach to the reuse of components, particularly batteries, and underdeveloped circular material flows.



## Key needs

Based on the identified challenges, the following priority needs have been defined for establishing a circular and energy-efficient public transport system in the Municipality of Maribor:

- ensuring a robust energy foundation, including increased available capacities and reduced dependence on the existing electricity grid,
- development of an integrated public transport energy system combining battery energy storage systems (BESS), renewable energy sources and smart charging,
- optimisation of energy use through monitoring, peak load management and efficient allocation of energy flows,
- utilisation of new energy sources within the system, particularly the potential of regenerative energy from the railway network,
- establishment of a supportive systemic and governance framework enabling efficient infrastructure deployment, cross-sectoral coordination and the development of circular processes.

## 4.3. The Maribor Action Plan

### 4.3.1. The main thematic area(s) covered

The Maribor Action Plan covers a set of interconnected thematic areas focused on energy efficiency, circular economy and sustainable development of public transport.

The core thematic area is the transformation of the public transport energy system, including the integration of battery energy storage systems (BESS), renewable energy sources and the utilisation of recovered energy (e.g. railway regenerative energy). This is complemented by the development of charging infrastructure and the establishment of energy-efficient and flexible operation of electric public transport.

In addition, the Action Plan includes measures related to operational optimisation and service improvement in public transport, such as the introduction of Bus Rapid Transit (BRT) corridors (dedicated lanes and bus priority at intersections), implementation of predictive maintenance, deployment of digital energy management and monitoring tools (Interreg E-MED), and the introduction of demand-responsive transport (DRT) solutions (Interreg DEGREE4ALPS).

The Action Plan also addresses key infrastructure investments in public transport, including the development of multimodal mobility hubs and the integration of railway infrastructure as part of a wider sustainable mobility system.

### 4.3.2. Vision, objectives and targets

#### Vision

The vision of the Maribor Action Plan is to develop competitive, energy-efficient and sustainable public transport services through the use of low-carbon technologies and alternative energy sources, in order to reduce emissions, improve air quality and decrease noise levels in urban areas. At the same time, the aim is to reduce energy consumption for mobility and to establish a user-friendly, digital and socially accepted transport system.

#### Strategic objectives and priorities

The Action Plan defines objectives across four main dimensions: mobility, environment, economy and energy, and society.



Table 2: Strategic objectives and priority areas of the Maribor Action Plan.

Category	Key priorities
<b>Mobility</b>	Service quality (punctuality, frequency, speed, reliability) Safety and security Digital systems and traffic management (real-time information, priority systems, infrastructure quality) Traffic system management (dedicated lanes, parking management, enforcement) Fleet optimisation (capacity utilisation, reduction of empty runs)
<b>Environment</b>	Air quality Noise reduction Reduction of greenhouse gas emissions Environmental impacts of technologies and infrastructure
<b>Economy and energy</b>	Affordability and accessibility of services Economic development and innovation Integration of renewable energy sources Energy efficiency and optimisation (eco-driving, BESS, energy management) System cost optimisation (total cost of ownership) Risk management (energy prices, regulation, technological risks)
<b>Social equity and inclusion</b>	Quality of life Green and healthy urban environment Social acceptance and behavioural change User comfort and accessibility

## Objectives

Table 3: Specific objectives and targets of the Maribor Action Plan.

Objective	Description	Key targets & timeline
<b>Objective 1</b>	Establish systemic, financial and governance conditions for energy-efficient and circular public transport infrastructure	Action Plan adopted (2026, revision every 2 years); stable financing secured (2026); organisational unit established (2026); propulsion systems defined (2027); cooperation models developed (2028); long-term electricity contracts (2028); integration into spatial planning (2030)
<b>Objective 2</b>	Ensure transparency and stakeholder involvement	Continuous involvement of key stakeholders in investments
<b>Objective 3</b>	Introduce tools for systematic energy monitoring	KPI monitoring established (2026); unified data platform (2026); optimisation tools implemented (2027)
<b>Objective 4</b>	Reduce emissions and noise from public transport	Zero-emission PT in urban areas (2032); noise reduction by 30% (2030); continuous monitoring
<b>Objective 5</b>	Increase the share of passengers using low-emission transport	≥50% electrified fleet (2028); adequate charging infrastructure; improved operational stability; fast/dynamic charging (2032)



<b>Objective 6</b>	Enable multifunctional use of public transport infrastructure	Use by other e-mobility services (2030); interoperability ensured (2028); grid stability with BESS & RES (2030); integration at multimodal hubs (2032)
<b>Objective 7</b>	Improve vehicle utilisation and reduce low-occupancy trips	+10% vehicle utilisation (2028); demand-based route optimisation
<b>Objective 8</b>	Support stakeholders in achieving environmental and circular targets	Environmental standards (2028); +10% user satisfaction (2030); higher share of zero-emission vehicles (2030); reduced administrative barriers (2028); -20% operating costs (2032)
<b>Objective 9</b>	Increase the use of renewable energy in public transport	PV deployment (2028); increased RES share (2032); BESS deployment (2030); second-life batteries (2030)
<b>Objective 10</b>	Strengthen cooperation with the railway sector	Integrated energy management PT-rail (2028); joint infrastructure solutions (2032)

#### 4.3.3. List of proposed measures, their prioritisation, timeline, costs and financing

The table below presents the proposed measures, their prioritisation, implementation timeline, estimated costs and financing sources.

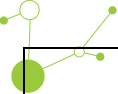
The presented costs are indicative and based on preliminary assessments. They may be further refined during the preparation of project documentation and implementation phases.

The implementation timeline is defined in broader periods rather than specific years. A more detailed and operational timeline is provided within the SUMP of Maribor, which serves as the main implementation framework for transport development in the city.



Table 4: Proposed measures, implementation timeline, estimated costs and financing sources of the Maribor Action Plan.

Measure	Description	Objective	Implementation	Estimated costs	Timeline	Funding source	Responsibility	Stakeholders involved
<b>Electric buses</b>	Procurement of electric buses for gradual electrification of priority PT lines	Increased share of clean vehicles; CO <sub>2</sub> reduction; noise reduction	Phased electrification by investment plan	Approx. 20-30 buses; total approx. €12-18 million (incl. 12 m, 18 m and smaller/special vehicles)	2026-2032	MOM, Eco Fund, EU projects	MOM	MOM, MZI, Marprom, Elektro Maribor, development agency, university
<b>Charging infrastructure - depot upgrade</b>	Upgrade of existing depot for overnight charging	Reliable overnight charging; improved system reliability	Upgrade of central depot	Approx. €2-4 million (chargers, substation upgrade, internal grid, civil works)	2026-2030	MOM, Eco Fund, EU projects	MOM	MOM, Marprom, Elektro Maribor, JHMB, development agency
<b>Charging infrastructure - additional depot</b>	Establishment of secondary overnight charging location	System redundancy; operational flexibility	New satellite depot	Approx. €3-5 million (substation, chargers, infrastructure, connection)	2026-2032	MOM, Eco Fund, EU projects	MOM	MOM, Marprom, Elektro Maribor, JHMB, development agency
<b>Charging infrastructure - fast charging</b>	Deployment of fast chargers at terminals and hubs	Reliable operation; peak load reduction	Phased deployment at terminals and hubs	Approx. €4-7 million (8-12 fast chargers at main station and 6-7 end line stops)	2026-2032	MOM, Eco Fund, EU projects	MOM	MOM, Marprom, Elektro Maribor, development agency, university
<b>Energy storage (BESS)</b>	Deployment of battery storage incl. second-life batteries	Energy savings; grid stability; peak shaving; flexibility	Upgrade of pilot and expansion to key locations	Main bus station: approx. 1 MW BESS; additional 3-4 locations with ~500 kW systems (fast-charging support); modular systems ~650-1000 kWh per site; total approx. €0.5-2 million (initial phase, scalable)	2026-2032	MOM, EU projects, CE4CE	MOM, JHMB	MOM, Marprom, JHMB, university, Elektro Maribor, suppliers
<b>Renewable energy (RES/PV)</b>	Installation of PV systems at PT facilities	CO <sub>2</sub> reduction; energy savings; partial self-sufficiency	Phase 1: main bus station; Phase 2: depot; further expansion	Bus station (~5000 m <sup>2</sup> ): ~€1M; depot (~3000 m <sup>2</sup> ): ~€0.6M; multimodal hubs (modular PV systems depending on scale); studies/design ~€15k	2026-2032	MOM, MOPE, EU projects, private partners	MOM, JHMB	MOM, MOPE, Marprom, Elektro Maribor, development agency
<b>Multimodal hubs</b>	Development of integrated mobility and logistics hubs (PT, rail, sharing, RES, BESS)	Increased PT use; CO <sub>2</sub> reduction; modal shift	Gradual implementation of different hub types	Total approx. €20.4M (large hub €7M; medium €3M; smaller hubs €0.3-0.5M/unit)	2026-2033	MOM, MZI, EU projects	MOM, MZI	MOM, MZI, Marprom, Elektro Maribor, development agency, university



<b>Smart energy management</b>	Digital tools for monitoring and optimisation of energy use	Energy savings; CO <sub>2</sub> reduction	Implementation of monitoring and management system	Approx. €100k-150k (meters, data platform, studies, training)	2026-2029	MOM, Ministry, EU projects, private partners	MOM, JHMB	MOM, Marprom, Elektro Maribor, Energy Agency, university
<b>Energy efficiency &amp; operational optimisation</b>	Eco-driving, monitoring, predictive maintenance, BRT measures, DRT	Energy savings; improved speed and reliability	Monitoring, training, predictive maintenance, BRT planning, priority measures, DRT	Monitoring €20-50k; eco-driving €20k; BRT study €50k; priority €20k/intersection; others not fully estimated	2026-2033	MOM, MZI, EU projects	MOM	MOM, Marprom, JHMB, Energy Agency, university
<b>Rail - infrastructure development</b>	Development of urban rail and integration with PT	Increased PT share; modal shift; CO <sub>2</sub> reduction	Studies, infrastructure upgrades, integration	Not specified (state-level investments)	2026-2033	MZI, MOM	MZI, MOM	MZI, development agency, MOM, Slovenian Railways
<b>Rail - energy recovery</b>	Use of regenerative braking energy from rail system	Energy savings; CO <sub>2</sub> reduction	Feasibility study and pilot integration with BESS	Study ~€50k; pilot ~€0.5-2M	2027-2033	MOM, MZI, EU projects	MZI, SŽ	MOM, MZI, SŽ, Elektro Maribor, Marprom, university
<b>Pohorje cable car (Vzpenjača)</b>	Integration of cable car system into PT energy system	Energy savings	Upgrade and integration	Not specified (separate investment documentation)	2026-2030	MOM, MZI, EU projects	MOM	MOM, MZI, development agency

Table 5: Abbreviations and stakeholder definitions.

<b>MOM</b>	Municipality of Maribor	<b>Development Agency</b>	Regional Development Agency for Podravje - Maribor
<b>MZI</b>	Ministry of Infrastructure of the Republic of Slovenia	<b>University</b>	University of Maribor
<b>MOPE</b>	Ministry of the Environment, Climate and Energy of the Republic of Slovenia	<b>Energy Agency</b>	Energy Agency of the Republic of Slovenia
<b>Marprom</b>	Public transport operator in Maribor	<b>SŽ</b>	Slovenian Railways
<b>JHMB</b>	Public Holdings Maribor (municipal utility holding)	<b>Suppliers</b>	Technology and equipment providers (e.g. charging infrastructure, BESS systems)
<b>Elektro Maribor</b>	Regional electricity distribution system operator (DSO)		



#### 4.3.4. Estimated impact(s) aligned with the municipality’s targets and objectives

The proposed measures are expected to contribute significantly to the achievement of Maribor’s strategic objectives in the fields of mobility, environment, energy and quality of life. The impacts are aligned with the SUMP objectives and focus on emission reduction, energy efficiency, system optimisation and increased attractiveness of public transport.

The transition to electric buses, deployment of charging infrastructure, integration of renewable energy sources and energy storage systems (BESS), together with digitalisation and operational optimisation measures, will improve system performance, reduce environmental impacts and enhance user experience.

### 4.4. Monitoring & evaluation plan

#### 4.4.1. The monitoring plan

Monitoring of the Action Plan will be aligned with the SUMP of Maribor, which defines annual monitoring and reporting obligations for key mobility indicators. The Action Plan builds on this framework and extends it to include energy and circularity-related indicators.

Key Performance Indicators (KPIs) are used to track progress towards the defined objectives. They cover mobility performance, environmental impacts, energy efficiency, system operation and user-related aspects.

Data will be collected through existing and newly established digital systems, including fleet management systems, energy monitoring tools, charging infrastructure data, and transport system analytics. Additional data sources include surveys, infrastructure monitoring and external datasets (e.g. energy providers).

Data collection and processing will be coordinated by the Municipality of Maribor (MOM) in cooperation with key stakeholders (Marprom, JHMB, Energy Agency, Elektro Maribor and the University of Maribor). The data will be aggregated on a central platform and analysed periodically to assess trends, identify deviations and support decision-making.

The monitoring results will be reported annually within the SUMP framework and used to update measures, optimise system performance and support future planning.

Table 6: Key Performance Indicators (KPIs) for monitoring the Action Plan.

Category	KPI	Description
Mobility	Public transport travel time ratio	Ratio between PT and car travel time
	PT punctuality and reliability	Share of on-time services
	Passenger numbers	Number of passengers transported
	Vehicle occupancy rate	Average utilisation of PT vehicles
Environment	CO <sub>2</sub> emissions	Emissions from PT system
	Air pollutants	NO <sub>x</sub> , PM levels (where available)
	Noise levels	Noise reduction in urban areas
Energy	Energy consumption	kWh per vehicle / per passenger
	Share of renewable energy	% of RES in PT energy mix
	Peak load reduction	Reduction of peak demand (BESS impact)



Infrastructure & system	Charging infrastructure capacity	Number and capacity of chargers
	BESS capacity	Installed storage (kWh / MW)
	RES capacity	Installed PV (kW / m <sup>2</sup> )
Operations	Predictive maintenance use	Share of fleet under predictive maintenance
	Eco-driving performance	Reduction in energy consumption due to driving behaviour
Users & society	User satisfaction	Survey-based indicator
	Accessibility	Coverage and access to PT services

#### 4.4.2. The evaluation methodology

The evaluation of the Action Plan focuses on assessing the effectiveness, efficiency and relevance of the implemented measures in relation to the defined objectives.

While monitoring provides continuous tracking of indicators, the evaluation process is carried out periodically (e.g. every 2-3 years) and includes a broader analytical assessment of progress, impacts and implementation challenges.

The evaluation is based on:

- comparison of achieved results with planned targets,
- assessment of cost-effectiveness and resource use,
- identification of implementation barriers and success factors,
- analysis of system-level impacts (mobility patterns, energy use, environmental performance),
- feedback from stakeholders and users.

Both qualitative and quantitative methods are applied. Quantitative analysis is based on KPI trends, while qualitative assessment includes stakeholder consultations, expert reviews and user feedback.

The evaluation results are used to:

- update and adjust measures,
- refine priorities and investment planning,
- support decision-making and policy development,
- ensure alignment with the SUMP and other strategic documents.

The evaluation process is coordinated by the Municipality of Maribor (MOM), in cooperation with key stakeholders and expert institutions.

#### 4.5. Risks associated to the implementation of measures

The implementation of the Action Plan may be affected by several risks related to financial, technical, regulatory and organisational aspects. These risks are inherent to complex infrastructure and system transformation processes, particularly in the context of energy transition and electrification of public transport.

A key systemic risk is that the Action Plan is not a legally binding document, but rather a strategic framework. Its successful implementation therefore depends on political commitment, institutional coordination and the availability of financial resources. However, this risk is mitigated by the integration of



the measures into the SUMP of Maribor, which represents the main strategic framework guiding transport development and enables alignment with national and EU funding mechanisms.

Additional risks include:

- **Financial risks:** uncertainty in securing sufficient funding, dependence on EU programmes, fluctuations in energy prices and investment costs.
- **Technical risks:** challenges related to integration of new technologies (electric buses, BESS, RES), system interoperability and grid capacity constraints.
- **Regulatory risks:** administrative barriers, lengthy permitting procedures and unclear regulatory frameworks for energy storage and infrastructure deployment.
- **Operational risks:** limited organisational capacity, lack of experience with new technologies and transition from reactive to predictive maintenance systems.
- **Energy system risks:** increasing demand for electricity, peak load pressures and insufficient integration of renewable energy sources.
- **Stakeholder coordination risks:** complexity of cooperation between multiple actors (PTO, energy, spatial planning sector).
- **Social risks:** potential resistance to changes in mobility patterns, infrastructure siting or operational measures.

Despite these risks, the Action Plan includes measures that actively address and mitigate them, such as phased implementation, pilot projects, integration of digital tools, stakeholder engagement and alignment with existing strategic frameworks.

Continuous monitoring and periodic evaluation will enable timely identification of risks and adaptive management of the implementation process.

## 4.6. The process of Action Plan approval

The Action Plan was presented to and endorsed by the Mayor of the Municipality of Maribor.

The measures included in this Action Plan are also integrated into the Sustainable Urban Mobility Plan (SUMP) of Maribor, which was formally adopted by the City Council. This ensures institutional alignment and provides a formal basis for the implementation of the proposed measures within the broader strategic framework of urban mobility development.

# 5. Main outcomes, lessons learned and conclusions

## 5.1. Main outcomes of the Action Plan development process

The development of the Action Plan resulted in a comprehensive and integrated framework for the transition towards energy-efficient and low-emission public transport in Maribor.

The process enabled the alignment of mobility, energy and spatial planning perspectives, with a strong focus on electrification, energy management (including BESS and RES), and system optimisation through digital tools and operational measures.

Key outcomes include:

- a structured set of measures covering infrastructure, operations, energy and governance,



- integration of circular and energy-efficient principles into public transport planning,
- identification of priority investments (electric buses, charging infrastructure, multimodal hubs),
- strengthened cooperation between transport and energy stakeholders,
- alignment with the SUMP and other strategic documents.

## 5.2. Lessons learned

The development of the Action Plan highlighted several important lessons:

- **Integration is essential:** Effective planning requires strong coordination between transport, energy and spatial planning sectors.
- **Energy becomes a central component:** With electrification, energy supply, storage (BESS) and management become critical system elements.
- **Data and digitalisation are key enablers:** Monitoring, optimisation and predictive maintenance significantly improve system performance.
- **Pilot projects are crucial:** Demonstration activities (e.g. CE4CE) provide valuable insights for scaling up solutions.
- **Institutional capacity matters:** Successful implementation depends on organisational readiness and stakeholder cooperation.
- **Flexibility is needed:** Due to technological and regulatory uncertainties, measures should allow phased and adaptive implementation.

## 5.3. Conclusions

The Action Plan provides a clear strategic direction for the development of a sustainable, energy-efficient and user-oriented public transport system in Maribor.

It supports the transition towards low-emission mobility, improves system performance and contributes to broader environmental and societal goals. The integration with the SUMP ensures that the proposed measures are embedded within the city's long-term development framework.

The implementation of the Action Plan will require continued coordination, investment and adaptive management. However, it also represents a significant opportunity to position Maribor as a forward-looking city in the field of sustainable and circular public transport.

## 6. Next steps

### Next steps for implementation

The following steps have been identified and agreed within the stakeholder group to ensure effective implementation:

- integration of the Action Plan measures into operational and investment planning frameworks (primarily through the SUMP),
- preparation of detailed project documentation (feasibility studies, design, permitting),
- establishment of governance structures and clear responsibilities for implementation,



- strengthening cooperation between transport, energy and spatial planning stakeholders,
- gradual implementation through pilot projects and phased investments,
- continuous monitoring and periodic evaluation of progress.

### Required support and additional input

To achieve the defined targets, the following support is required:

- access to EU and national funding mechanisms,
- technical expertise for system integration (BESS, RES, smart charging, digital tools),
- regulatory support, particularly for energy storage systems and infrastructure deployment,
- development of data platforms and analytical tools,
- capacity building and training for involved institutions.

### Sustainability aspects

The Action Plan contributes to environmental, economic and social sustainability by:

- reducing greenhouse gas emissions and air pollution,
- improving energy efficiency and integrating renewable energy sources,
- optimising resource use through system-level approaches (e.g. energy storage, digitalisation),
- enhancing accessibility and quality of public transport services,
- supporting long-term resilience of the transport and energy systems.

### Funding sources

Potential funding sources for implementation include:

- municipal budget (MOM),
- national funding programmes (MZI, MOPE),
- EU funding instruments (e.g. Cohesion Policy funds, Horizon Europe, Interreg),
- financial mechanisms such as the Eco Fund (Slovenia),
- public-private partnerships (PPP), particularly for infrastructure and RES deployment.

### Synergies with EU-funded projects

The Action Plan builds on and complements existing and future EU-funded initiatives, including:

- **Interreg CE4CE** - circular economy solutions in public transport (BESS, energy management, business models),
- **Interreg EfficienCE** - deployment of fast-charging infrastructure and optimisation of electric bus operations,
- **Interreg E-MED** - digital tools, energy monitoring and optimisation,
- **Interreg DEGREE4ALPS** - demand-responsive transport solutions (DRT),
- potential future EU-funded projects focusing on electrification, smart energy systems and multimodal integration.



## 7. Annexes

The deliverable annexes have been prepared as separate documents.

### 7.1. Annex 1: Stakeholder workshop report

Summary of the stakeholder workshop conducted within the CE4CE project, including identified challenges, needs and evaluation results.

### 7.2. Annex 2: Updated Action Plan (detailed version)

Detailed version of the Action Plan, including extended descriptions of measures, technical specifications and implementation details.

### 7.3. Annex 3: Strategy for environmentally efficient multipurpose charging infrastructure (2022)

Previous strategic document forming the basis for the updated Action Plan: [Strategija EFFICENCE MOM-2.pdf](#)

Published on : [EFFICENCE - Energy Efficiency for Public Transport Infrastructure in Central Europe | Mestna občina Maribor](#)

### 7.4. Annex 4: Sustainable Urban Mobility Plan (SUMP) of Maribor

Strategic transport document providing the main framework for mobility development in the city.

SUMP 2025: <https://maribor.si/wp-content/uploads/2026/03/OCPS-MOM-brosura-05.pdf>

Published on: <https://maribor.si/mestni-servis/promet-in-javne-povrsine/obcinska-celostna-prometna-strategija-2025/>

### 7.5. Annex 5: Circular Economy Strategy of the Municipality of Maribor (2024-2030)

Strategic document defining the transition towards circular economy at the municipal level: [SKG-MOM-2024-2030.pdf](#)

Published on: [Strategija prehoda mesta Maribor v krožno gospodarstvo | Mestna občina Maribor](#)