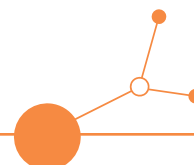


SUSTANCE

D.1.4.2 Transnational action plan for better cross-border public transport connectivity solutions



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1 Introduction

Within the SUSTANCE project, two Transnational Action Plans (TAPs) have been prepared as key strategic outputs, each addressing one of the SUSTANCE project's central thematic areas:

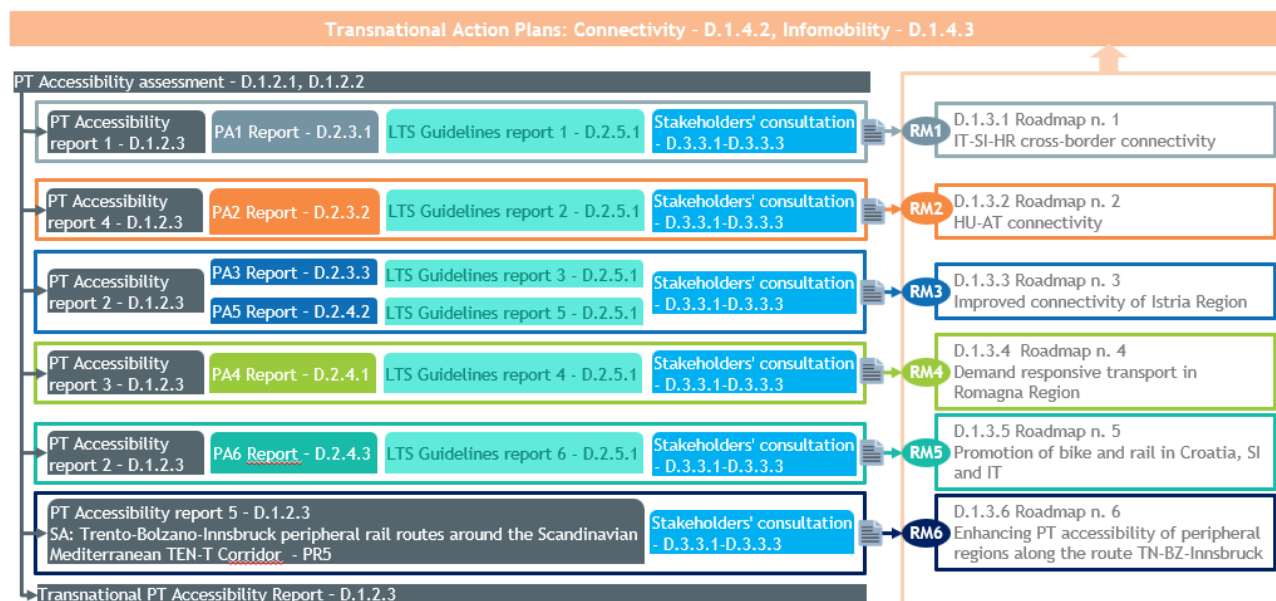
- Deliverable 1.4.2: Transnational Action Plan for Better Cross-Border Public Transport Connectivity,
- Deliverable 1.4.3: Transnational Action Plan for Better ICT Solutions for Public Transport.

Both Action Plans build on the strategic foundations established through the Roadmaps and translate them into a wider, transnational context. Their purpose is to support the improvement of public transport (PT) accessibility in peripheral, rural and cross-border areas of Central Europe by providing recommendations that go beyond individual SUSTANCE study areas and can be applied more broadly across the region.

1.1 Development approach

The TAPs build upon the knowledge gained through previous SUSTANCE activities of WP1 and are further refined through co-design processes and the exchange of outputs with WP2 and WP3. The overall development process is illustrated in Figure 1.

Figure 1: Diagram - process of elaboration of Transnational Action Plans



At the outset of the project, a transnational online conference (D.1.2.1) was organised on the methodological approach to accessibility assessment in rural, peripheral and cross-border areas. The event gathered experts and institutions working on innovative solutions for improving PT connectivity in sparsely populated and cross-border regions. During the conference, the innovative SUSTANCE methodology for PT accessibility assessment was presented and recognised as a promising and objective tool for numerical accessibility evaluation, as it effectively captures the challenges of low-demand, dispersed areas and supports regional mapping and prioritisation of development needs. Participants also highlighted the relevance of this approach within the wider context of evolving EU transport policy, particularly the ongoing revision of the TEN-T regulation, where the project contributes to identifying priority areas and strengthening the integration of fragmented networks.



Subsequent activities focused on developing the SUSTANCE PT accessibility methodology (D.1.2.2), which places particular emphasis on PT connectivity and PT infomobility. It is based on the Relative Network Efficiency (RNE) indicator, which compares actual and ideal PT performance while considering the opportunities available at destinations. The SUSTANCE methodology enables an assessment of the current situation (AS-IS) and an evaluation of the effects of proposed measures (TO-BE), helping users identify key factors and actions needed to improve PT accessibility in studied area. The methodology can be applied to different types of study areas (routes or regions), target groups (commuters or tourists), and types of opportunity indicators (ideal or alternative), allowing the analysis to be adapted to the specific context defined by the user. The entire methodology is available as a free online tool (<https://sustance.sz.si>), open to anyone involved in planning of PT measures.

The SUSTANCE methodology was tested on specific PT situations across the five SUSTANCE study areas (D.1.2.3)¹, as shown in Figure 2, and further validated through six pilot actions implemented under WP2 – three addressing connectivity (D.2.3.1², D.2.3.2³ and D.2.3.3⁴) and three focusing on infomobility (D.2.4.1⁵, D.2.4.2⁶ and D.2.4.3⁷). This approach provided valuable insights for the effective design and implementation of the pilot actions. The process of accessibility evaluation, together with the testing of the SUSTANCE methodology through the pilot actions, formed the foundation for defining long term sustainability guidelines for solutions in SUSTANCE pilot areas (D.2.5.1) and were consolidated in the six Roadmaps (D.1.3.1-D.1.3.6) to support the continuation of PT development beyond the end of the project.

Figure 2: Geographical scope of the SUSTANCE PT accessibility assessment study areas



¹ The test cases have applied different parameters of the SUSTANCE methodology, considering the specific characteristics of each area. Each test case focussed on distinct aspects of accessibility analysis, including area type, opportunity indicators, target groups and the applied PT improvement measures. The PT accessibility assessment included both the current state of PT accessibility for each study area (AS-IS analysis) and the changes resulting from the application of the improvement measures (TO-BE analysis).

² Pilot action n. 1: Cross- border train connection IT-SI-HR - Trieste V.O.-Divača-Pivka-Rijeka.

³ Pilot action n. 2: Cross- border train connection HU-AT - Neusiedl am See-Fertőszentmiklós- Sopron.

⁴ Pilot action n. 3: Feasibility analysis on train connections along the route Divača-Buzet-Pula.

⁵ Pilot action n. 4: New ICT booking service of DRT in RER: Rimini-Ravenna -Forlì.

⁶ Pilot action n. 5: New ICT service for MaaS in Istria.

⁷ Pilot action n. 6: New IT tool for bike and rail in HR and neighbouring regions in SI & IT.



The SUSTANCE methodology, the PT accessibility assessments in SUSTANCE study areas, the implementation of SUSTANCE pilot actions, the evaluation of outcomes, and the formulation of measures for uptake and transferability of PT connectivity and infomobility were developed in close cooperation with local stakeholders. Stakeholders were regularly informed and consulted of PT challenges, needs and potential measures through three official consultation meetings and ongoing exchanges (D.3.3.1, D.3.3.2 and D.3.3.3). Their input shaped all deliverables, particularly the vision, goals and measures in the Roadmaps, which underpin **Transnational Action Plans**. Associated partners also played an especially important role by sharing their perspectives on PT development and contributing significantly to shaping the Roadmaps.

The Transnational Action Plans build directly on the Roadmaps (D.1.3.1-D.1.3.6) by integrating and harmonising their findings across two thematic fields: PT connectivity and PT infomobility.

1.2 Transnational Action Plan on Connectivity

Transnational Action Plan on Connectivity (TAP Connectivity) focuses on measures that enhance public transport accessibility by improving network connectivity. Its purpose is to consolidate the key findings of the accessibility assessments, pilot actions and Roadmaps, and translate them into a coordinated strategic framework for strengthening PT connectivity across Central Europe. The Action Plan outlines the main challenges, goals and priority measures for improving cross-border and regional PT links, with particular emphasis on connectivity-related solutions.

2 Current State of PT Connectivity in SUSTANCE Study Areas

The assessment of PT connectivity across the four analysed SUSTANCE study areas—the cross-border railway corridor Trieste-Rijeka (SA1), the Istria Region (SA2), the Sopron-Bruck an der Leitha cross-border corridor (SA4), and the Trento-Bolzano-Innsbruck axis with its peripheral railway networks (SA5)—is presented in detail in the accessibility reports (D.1.2.3). The analysis revealed notable differences in public transport accessibility between the study areas. Some areas experience limited-service frequency and poor availability of travel information, while others benefit from more frequent, direct, and better-integrated PT services. Travel times also vary considerably, reflecting differing levels of network connectivity and coverage. Overall, SA4 and SA2 face the most significant accessibility challenges, whereas SA3 and SA5 exhibit comparatively better PT performance.

The implementation of pilot measures led to measurable improvements across all study areas. While individual measures did not dramatically change overall accessibility, they contributed to incremental gains, particularly in areas where targeted interventions addressed specific gaps such as service frequency, route directness, and information availability. Connectivity-focused measures showed improvements in route-based areas, while infomobility measures yielded noticeable benefits in regions where digital tools and journey planning were introduced.

The analysis also highlighted those different aspects of PT accessibility—such as rapidity, frequency, directness, information availability, and integration of information—show varying levels of performance and user importance across regions. Rapid and direct connections remain a challenge in most areas, while information availability and digital integration are better in regions with more developed systems.

The findings of the SUSTANCE accessibility analysis closely mirror the concerns raised by stakeholders across all study areas. Across all consultations, stakeholders consistently recognised that rural, peripheral and cross-border areas suffer from poor PT connectivity caused by low population density, fragmented governance and limited financial and technical resources. PT services are often irregular, insufficiently coordinated and difficult to integrate across borders due to regulatory differences, incompatible IT systems



and lack of harmonised tariffs. Digitalisation gaps—including unstandardised data, limited real-time information and non-integrated ticketing—further weaken the user experience and hinder planning. Financial sustainability remains a major challenge because many services depend on temporary EU funding and lack long-term public service obligation agreements that cover cross-border operations.

Stakeholders emphasised that user needs—especially those of elderly people, travellers with disabilities, tourists and cyclists—are not consistently met. Awareness of available services is low, marketing efforts are modest and multimodal connections are weak. Infrastructure constraints, such as insufficient bicycle capacity on trains, outdated rolling stock and accessibility problems at stations, add to these challenges. These shortcomings collectively undermine the attractiveness of PT and reinforce reliance on private cars.

To address these issues, stakeholders proposed improving timetable coordination, increasing service frequency, extending pilot durations and enhancing digital tools for journey planning, booking and cross-border ticketing. They stressed the need for harmonised data standards, shared governance structures and stable cross-border financing mechanisms. Strengthening cooperation between railway operators, ministries and regional authorities is seen as essential to achieving seamless services. Stakeholders also recommended targeted promotional campaigns, user feedback systems and investments in multimodal hubs, bike-sharing and first/last-mile connections.

Overall, the consultations revealed strong territorial demand for better-integrated, more accessible and sustainable mobility solutions. Pilot actions demonstrated clear potential, especially for tourism and regional cohesion, and stakeholders widely agreed that the approaches tested in SUSTANCE are replicable in other peripheral and cross-border areas. Long-term benefits are expected in the form of reduced emissions, improved accessibility, stronger economic links and greater social integration across regions.

3 Development of public transport accessibility through PT connectivity solutions

3.1 Identified challenges

The assessment of PT connectivity across the four analysed SUSTANCE study areas reveals a set of recurring structural weaknesses. Despite differences in geographical contexts and institutional frameworks, these areas share common challenges, presented in the table below, that constrain the effectiveness, attractiveness, and territorial cohesion potential of regional and cross-border PT systems, particularly in peripheral and less urbanised regions.

The PT challenges share common patterns and have similar implications for accessibility and territorial cohesion. The most critical issues do not stem from a single transport mode or infrastructure element, but rather from structural weaknesses in *connectivity performance*, *network integration* and *cross-border coordination*. These structural weaknesses can be categorised in four types:

- Operational shortcomings,
- Institutional and governance barriers,
- Technical and infrastructure constraints and
- Financial and organisational limitations.

The following table summarises the main challenges observed across the study areas. For each challenge presented in the table, the type of weakness is defined and accompanied by a brief description. The affected study areas are indicated where the challenge has been identified, along with the related issues observed in those areas and the ways in which the pilot action addressed the challenge.



Table 1: Common Structural Challenges of Public Transport Connectivity on the study areas

No	Challenge	Weakness type	Description	Affected Study Areas	Main issues	Impact of measures on PT accessibility
1.	Insufficient connectivity performance	Operational	Low service frequency, limited direct services and weak network integration, especially on cross-border and peripheral sections.	SA1, SA2, SA5	Longer travel times, reduced PT attractiveness, increased car dependency	- New train services (Trieste-Rijeka corridor) increased frequency and directness of connections. - Planned regional measures in Trento-Bolzano-Innsbruck enhance peripheral connectivity. - Targeted infrastructure upgrades support higher operational speeds. - PA1 & PA2 show low P2 (frequency) is main barrier; limited services reduce daily usability.
2.	Low accessibility in peripheral locations	Operational / Technical	Areas outside main transport corridors and urban centres exhibit significantly lower accessibility levels.	SA1, SA2, SA5	Territorial exclusion, reduced access to services, jobs and education	- Multimodal solutions (micromobility hubs in Istria, on-demand services in Tyrol) improve last-mile accessibility. - Feasibility studies guide targeted infrastructure investments in peripheral corridors. - PA2 & PA3 highlight low multimodal integration and weak last-mile links as persistent barriers.
3.	Low competitiveness of rail services	Operational / Technical	Rail transport suffers from low commercial speeds, infrequent services and indirect routings compared to road-based modes.	SA1, SA2, SA5	Modal shift towards private cars, underutilisation of rail infrastructure	- Pilots demonstrate that new or modernised rail links can improve competitiveness. - Plans of electrification and rolling stock upgrade to enhance average speed, frequency and reliability.



No	Challenge	Weakness type	Description	Affected Study Areas	Main issues	Impact of measures on PT accessibility
						- PA1 & PA2 show that even improved directness does not fully overcome travel time disadvantages.
4.	Missing or discontinuous PT services and infrastructure links	Technical / Institutional	Absence of key railway network or missing PT services along strategic corridors creates structural bottlenecks.	SA1, SA2	Fragmented cross-border connectivity, missing railway link alignments that could efficiently connect urban centres to the main line due to difficult terrain	- Direct cross-border rail service established between Trieste-Rijeka. - Feasibility studies for Divača-Buzet-Pula identify infrastructure gaps and priority investments. - Inefficient (missing) railway infrastructure links limit the benefits of direct transport services.
5.	Weak cross-border coordination	Institutional / Operational	Limited institutional coordination, poorly synchronised timetables and scarce cross-border services.	SA1, SA2, SA5	Increased interchanges, unreliable journeys, reduced system coherence	- Pilot services highlight need for timetable integration and cross-border interoperability. - Stakeholders' engagement supports coordinated planning across Italy, Slovenia, Croatia, Austria, and Hungary. - Institutional and PSO fragmentation limits scalability and long-term sustainability.
6.	Low level of multimodal integration	Operational / Technical	Inadequate coordination between rail and bus services and poorly aligned arrivals and departures.	SA2, partly SA1	Poor user experience, limited PT usability without combining it with private vehicles	- Installation of micromobility hubs and integration with bus services. - MaaS platform (Mobility Plus) provides unified multimodal journey planning and ticketing. - Low multimodal integration still limits accessibility for peripheral users.



No	Challenge	Weakness type	Description	Affected Study Areas	Main issues	Impact of measures on PT accessibility
7.	Infrastructure and topographical constraints	Technical	Orographic conditions and outdated railway alignments (routes) constrain speed, capacity and reliability.	SA1, SA5	Structural limitations to service improvements without major investments	- Planned upgrades (electrification, bypasses, rolling stock renewal) aim to overcome physical constraints. - Greater efficiency requires not only soft measures but also prioritising cost-effective infrastructure interventions. - Rapidity remains weak, where topography and infrastructure limit operational improvements..
8.	Deficiencies in infomobility systems	Operational / Technical	Fragmented passenger information, lack of unified digital platforms and weak support for multimodal journey planning.	SA2 (strongly), partly SA1	User uncertainty, particularly for tourists; reduced PT uptake	- MaaS platform and integrated info-mobility tools improve accessibility and transparency. - Pilots (PA4-PA6) show digital tools enhance user experience (P4, P5) but cannot replace core service availability.
9.	Disadvantaged accessibility of peripheral lines	Operational / Institutional	High accessibility is concentrated along main axes, while peripheral lines remain significantly disadvantaged.	SA5	Intra-regional inequalities, constrained development of peripheral areas	- Planned measures (mobility hubs, on-demand services, multimodal integration) improve accessibility of peripheral lines. - Good links between peripheral nodes and main corridors can improve connectivity on peripheral lines. - Persistent territorial inequalities remain unless cross-border planning and institutional support are strengthened.



The structural weaknesses observed manifest in recurring challenges that affect the effectiveness, reliability, and overall attractiveness of regional and cross-border PT. Operational limitations—such as low service frequency, long travel times, and fragmented networks—reduce the competitiveness of PT relative to private cars and constrain usability of PT, particularly in peripheral regions.

Institutional and governance gaps, including limited cross-border coordination and unstable PSO frameworks, hinder the scaling of successful interventions and the integration of cross-border services into regular operations. Technical and infrastructure constraints, together with insufficient multimodal integration and incomplete passenger information systems, further limit accessibility and last-mile connectivity. Financial and organisational barriers compound these issues, preventing sustainable and long-term improvements.

As a result, regional and cross-border PT systems often struggle to operate as coherent networks rather than fragmented services. Addressing these challenges requires integrated interventions combining operational, institutional, technical, and digital measures. Evidence from the SUSTANCE pilots demonstrates that both low-cost, quick-win measures and strategic long-term investments are necessary to ensure equitable accessibility, enhance territorial cohesion, and provide viable alternatives to private car use.

3.2 Development goals

The assessment of public transport (PT) connectivity across the analysed study areas—Trieste-Rijeka (SA1), Istria (SA2), Sopron-Bruck (SA4), and Trento-Bolzano-Innsbruck (SA5)—has highlighted recurring structural weaknesses that constrain accessibility, attractiveness, and territorial cohesion. These challenges, stemming from operational, institutional, technical, and financial limitations, require a strategic approach to enable both short-term improvements and long-term system-level development.

Building on the lessons learned from the pilot activities and analyses of PT accessibility before and after the implementation that were conducted within the SUSTANCE project, the transnational development goals aim to:

- Ensure **equitable accessibility** for cross-border and peripheral areas,
- Increase the **competitiveness of PT** relative to private cars,
- Strengthen **institutional and operational coordination** across regions and borders,
- Promote **cost-effective interventions** in the short to medium term and
- Support **long-term structural investments** aligned with EU transport and sustainability policies.

Table 2: Development goals

No	Goal	Focus	Short-term & Long-term Objectives
G1	Increase operational & organisational capacity of PT at cross-border and peripheral areas	Accessibility as a broader target rather than just mobility	Short-term: Improve existing transport links & services on peripheral and cross-border routes and implement low-cost quick-win measures
			Long-term: Achieve comparable accessibility standards across central and peripheral areas and fully integrated multimodal network
G2	Enhance competitiveness of	Faster, more frequent, and more direct connections	Short-term: Increase service frequency; reduce travel times; optimize timetable integration



No	Goal	Focus	Short-term & Long-term Objectives
	PT compared to private cars		Long-term: Long-term infrastructure upgrades; maintain reliable, high-speed services to encourage modal shift
G3	Reduce fragmentation of cross-border PT systems	Integration of services, timetables, and PSO frameworks	Short-term: Establish cross-border coordination mechanisms and align operational rules
			Long-term: Fully harmonize cross-border PT systems with stable governance and interoperable PSO frameworks
G4	Promote cost-effective improvements with low- and medium-cost investments	Operational and organizational measures	Short-term: Conduct pilot actions with quick-win measures such as timetable optimization, temporary PSO agreements, digital info integration
			Long-term: Scale up effective interventions sustainably and replicate best practices across regions
G5	Support long-term structural investments	Targeted infrastructure upgrades	Short-term: Prepare technical documentation and funding applications
			Long-term: Modernize infrastructure, acquire low-carbon rolling stock, ensure interoperability and long-term stability

3.3 Proposed measures

The strategic development goals for enhancing PT accessibility and cross-border connectivity in transnational areas build on analyses of PT accessibility and lessons learned from SUSTANCE pilot actions, addressing recurring challenges such as low service frequency, fragmented networks, limited multimodal integration, and institutional barriers.

To enhance connectivity effectively, interventions should be coordinated across national and regional levels, combining operational, technical, institutional, and digital measures. Short-term actions should focus on low-cost, quick-win improvements, while long-term measures aim at structural upgrades, sustainable governance, and fully integrated multimodal networks. EU support can play a crucial role in overcoming institutional constraints, providing funding incentives, harmonizing digital solutions, and facilitating cross-border coordination.

The following tables outline each strategic goal with recommended measures, providing a roadmap to enhance regional and cross-border PT accessibility.



Table 3: Recommended Measures to Achieve Goal 1

Goal 1	Increase operational & organisational capacity of PT at cross-border and peripheral areas
Measures	- M1: Establish cross-border working group (coordination and joint planning) - M2: Upgrade peripheral PT services (increase frequency, improve timetable integration) - M3: Integrate multimodal options and data (bus, micromobility, P&R)
Effects	- Improved service coverage and accessibility for residents in peripheral areas - Reduced travel times and waiting times - Higher PT ridership and better cross-border connectivity - Enhanced cross-border connectivity and coordinated planning
Stakeholders	- PT operators - National & regional PT Authorities - Local authorities / Municipalities
EU Role	- EU Funding & coordination support for cross-border initiative - EU Best-practice guidance - EU Provision of guidelines for cross-border coordination

Table 4: Recommended Measures to Achieve Goal 2

Goal 2	Enhance competitiveness of PT vs. private cars
Measures	- M4: Modernize key lines and rolling stock (improve speed and comfort) - M5: Implement timetable harmonization and direct connections - M6: Promote PT as attractive alternative to car travel
Effects	- Increased attractiveness and reliability of PT services - Modal shift from private cars to PT - Reduced congestion and emissions - Increased uptake by tourists and seasonal users
Stakeholders	- PT operators - Infrastructure managers - National / regional PT authorities
EU Role	- EU Funding support - EU Operational guidelines for modal shift



Table 5: Recommended Measures to Achieve Goal 3

Goal 3	Reduce fragmentation of cross-border PT systems
Measures	- M7: Align PSO contracts across borders - M8: Standardize ticketing and info-mobility - M9: Integrate digital information platforms and apps - M10: Develop interoperable reservation and ticketing solutions
Effects	- Seamless cross-border travel experience - Simplified ticketing and passenger information - Improved operational coordination between operators - Enhanced multimodal journey planning
Stakeholders	- EU agencies - National & regional PT authorities - Regional stakeholders
EU Role	- EU Policy frameworks - EU Technical guidance - EU Funding support for interoperability projects

Table 6: Recommended Measures to Achieve Goal 4

Goal 4	Promote cost-effective improvements with low- and medium-cost investments
Measures	- M11: Digital info tools and apps for ticketing and info-mobility - M12: Staff training and operational coordination - M13: Small-scale intermodal and micromobility infrastructure upgrades
Effects	- Quick service quality improvements with limited investment - Increased operational efficiency - Higher ridership among tourists and occasional travellers - Strengthened first- and last-mile connectivity
Stakeholders	- PT operators, - National & regional PT authorities, - Local authorities /municipalities
EU Role	EU Funding support for interoperability projects pilot cross-border innovations, operational tools



Table 7: Recommended Measures to Achieve Goal 5

Objective 5	Support long-term infrastructural investments
Measures	- M14: Infrastructure modernization (stations, tracks, bridges) - M15: Procurement of hybrid/battery rolling stock - M16: Upgrading signalling and interoperability systems - M17: Align regulatory and operational procedures across borders
Effects	- Increased system capacity and reliability - Reduced maintenance costs over time - Long-term resilience of the PT network - Improved cross-border interoperability and coordinated service planning
Stakeholders	- Infrastructure managers, - National / regional PT authorities, - PT operators,
EU Role	- EU Policy frameworks, - EU Technical guidance, - EU Funding support for infrastructure and low-carbon vehicles

Disclaimer

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