



E-MED

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E-MED policy recommendations for energy-efficient & resource-efficient upscaling of zero emission PT

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Introduction

The E-MED initiative seeks to examine and validate strategies aimed at enhancing the energy and resource efficiency of public transportation systems, thereby significantly mitigating the sector's environmental impact and enabling adaptability in response to fluctuating energy prices driven by the prevailing energy crisis.

The E-MED solutions encompass a suite of measures designed to bolster energy efficiency and promote the adoption of Renewable Energy Systems (RES), with tools tailored for fleet and network planning, driver support systems, and artificial intelligence-driven maintenance of energy infrastructure.

Additionally, these solutions aim to bolster resource efficiency and resilience through initiatives such as battery and rainwater reuse, tire maintenance, and adherence to sustainable procurement guidelines. They facilitate evidence-based planning and deployment of electric bus systems, thereby aiding in objective decision-making and strategic planning from inception.

Consequently, E-MED solutions facilitate the strategic configuration of Public Transport (PT) systems by enabling intelligent organisation and optimization of networks and operations, deploying efficient charging strategies, leveraging advanced engineering technologies, and fostering capacity building around eco-driving and other pertinent human-centric topics.

The primary purpose of Deliverable D.4.3.2 is, after providing an analysis of regulatory frameworks at EU level and in the target regions of the E-MED project, to provide policy recommendations to enable the successful implementation of pilot activities and upscaling of sustainable, resource efficient and circular solutions in public transport.

Recommendations will on one side advise pilot implementers and solution adopters in adapting, complying with and deploying the opportunities provided by the current stage of regulation, and at the same time suggest improvements for the existing regulatory frameworks in order to maximise the impact of the developed and tested innovations.

1 Overview of regulatory policy instruments on public transport decarbonisation and circularity in Europe

The regulatory framework governing decarbonisation and circularity in public transport is characterised by a composite legal and policy framework, integrating legislations, strategic action plans, and supporting guidelines.

Regulations, directives, decisions and other initiatives embed decarbonisation and circularity principles in the EU legislation, while allowing flexibility for Member States in implementation.

At the center of the framework is the **European Green Deal**, that aims to make Europe a climate-neutral continent by 2050, decoupling growth from resource use and environmental degradation. Concerning mobility, its objective is to reduce transport-related greenhouse gas emissions by 90%. To reach this target, a radical shift in the way vehicles are fuelled is necessary in all sectors, including public transport.

Under the umbrella of the European Green Deal, the EU has adopted and put in place a series of policy packages and set concrete targets in different sectors.



The **Fit for 55 package** is a set of laws aiming to reduce EU greenhouse gas emissions by at least 55% by 2030 and put the EU to the path to achieve climate neutrality by 2050.

In the context of the Fit for 55 package, the following initiatives are particularly relevant for the public transport context.

The **Alternative Fuels Infrastructure Regulation**, whose main objectives are

- to ensure minimum infrastructure to support the required uptake of alternative fuel vehicles across all transport modes and in all EU Member States to meet the EU's climate objectives;
- to ensure full interoperability of the infrastructure;
- to ensure comprehensive user information and adequate payment options at alternative fuels infrastructure.

The **effort sharing regulation (ESR)**, which updates the member states' current emissions reduction targets for 2030 in sectors such as the transport, buildings, agriculture and waste sectors.

The **revised regulation on CO₂ standards**, strengthening CO₂ emission performance standards for new passenger cars and new light commercial vehicles to ensure that the automotive sector contributes to the EU's climate goals, and to stimulate innovation.

The **revised Energy Efficiency Directive ((EU/2023/1791)**, strengthening the EU's commitment to reducing energy consumption and improving energy efficiency. The revised directive, which entered into force on October 10, 2023, sets a binding EU-level target to reduce final energy consumption by 11.7% by 2030 compared to projected 2020 levels. It significantly impacts the transport sector by setting binding targets for energy consumption reduction and requiring Member States to prioritize energy efficiency in transport policies.

The **EU ETS2 emission trading scheme**, that will cover and address the CO₂ emissions from fuel combustion in buildings, road transport and additional sectors (mainly small industry not covered by the existing EU ETS).

The **REPowerEU plan**, fast tracking the permitting process of renewable energy projects, to reduce greenhouse emissions from the energy sector and provide an alternative to fossil fuel imports for the EU.

Further initiatives complement the regulatory framework at EU level within which innovations for decarbonisation and circularity in Public Transport must find resources and policy support for their implementation and scaling up.

The **EU circular Economy Action Plan (2020)** focuses on the acceleration of the transition to a circular economy in Europe. It promotes sustainable product design, circular processes, and waste reduction. It targets stakeholders from six key value chains: Electronics and ICT, Batteries and Vehicles, Packaging, Plastics, Textiles, and construction and buildings. The plan encourages the design of vehicles for easier disassembly, reuse, and recycling of materials, parts, and components, and sets requirements for minimum percentages of recycled content, including recycled end-of-life vehicles (ELVs), to be used in the production of new vehicles.

The plan also promotes the identification of sustainability and transparency requirements for batteries taking account of, for instance, the carbon footprint of battery manufacturing, ethical sourcing of raw materials and security of supply, and facilitating reuse, repurposing and recycling.



The **New battery regulation (2023)** promotes the application of circular economy principles, aims at reducing the environmental impact and at strengthening the EU's internal market for batteries. It defines mandatory requirements for all batteries placed on the EU market covering sustainability and safety, labelling, marking and information, due diligence, waste battery management, battery passport, green public procurement. It will progressively introduce obligations such as Digital Battery Passport, Recycling Requirements, Carbon Footprint Declaration, Recycled Content, Removability and Replaceability Requirements, etc.

The **End-of-life vehicles Regulation (proposal, 2023)** aims at preventing and limiting waste from end-of-life vehicles and their components; improve the environmental performance of all economic operators involved in the life-cycle of vehicles. It amends the existing regulation to improve circular design, ensure that at least 25% of plastic used to build a vehicle comes from recycling, recover more and better-quality raw materials, extend responsibilities of manufacturers, extend to different vehicle categories including buses.

The **Revised Clean Vehicles Directive (2019)** promotes clean mobility solutions in public procurement tenders, and defines national targets for procuring clean vehicles, defined as a minimum percentage of clean vehicles in the aggregate public procurement across a Member State. The Directive applies to public administrations and other bodies issuing public tenders. Targets are variable depending on the Country and on the vehicle category (light-duty, heavy duty). For buses, half of the target to be fulfilled by procuring zero-emission buses.

2 Regulatory frameworks for decarbonisation and circularity in public transport in the E-MED target regions

The following paragraphs present, per each pilot area, a summary of the regulatory frameworks on decarbonisation and circularity at national, regional and local level in order to provide useful elements to assess the policy implications of the development of E-MED pilot activities in the whole area targeted by the project.

2.1 Spain, Barcelona Metropolitan Area

The regulatory framework guiding sustainable and energy-efficient public transport in Badalona is shaped by a multi-level governance structure: national legislation from the Spanish state, regional instruments from the Government of Catalonia, and metropolitan plans coordinated by the Barcelona Metropolitan Area Authority (AMB).

At national level, the **Spanish Climate Change and Energy Transition Law (Law 7/2021)**, adopted in May 2021, establishes the long-term legal foundation for Spain's decarbonisation objectives. Main features include the creation of **Low Emission Zones (LEZs)** in urban areas with more than 50.000 inhabitants, the prioritisation of **zero-emission vehicles in public fleets**, and the **integration of climate elements** in mobility and urban planning strategies.

The **new Sustainable Mobility Law (Ministerio de Transportes y Movilidad Sostenible, Anteproyecto de Ley de Movilidad Sostenible, Draft 2023)** is, as of 2025 under drafting, aims at consolidating and modernising the mobility governance framework in Spain. The main strategic streams proposed list the definition of **mobility as a social right**, the promotion of **data-driven, low-**

carbon, and **multimodal** transport. Objectives of the new law are also the strengthening of **public transport authorities' competencies**, particularly for metropolitan areas, the introduction of **mandatory Sustainable Urban Mobility Plans (SUMP)**s for municipalities, and the integration of **sustainability criteria** in transport-related public investments.

At regional level, the **Catalonia Mobility Law (Law 9/2003)** represents the regulatory basis for mobility, defining public services. The law highlights as main principles for planning and development of mobility networks and services **energy efficiency** and **environmental sustainability**, **intermodality** and **coordinated planning** between municipalities, **preference for collective and non-motorised** transport.

The **regional Integrated Mobility System of Catalonia (SIMC)** enables technical and **financial coordination** among local transport authorities and service providers, facilitating **interoperability** and **harmonised fare systems**.

Concerning the topic of climate change, it is worth to mention at regional level the **Catalan Energy and Climate Change Strategies** (ProENCAT 2050 & PNIEC alignment): these strategies guide energy transition in public infrastructure, with **specific targets for electrification of buses, energy efficiency of depots, and green procurement**.

At metropolitan level, mobility in the Barcelona Metropolitan Area) is governed by the **Metropolitan Urban Mobility Plan (PMMU 2020–2025)**, a SUMP establishing the roadmap for sustainable mobility, including expanding **zero-emission bus fleets**, **reorganising and optimising** the metropolitan bus network, promoting **intermodal hubs** with **electric charging** and **bike-sharing infrastructure**. The SUMP objective is to increase the modal share of public transport to 35% by 2025.

The Metropolitan area developed a **Climate Plan & Green Public Procurement Strategy**, complementing the SUMP by integrating and declining energy efficiency and circularity principles in all metropolitan operations, including environmental clauses in **procurement**, especially for public transport **rolling stock**, promotion of **life-cycle assessment (LCA)** and **resource-efficient design**, alignment with the EU Green Deal and Spain's Circular Economy Strategy 2030.

In Spain, like in the other EU countries, **fleet renewal** and the deployment of **electric charging infrastructure** are funded through the **Recovery and Resilience Plan (PRTR)**. Additional co-financing from the **Ministry of Transport (MITMA)** and regional budgets facilitates the shift to sustainable transport.

Document	Key elements for decarbonisation and circularity
Spanish Climate Change and Energy Transition Law (Law 7/2021)	<i>zero-emission vehicles in public fleets integration of climate elements in planning</i>
New Sustainable Mobility Law (Ministerio de Transportes y Movilidad Sostenible, Anteproyecto de Ley de Movilidad Sostenible, Draft 2023)	<i>data-driven, low-carbon, multimodal transport mandatory SUMPs integration of sustainability criteria in transport-related public investments</i>
Recovery and Resilience Plan (PRTR)	<i>fleet renewal</i>

	<i>electric charging infrastructure</i>
Catalonia Mobility Law (Law 9/2003)	<i>energy efficiency environmental sustainability intermodality coordinated planning between municipalities</i>
Regional Integrated Mobility System of Catalonia (SIMC)	<i>financial coordination among local transport authorities and service providers</i>
Catalan Energy and Climate Change Strategies (ProENCAT 2050 & PNIEC alignment)	<i>electrification of buses energy efficiency of depots green procurement</i>
Metropolitan Urban Mobility Plan (PMMU 2020–2025)	<i>zero-emission bus fleets reorganising and optimising bus network intermodal hubs with electric charging</i>
Climate Plan & Green Public Procurement Strategy	<i>life-cycle assessment (LCA) resource-efficient design</i>

Table 1. Summary of main regulatory documents and key elements for decarbonisation and circularity of public transport in Spain, Barcelona Metropolitan Area

2.2 Portugal, Lisbon Metropolitan Area

The legal framework for public passenger transport services in Portugal, is provided by the **Legal Regime for Public Passenger Services (Law 52/2015)**, aligning with EU Regulation 1370/2007. The law decentralizes urban transport planning and service provision to municipalities and metropolitan authorities, requiring formal concessioning or public service contracts.

The **Decree-Law No. 86-D/2016 (Decreto-Lei n.º 86-D/2016, de 30 dezembro)** focuses on the functional integration of Carris Metropolitana into the local public transport sector, transferring inter-municipal bus services within the Lisbon Metropolitan Area (AML) to Carris's competence, enabling **testing and innovation** in service delivery and **integration within local business operations**.

The **Basic Law on Climate (Lei de Bases do Clima 2021)**, imposes a legal obligation on all levels of government to actively **promote active mobility** - such as walking and cycling - as key elements of climate action.

At regional metropolitan level, the **SUMP (Metropolitan Sustainable Urban Mobility Plan - PMMUS)**, coordinated by Transportes Metropolitanos de Lisboa (TML), it is set to guide sustainable, **low-carbon** mobility for 18 municipalities, incorporating **climate, energy, and environmental assessments** alongside extensive stakeholder participation.

The **Local Business Mobility Pact (PMEL)** is a voluntary initiative encourages businesses across Lisbon to **decarbonise fleets** and **promote sustainable transport modes** among employees, aligned with city climate targets.

As a signatory to the **Covenant of Mayors**, Lisbon targets a 40% reduction in GHG emissions by 2030, with public transport contributing through **electrification** and **modal shift**—targeting a **zero-emission bus fleet** by 2040.

Document	Key elements for decarbonisation and circularity
Legal Regime for Public Passenger Services (Law 52/2015)	<i>decentralised urban transport planning</i>
Decree-Law No. 86-D/2016 (Decreto-Lei n.º 86-D/2016, de 30 dezembro) Decree-Law No. 86-D/2016	<i>testing and innovation</i> <i>integration within local business operations</i>
Basic Law on Climate (Lei de Bases do Clima 2021)	<i>promote active mobility</i>
SUMP (Metropolitan Sustainable Urban Mobility Plan - PMMUS)	<i>low-carbon mobility</i> <i>climate, energy, and environmental assessments</i>
Local Business Mobility Pact (PMEL)	<i>decarbonise fleets and promote sustainable transport modes among employees</i>
Covenant of Mayors	<i>electrification</i> <i>modal shift</i> <i>zero-emission bus fleet in 204</i>

Table 1. Summary of main regulatory documents and key elements for decarbonisation and circularity of public transport in Portugal, Lisbon

2.3 Italy, Bergamo

In Italy, the **Ministry of Environment and Energy Security Integrated plan (Piano integrato di attività e organizzazione 2025-2027 - Decreto n. 36 del 3 Febbraio 2025)** defines the strategic framework for energy security, sustainability, circular economy, decarbonisation, energy transition and sustainable development. The plan emphasizes among the actions the **electrification of transport**, expansion of **electric vehicle (EV) charging infrastructure**, use of **sustainable biofuels**, and **modernization of public transport**.

The **National Energy and Climate Plan (PNIEC)** and the **National Recovery and Resilience Plan (PNRR)** are the main policy instruments to **accelerate renewable energy** and **energy efficiency projects**.

Furthermore, the Ministry of Infrastructure and Sustainable Mobility issued in 2022 the **Operational Guidelines for Sustainable Urban Mobility Plans (SUMPs)**, to streamline planning and implementation of sustainable transport solutions.

Italy's **National Strategic Plan for Sustainable Mobility (2021)** provides a long-term vision for decarbonising the transport sector by 2030 and 2050. For urban contexts like Bergamo, the PSNMS prioritises: the replacement of high-emission vehicles with **zero-emission alternatives in public fleets**, the expansion of **multimodal and active transport** options, and the **integration of air quality and climate objectives** into urban mobility policy.

Concerning circular economy aspects, the 2016 **Public Procurement Code (Decree no. 50/2016)** made **Green Public Procurement (GPP)** mandatory, requiring all public tenders - including those for public transport vehicles and services. - to include **minimum environmental criteria** set by the Ministry for the Environment. The **New Procurement Law (D.Lgs 36/2023)** integrates the application of **life-cycle assessment (LCA)** and **circularity principles**, the use of environmental impact assessment during infrastructure and fleet acquisition, and the facilitation of **innovative and pre-commercial procurement** procedures.

Bergamo has developed a comprehensive SUMP in 2022 (**Piano Urbano della Mobilità Sostenibile – PUMS**). Key objectives include the **reduction of private car use** through **improved public transport** and active mobility infrastructure, the promotion of **fleet electrification and decarbonisation of local services** (e.g. ATB's electric bus deployment), **encouraging digitalisation**, data-driven planning, and stakeholder participation, integration of land-use and mobility planning to support compact and climate-resilient urban development.

On the topics of sustainable energy and climate change, Bergamo's **Climate City Contract (2024)**, elaborated in the framework of the NetZeroCities, represents the assumption of responsibility for **reducing carbon dioxide emissions**, by the Administration and by those stakeholders, including private individuals, who have decided and will decide to participate in the challenge of ecological transition. It includes all the activities that the City of Bergamo and its partners will implement towards **zero neutrality**. In particular, concerning mobility, the PTO operator ATB is committed to the fleet electrification by 2033, the construction of the new "T2 della Valle Brembana" tramway, and of the e-BRT (Bus Rapid Transit) Bergamo-Dalmine by 2026.

Document	Key elements for decarbonisation and circularity
Ministry of Environment and Energy Security Integrated plan (Piano integrato di attività e organizzazione 2025-2027 - Decreto n. 36 del 3 Febbraio 2025)	<i>electrification of transport electric vehicle (EV) charging infrastructure sustainable biofuels modernization of public transport</i>
National Energy and Climate Plan (PNIEC)	<i>accelerate renewable energy and energy efficiency projects</i>
National Recovery and Resilience Plan (PNRR)	<i>accelerate renewable energy and energy efficiency projects</i>
Operational Guidelines for Sustainable Urban Mobility Plans (SUMPs)	<i>streamline planning and implementation of sustainable transport solutions</i>

National Strategic Plan for Sustainable Mobility (2021)	<i>zero-emission alternatives in public fleets multimodal and active transport integration of air quality and climate objectives in urban mobility policy</i>
Public Procurement Code (Decree no. 50/2016)	<i>mandatory Green Public Procurement (GPP)</i>
New Procurement Law (D.Lgs 36/2023)	<i>life-cycle assessment (LCA) circularity principles environmental impact assessment for infrastructure and fleet acquisition facilitation of innovative and pre-commercial procurement</i>
Piano Urbano della Mobilità Sostenibile – PUMS (2022)	<i>reduction of private car use improved public transport active mobility infrastructure fleet electrification and decarbonisation digitalisation, data-driven planning</i>
Climate City Contract (2024)	<i>reducing carbon dioxide emissions fleet electrification by 2033 new public transport systems (“T2 della Valle Brembana” tramway, e-BRT Bus Rapid Transit Bergamo-Dalmine by 2026</i>

Table 1. Summary of main regulatory documents and key elements for decarbonisation and circularity of public transport in Italy, Bergamo

2.4 Slovenia, Maribor

Maribor’s governance framework for sustainable urban mobility is structured around Slovenia’s national legal commitments to climate neutrality, EU-level obligations, and a growing emphasis on integrated local planning. Although smaller than major metropolitan areas, Maribor leverages national legislation, regional coordination mechanisms, and local Sustainable Urban Mobility Plans (SUMPs) to operationalise low-emission mobility strategies.

At national level, the **Act on Comprehensive Transport Planning (ZCPN)** adopted in 2017, is the principal legal foundation for sustainable mobility planning in Slovenia. It mandates municipalities—including Maribor—to develop and regularly update **Sustainable Urban Mobility Plans** (Celostne prometne strategije – CPS) that align with national environmental, climate, and spatial planning objectives. Key elements include the **promotion of public and non-motorised transport**, participatory planning and evidence-based policy, integration of mobility and spatial development strategies to reduce car dependency.

The **National Energy and Climate Plan (NEPN)**, aligned with EU Regulation 2018/1999, establishes national targets for greenhouse gas (GHG) reductions, with a strong emphasis on the decarbonisation of transport. For the urban context, it prioritises the transition to **electric public transport fleets**, the development of **charging infrastructure**, **modal shift policies** favouring cycling, walking, and public transport.

The **National Strategy for Low-Carbon Transport (2021–2030)** complements the NEPN and lays out operational measures to support clean mobility, including financial **incentives for municipalities to electrify public transport**, national co-financing of urban logistics decarbonisation projects, deployment of **alternative fuel infrastructure** along urban and regional corridors.

In Maribor, the **Sustainable Urban Mobility Plan (SUMP / CPS Maribor)** was adopted in 2015 and updated it in line with the 2019 EU guidelines. The plan includes: objectives to reduce CO₂ emissions from urban transport by **increasing the public transport modal share**, network redesign to improve accessibility and connectivity, including for peripheral neighbourhoods, integration of cycling infrastructure with public transport and land-use planning.

Furthermore, mobility measures in Maribor are embedded in broader city planning instruments, particularly those relating to urban regeneration and compact development, smart city initiatives focusing on data-driven transport solutions, and **climate adaptation**, including low-emission zones and heat-resilient infrastructure.

Document	Key elements for decarbonisation and circularity
Act on Comprehensive Transport Planning (ZCPN)	<i>Sustainable Urban Mobility Plans promotion of public and non-motorised transport</i>
National Energy and Climate Plan (NEPN)	<i>electric public transport charging infrastructure modal shift policies</i>
National Strategy for Low-Carbon Transport (2021–2030)	<i>incentives for municipalities to electrify public transport alternative fuel infrastructure</i>
Sustainable Urban Mobility Plan (SUMP / CPS Maribor)	<i>increasing the public transport modal share climate adaptation</i>

Table 1. Summary of main regulatory documents and key elements for decarbonisation and circularity of public transport in Slovenia, Maribor

2.5 Greece, Thessaloniki

The governance of sustainable urban mobility in Thessaloniki is shaped by a layered legal and policy framework, encompassing national legislation, European directives, and metropolitan-level

initiatives. The most relevant instruments include laws regulating public transport, promoting electrification, and transposing EU environmental objectives into Greek law.

The **•New Regulatory Framework for Urban Transport in Thessaloniki (Law 4482/2017)** restructured the governance of urban public transport in the Thessaloniki Metropolitan Area. The new regulatory framework envisaged **fiscal and regulatory incentives for the adoption of electric vehicles** including public fleets, the **deployment of EV charging stations** in urban areas, the **integration of environmental criteria in public procurement** procedures related to transport.

The **Law 4710/2020 - Promotion of Electromobility** represents the national legal framework for electric vehicles, **public procurement of e-buses**, deployment of **charging infrastructure**, and **incentives for zero-emission fleets**.

The **National Climate Law (Law 4936/2022)** sets binding targets for climate neutrality by 2050, includes **clean vehicle procurement** mandates, and reinforces the **alignment of public transport with energy and environmental goals**.

The Sustainable Urban Mobility and Public Transport Planning Law (Law 4784/2021) defines strategic mobility planning obligations, including the **integration of clean vehicles** and **public transport decarbonisation** objectives.

For Thessaloniki, the **transposition of EU Directive 2019/1161 – Clean Vehicles Directive** at national level encourages the **replacement of diesel buses** with electric, hybrid, or alternative-fuel vehicles, the integration of **life-cycle assessment** and **environmental impact** into procurement processes, the alignment with broader EU goals for **zero-emission urban transport**.

The Urban Transport Authority of Thessaloniki (TheTA), which oversees transport planning and policy development across the metropolitan area.

The **Thessaloniki Sustainable Urban Mobility Plan (SUMP)** aims at reducing private car use and promote public transport, walking, and cycling, enhancing accessibility and connectivity across the urban and suburban areas, **integrating land-use and transport planning with environmental objectives, supporting innovation, data use**, and stakeholder participation in decision-making. The plan is currently being updated to reflect new targets under the EU Green Deal and Greece's National Energy and Climate Plan (NECP).

TheTA facilitates collaboration among local authorities, operators, and infrastructure providers, particularly in implementing **electrification projects supported by EU and national funds**, multimodal mobility hubs that combine public transport with micromobility and park-and-ride services, and ITS (Intelligent Transport Systems) for real-time passenger information and traffic management.

The **Greece's National Recovery and Resilience Plan (NRRP)**, focusing on **sustainable transport** and **green infrastructure**, represents the main funding source for public transport decarbonisation.

Document	Key elements for decarbonisation and circularity
New Regulatory Framework for Urban Transport in Thessaloniki (Law 4482/2017)	<i>fiscal and regulatory incentives for the adoption of electric vehicles including public fleets</i> <i>deployment of EV charging stations in urban</i>

	<i>areas integration of environmental criteria in public procurement</i>
Law 4710/2020 - Promotion of Electromobility	<i>national legal framework for electric vehicles public procurement of e-buses deployment of charging infrastructure incentives for zero-emission fleets</i>
Law 4936/2022 – National Climate Law	<i>clean vehicle procurement alignment of public transport with energy and environmental goals</i>
Law 4784/2021 - Sustainable Urban Mobility and Public Transport Planning	<i>integration of clean vehicles and public transport decarbonisation objectives</i>
Greece's National Recovery and Resilience Plan (NRRP)	<i>sustainable transport green infrastructure</i>
Thessaloniki Sustainable Urban Mobility Plan (SUMP)	<i>integrating land-use and transport planning with environmental objectives supporting innovation, data use</i>

Table 1. Summary of main regulatory documents and key elements for decarbonisation and circularity of public transport in Greece, Thessaloniki

2.6 Main findings

The analysis of the regulatory frameworks for decarbonisation and circularity in public transport across the E-MED target regions highlighted the following key elements:

- Regulatory frameworks across target regions are aligned with Recovery fund and main EU legislation;
- Funding for electrification and charging infrastructure is mainstream from national to local regulatory and planning frameworks;
- Public transport planning is strongly connected with energy and environmental goals;
- Public transport decarbonisation objectives are integrated in the planning process, in particular in SUMP and SUMP regulations;
- In some cases, the space for innovation testing is well defined, and regulatory sandboxes could be activated in the near future;
- Criticalities remain especially with innovations such as second life batteries and AI applications;
- There is a limited relevance of systemic approach (infrastructure, rolling stock, energy);
- Circularity is introduced also through methodologies such as LCA, but standards and common indicators must be defined;
- Green procurement: the role and incentive schemes to circularity should be improved;

- The time frames of service planning and awarding (service contracts) and infrastructure/rolling stock investment plans shall be improved, in order to allow PT operators to better embed innovation and investments in their long term strategies.

3 E-MED pilots in the current regulatory framework, gaps, barriers and opportunities

The E-Med pilot activities explore innovative fields where, in some cases, the existing framework might not be able to guarantee favorable regulatory conditions sometimes for the testing, but especially for the upscaling of sustainable, resource efficient and circular solutions.

Furthermore, the sometime incomplete regulatory frameworks may suggest a space for policy measures supporting the take up of the innovative solutions developed within the project.

The following paragraphs will summarise the main barriers and opportunities to be faced in the testing and scaling of the E-MED solutions, paving the way for policy recommendations fostering regulatory innovations.

3.1 Planning tools

3.1.1 [Bus route-layouts design \(toolkit\)](#), [Best powertrain identification \(toolkit\)](#), [Reliable bus control in electric bus \(toolkit\)](#)

The first toolkit aims at optimising route planning, vehicle allocation, and operational strategies to reduce energy consumption across the entire transit system.

The second toolkit focuses on identifying the best powertrain configurations for energy efficiency.

The third toolkit is developed to ensure a reliable bus control operation in electric routes.

<i>Developed/tested in:</i> Thessaloniki, Maribor, Lisbon, Bergamo (only powertrain)
<i>Gaps/barriers:</i> Mainly operational barriers, related to the need of balancing the network planning and the energy optimisation. The existing regulatory frameworks do not highlight relevant barriers for the testing nor the scaling up of the tools.
<i>Opportunities:</i> The tools could be embedded in planning and procurement processes, in order to drive efficiently the choices of technologies and infrastructure.

3.1.2 [Bus garage charging management \(toolkit\)](#), [Energy provision from tramways \(feasibility study\)](#), [Renewable energy generation at bus garage \(feasibility study\)](#)

The toolkit to optimise the placement, scheduling, and operation of charging stations to ensure minimal downtime and maximum energy efficiency.

Feasibility studies on energy provision from tramways and renewable energy generation at bus garages will be conducted in Lisbon and Bergamo, to explore sustainable energy solutions for public transportation infrastructure.

<i>Developed/tested in:</i> Barcelona, Lisbon, Bergamo
<i>Gaps/barriers:</i>

The existing regulatory frameworks do not highlight relevant barriers for the testing nor the scaling up of the tools.

The integration of modular elements such as storage, second life batteries and integration of depots in Renewable Energy Community (REC) might need legal validation.

Opportunities:

The toolkit could be embedded in planning and procurement processes, in order to drive efficiently the choices of technologies and infrastructure.

A systemic approach to planning and procurement integrating LCA elements across infrastructure, energy, rolling stock and re-use of batteries could be developed within the project to become an innovative policy instrument.

3.2 Operational tools

3.2.1 [Eco-driving, AI techniques and data analytics](#)

Eco-driving programs are designed to educate drivers on techniques that reduce fuel consumption and emissions, such as smooth acceleration, optimal speed maintenance, and regenerative braking. By fostering eco-friendly driving practices, these programs aim to enhance vehicle efficiency and reduce the environmental impact of public transportation.

The solution for bus energy consumption using advanced AI tools will analyse extensive data from vehicle sensors, GPS, and environmental conditions to optimize energy consumption. By providing real-time recommendations and long-term insights, these analytical tools will enable transit operators to make informed decisions, further enhancing energy efficiency and operational effectiveness.

Developed/tested in: Maribor, Lisbon (Eco-driving), Barcelona, Lisbon, Thessaloniki (AI)

Gaps/barriers:

The existing regulatory frameworks do not highlight relevant barriers for the testing nor the scaling up of the eco-driving concepts.

Concerning the AI applications, although there are no barriers for their testing, the lack of standard requirements might be a regulatory gap for their scaling up.

Opportunities:

By testing the potential impact of these innovations on operations, and assessing their saving potentials, the scaling up could produce a knowledge base for planning and investment decisions, as well as for regulatory innovations introducing assessment tools and indicators as standards.

3.3 Procurement guided tools

3.3.1 [Vehicle procurement](#)

This tool is represented by a comprehensive procurement methodology for fleet and infrastructure. This methodology incorporates lifecycle cost analysis and performance metrics to ensure that all acquisitions meet high standards of energy efficiency and sustainability.

Developed/tested in: Barcelona, Bergamo, Lisbon, Maribor, Thessaloniki

Gaps/barriers:

Although LCA is frequently mentioned as methodology for the assessment of environmental impact in procurement processes, the awarding criteria and relative relevance in the analysis of offers is often largely discretionary. In some cases, depending on the assessment methods and on the time horizon chosen, circularity might conflict with other economic and financial evaluations and therefore might not be fully applicable.

Opportunities:

The testing of the methodology in different environments will generate knowledge useful to elaborate a set of policy recommendations for the adaptation of the procurement framework, in order to integrate elements to better valorise circularity in the procurement process.

Another element to be considered is related to the blending between infrastructure, energy and rolling stock to maximise the systemic effects.

3.3.2 [Procure Local RE through PV installed on carport](#)

Procuring local renewable energy through PV installations on carports.

Developed/tested in: Lisbon, Maribor

Gaps/barriers:

The existing regulatory frameworks do not highlight relevant barriers for the testing nor the scaling up of this application.

The integration of modular elements such as storage, second life batteries and integration of depots in Renewable Energy Community (REC) might need legal validation.

Opportunities:

A systemic approach to planning and procurement integrating LCA elements across infrastructure, energy, rolling stock and re-use of batteries could be developed within the project to become an innovative policy instrument.

3.3.3 [Collection of rainwater to bus washing operations \(feasibility study\)](#)

A project integrating technical and architectural elements to collect rainwater for bus washing operations.

Developed/tested in: Lisbon, Maribor

Gaps/barriers:

The existing regulatory frameworks do not highlight relevant barriers for the testing nor the scaling up of this application.

Opportunities:

A concept of circular depot could be developed integrating different elements.

3.3.4 [Predictive maintenance of tyres](#)

Predictive maintenance to extend the life of tyres.

Developed/tested in: Barcelona, Lisbon, Maribor

Gaps/barriers:

The existing regulatory frameworks do not highlight relevant barriers for the testing nor the scaling up of this application.

Opportunities:

Extend circularity upstream in the supply chain through procurement, common standards could be proposed to integrate policy tools.

3.3.5 [Battery re-use \(Feasibility study\)](#)

Developed/tested in: Bergamo, Maribor, Thessaloniki

Gaps/barriers:

Specific regulations on safety must be taken into account prior to testing phase.

In the case of Bergamo the batteries will be removed in the depot; in other cases, regulation on transportation of second life batteries must be verified according to local rules.

In general, the adoption and implementation of the dispositions of the new battery regulation at EU level (including battery passport) must be completed to act as enabler.

Opportunities:

A systemic approach to planning and procurement integrating LCA elements across infrastructure, energy, rolling stock and re-use of batteries could be developed within the project to become an innovative policy instrument.

Conclusions: recommendations to accompany the evolution of pilot actions and scaling up of innovation in decarbonisation and circularity for Public Transport

The analysis highlighted several opportunities to better accompany decarbonisation process and the development and scaling up of experimental approaches and innovative solutions in Public Transport Infrastructure, Rolling Stock and integration of renewable energy sources.

The EU regulatory framework encompasses elements useful to integrate circularity along the path, but new assessment and valorisation methods must be developed and adopted on a broad scale to capture its value along the PT supply chain.

Circularity is fundamental not only for environmental and geopolitical reasons, but also to ensure long term sustainability to the investments put in place through the Resilience and Recovery Fund across Europe.

The analysis proposed in the present document brings to the formulation of four main recommendations for policy change:

1. **Set the ground for innovation:** the integration between transport, energy, infrastructure networks has become, through the large scale electrification process, a central challenge engaging a broad set of technologies, innovations and industries. To manage this complexity and sometime multidisciplinary, the development of experimental spaces such as **living testbeds** and **regulatory sandboxes** is fundamental; at the same time, successful proofs of concept must find markets ready for their upscaling and deployment, for which **promptly adaptive regulatory frameworks** are necessary.

2. **Promote and award systemic approaches:** a systemic approach to planning and procurement **integrating LCA elements across infrastructure, energy, rolling stock and re-use of batteries** could be developed within the project to become an innovative policy instrument.



3. Develop and promote innovative procurement schemes: procurement processes must be able to capture the value of generated benefits, internal and external, along the lifespan of investments; in order to allow that, procurement rules must be designed around assessment methodologies, standards and indicators focused on the **valorisation of the impact of circularity strategies and practices along the value chains**, to foster the transition.

4. Innovate the financing mechanisms, aligning investment cycles and service funding: the time frames of service planning and awarding (service contracts) and infrastructure/rolling stock investment plans shall be improved, in order to allow PT operators to **better embed innovation and investments in their long term strategies**.



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- Recovery and Resilience Plan (PRTR)
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- Catalan Energy and Climate Change Strategies (ProENCAT 2050 & PNIEC alignment)
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- Climate Plan & Green Public Procurement Strategy

Portugal, Lisbon Metropolitan Area:

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