



ASSESSING THE POTENTIAL OF ELECTRIC MOBILITY FOR LOW CARBON TRANSIT TOURISM: EVIDENCE FROM THE BELGRADE-ZLATIBOR CORRIDOR

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Abstract:

Transit tourism in mountainous regions generates a considerable carbon footprint due to the dominant use of internal combustion vehicles, particularly along intensively used routes such as the Belgrade-Zlatibor corridor. Although electric mobility offers the potential to reduce transport-related emissions, its relevance for Serbia's transit tourism has not been systematically examined. This study addresses this gap by integrating an assessment of the existing charging infrastructure, an on-site survey of travelers conducted on Zlatibor (N=500), and a comparison of electric and conventional vehicles using established life cycle assessment (LCA) data. The aim is to evaluate the extent to which electric mobility can support a transition toward lower-carbon transit tourism along this corridor. The findings show that adventure- and nature-based activities represent the primary motivation for travel, increasing the importance of sustainable transport solutions in environmentally sensitive mountain destinations. Survey results further indicate that more than half of respondents would be willing to use electric vehicles if the charging infrastructure were more accessible and spatially distributed along the route. In line with international evidence, established LCA data consistently show significantly lower life-cycle CO₂ emissions for electric vehicles relative to conventional vehicles, depending on the energy mix and vehicle segment. Overall, the study highlights electric mobility as a feasible pathway for reducing transit-tourism-related emissions and strengthening destination sustainability planning.

Keywords:

low-carbon transport; sustainable mobility; electric vehicle infrastructure.

JEL Classification:

O33, Z32

INTRODUCTION

Transit tourism represents a growing component of mobility-driven travel across Europe, yet its environmental footprint remains a major challenge, particularly in regions where transport relies almost exclusively on conventional fossil-fuel vehicles. Transport-related emissions account for a substantial share of tourism's global carbon footprint, and recent assessments indicate that mobility is responsible for most of the sector's greenhouse gas (GHG) output (Lenzen *et al.*, 2018; Cadarso *et al.*, 2016).

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In countries such as Serbia, where road transport dominates domestic tourist flows, the environmental pressure is especially pronounced along major tourist corridors. The Belgrade-Zlatibor route, one of the country's busiest recreational and transit routes, illustrates these challenges, as increasing visitor numbers coincide with rising transport emissions, local air-quality concerns, and congestion during peak seasons.

Electric mobility has emerged as a central mechanism for decarbonizing short- and medium-distance travel, offering a practical pathway for reducing emissions, noise, and local pollutants in tourism-dependent regions (Hawkins *et al.*, 2013; Gössling *et al.*, 2023). Life-cycle assessment studies consistently show that battery electric vehicles generate significantly lower total CO₂ emissions than internal combustion engine vehicles, depending on the electricity mix and vehicle segment. As European mobility policies accelerate the shift toward low-emission transport solutions (European Commission, 2016; 2018; 2020), integrating electric vehicles (EVs) into tourism systems becomes increasingly relevant for strengthening sustainability, competitiveness, and regional development (Gibbins *et al.*, 2007).

Despite this growing relevance, the application of electric mobility in transit tourism remains understudied in Southeast Europe. Previous research has predominantly focused on environmental benefits, technological performance, and visitor preferences in Western European Mountain destinations (Scuttari & Isetti, 2019; Gühnemann *et al.*, 2021), while little is known about how electric mobility can be operationalized within tourism corridors in emerging markets. In Serbia, although policy documents acknowledge the strategic importance of sustainable tourism and low-carbon transport, empirical evidence on the feasibility, infrastructure requirements, and behavioral drivers of EV use in tourism is still limited. More importantly, no prior study has examined the Belgrade-Zlatibor corridor as a potential low-carbon tourism route, nor has it quantified visitor attitudes or infrastructural constraints in this context.

This lack of systematic evidence creates a critical gap in understanding the economic, environmental and behavioral dimensions of integrating EVs into national tourism routes. Transit tourism along the Belgrade-Zlatibor axis combines several elements that make the corridor an ideal case study: high annual visitor loads, strong links to nature-based and adventure tourism, and a geographically diverse landscape with varying infrastructure quality. The corridor also connects two major tourism hubs, enabling the assessment of EV implementation not only as a climate-mitigation strategy but also as an instrument for improving destination accessibility and stimulating sustainable tourism demand.

Addressing this gap, the present study evaluates the potential of electric mobility to reduce transport-related carbon emissions and enhance sustainable transit tourism along the Belgrade-Zlatibor route. The research integrates spatial analysis of EV charging infrastructure, life-cycle-based emission estimates, and primary survey data collected from 500 visitors across three data-collection waves in 2025. This mixed-method approach allows for a comprehensive assessment of infrastructural readiness, visitor preferences, behavioral intentions, and environmental impacts. By combining technical, economic, and perceptual dimensions, the study provides a richer understanding of how electric mobility can function as a catalyst for low-carbon tourism development in Southeast Europe.

The contribution of this paper is threefold. First, it provides the first empirical analysis of the viability of an EV-based transit tourism model in Serbia, grounded in infrastructure assessment and tourist behavior. Second, it quantifies potential reductions in transport emissions when substituting conventional vehicles with EVs along a specific, high-traffic tourism route. Third, it offers policy-relevant insights for designing low-carbon tourism corridors, integrating transport planning, tourism development, and environmental objectives. These findings are pertinent for national and regional decision-makers seeking to align tourism growth with climate-mitigation commitments under the European Green Deal (European Green Deal, 2019) and Sustainable Development Goal 13.



MATERIALS AND METHODS

Data sources and study area

The analysis focuses on the Belgrade-Zlatibor transit corridor, a 230 km route that connects Serbia's capital with one of its most visited mountain destinations. Several complementary datasets were used to evaluate the potential for integrating electric mobility into transit tourism along this corridor.

First, transport and infrastructure data were compiled from official road maps, public spatial datasets, and operator databases on electric vehicle (EV) charging stations. These data include road segments, distances, approximate travel times, charger locations, charger types (AC/DC), nominal power (kW), operator information, and availability at key tourist nodes. Table 1 summarizes the main road segments between Belgrade and Zlatibor, while Figure 1 presents the conceptual research framework linking EV infrastructure, energy consumption, and tourism mobility.

Figure 1. Research Framework of the Study – Links between EV Infrastructure, Energy Consumption and Sustainable Tourism

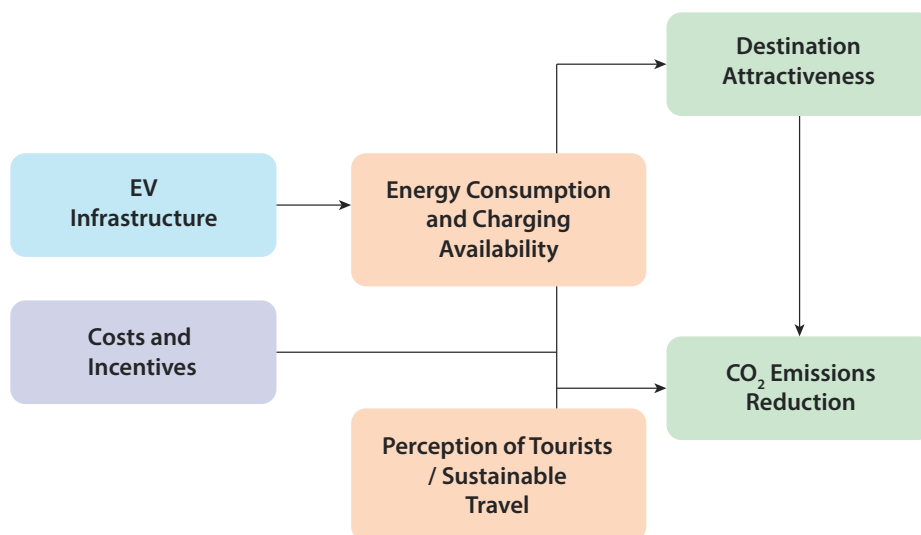


Table 1. Sections and Approximate Travel Times (Belgrade–Zlatibor)

Section	Distance (km)	Travel Time (min)
Beograd → Ljig/Rajac	78	55
Ljig/Rajac → Preljina/Čačak	38	30
Preljina/Čačak → Ovčar Banja/Kablar	18	20
Ovčar Banja/Kablar → Požega	32	30
Požega → Užice	25	25
Užice → Zlatibor	25	30

Source: Author's processing based on data from the Public Enterprise "Putevi Srbije" (2025)



Second, EV uptake and policy data were collected from national and European sources, including statistics on EV adoption, charging-network development, and incentive schemes relevant for sustainable mobility and tourism. These data were used to contextualize infrastructural readiness and interpret potential emission reductions.

Third, tourism statistics were obtained to describe tourist flows between Belgrade and Zlatibor and to evaluate the potential impact of low-carbon mobility on visitor behavior. These include annual visitor numbers, seasonal variations, and activities associated with nature- and adventure-based tourism.

Survey design and sampling

To complement the infrastructural assessment, a primary survey was conducted to examine visitors' perceptions, environmental attitudes, and behavioral intentions related to EV-based tourism mobility.

Data were collected in three waves during 2025 (January, April, and June) at major visitor locations in Zlatibor, including the central tourist zone, bus station, parking areas, fuel stations, hotel districts, and the tourist information center. A total of 500 respondents participated in the survey. A stratified purposive sampling strategy was applied to ensure adequate representation across visitor types and trip purposes. The final sample consisted of: 52% overnight visitors, 28% transit travelers, 20% day visitors.

The demographic composition included 53% female and 47% male respondents, with an average age of 37.4 years ($SD = 9.8$). Approximately 70% were domestic visitors, and 30% international tourists.

The structured questionnaire contained 21 items divided into four thematic sections:

(1) sociodemographic characteristics, (2) awareness and attitudes toward electric mobility, (3) willingness to use EVs and familiarity with charging infrastructure, (4) perceived environmental benefits and barriers to EV-supported tourism. The survey instrument was structured to capture four key analytical dimensions relevant for EV-supported transit tourism: socio-demographic characteristics, travel frequency and transport choice criteria, environmental attitudes toward sustainable mobility, and behavioral intentions related to the use of electric vehicles in tourism contexts. Several items allowed multiple responses in order to better reflect real-world travel decision processes.

The questionnaire combined ordinal response formats conceptually comparable to Likert-type scaling (e.g., graded importance or attitudinal agreement levels), binary choice items, and multiple-response questions aimed at capturing travel behavior and environmental preferences.

This mixed measurement design enabled the assessment of behavioral intentions and perceived barriers without imposing scale fatigue on respondents in an on-site tourism survey context.

Qualitative data

Semi-structured stakeholder interviews were conducted during the empirical research period in 2025 in order to contextualize survey findings and provide qualitative insight into infrastructural readiness and institutional attitudes toward the integration of electric mobility into tourism services along the corridor.

The interviews involved tourism operators, eco-accommodation providers, and representatives of local governance structures.

Their primary purpose was to identify perceived infrastructural constraints, investment readiness, and broader feasibility considerations related to EV-supported tourism mobility. Qualitative insights were used to complement and interpret behavioral patterns observed in the visitor survey.



In addition, official tourism development strategies, mobility plans, and environmental reports were reviewed to provide institutional context and policy alignment for low-carbon tourism transition.

Official tourism development strategies, mobility plans and environmental reports were reviewed to contextualize institutional priorities and policy alignment with low-carbon tourism objectives.

Analytical approach

A mixed-methods design was applied, integrating spatial, quantitative and qualitative procedures to assess the feasibility and environmental impact of EV-supported transit tourism.

Spatial analysis

Spatial datasets on the charging network were analyzed to identify the geographic distribution of chargers, gaps between stations, accessibility of charging points near adventure tourism sites, and average distances relative to European AFIR recommendations for EV corridors. Mapping outputs were used to evaluate the operational readiness of the corridor for EV travel and to pinpoint critical infrastructure gaps.

Carbon footprint estimations were conducted through emission comparisons between EV and internal combustion engine (ICE) vehicles were computed using established life-cycle emission factors from European sources. The analysis estimates potential CO₂ reductions for a 230 km trip under typical driving conditions, incorporating both direct energy-use and electricity-mix factors. (EEA, 2018; Sun *et al.*, 2020)

Scenario modelling was applied to compare ICE vehicles using fossil fuels and EVs with mid-range (45–60 kWh) batteries, charging under average regional electricity-mix assumptions.

Emission calculations were based on representative mid-segment passenger electric vehicles with battery capacity between 45 and 60 kWh and average energy consumption of approximately 16–18 kWh per 100 km. Under average Serbian electricity-mix assumptions, EV travel emissions were estimated at approximately 70–90 g CO₂ per km, depending on driving conditions and variability in energy consumption. For conventional vehicles, an emission intensity of approximately 150 g CO₂ per km was assumed, corresponding to typical fuel consumption of 6–7 liters per 100 km.

RESULTS AND DISCUSSION

Availability and spatial distribution of EV charging infrastructure

Spatial analysis of the Belgrade–Zlatibor corridor reveals a highly uneven distribution of EV charging stations. While fast and semi-fast chargers are available in Belgrade, Užice and Zlatibor, large infrastructural gaps exist along intermediary highway segments, particularly between Čačak and Užice. The average distance between functional chargers (≈ 110 km) significantly exceeds the recommended EU AFIR (AFIR, 2023) threshold of ≤ 60 km for tourist and transit corridors.

This infrastructural imbalance presents a major constraint for the adoption of electric mobility in transit tourism. The findings indicate that insufficient intermediate charging infrastructure remains a key barrier to long-distance EV travel, consistent with international evidence (Scuttari & Isetti, 2019; Gühnemann *et al.*, 2021a; Sierzchula *et al.*, 2014).



However, technical modelling based on typical 45–60 kWh EV batteries shows that one strategic DC fast-charging stop (e.g., near Čačak or Užice) is sufficient to complete the full route, indicating that the corridor is energetically feasible, but not yet infrastructurally optimized.

These results underscore the need for targeted investment in missing segments to support low-carbon tourism mobility.

Estimated carbon footprint reductions

Using life-cycle emission factors (ICCT 2021; EEA 2022), substituting conventional internal combustion engine (ICE) vehicles (≈ 150 g CO₂/km) with electric vehicles EV travel emissions were estimated at approximately 70–90 g CO₂/km under current electricity-mix conditions) results in an estimated reduction of 20–30 kg CO₂ per single trip along the 230 km corridor. This corresponds to a 25–40% decrease in total travel-related emissions, depending on vehicle type and electricity source.

These findings confirm the decarbonisation potential of EV mobility observed in previous LCA-based studies (Hawkins *et al.*, 2013; ICCT, 2021). In the context of transit tourism, where transport dominates total emissions (Lenzen *et al.*, 2018; Cadarso *et al.*, 2016), this reduction represents a meaningful contribution to low-carbon destination development.

The findings support the classification of the Belgrade-Zlatibor route as a high-impact corridor, where electrification can substantially improve environmental performance without compromising accessibility.

Visitor attitudes and behavioral intentions

Survey data ($n = 500$) indicate strong tourist readiness to adopt EV-based mobility in transit and destination-level travel:

- 63% of respondents prefer environmentally friendly transport options.
- 52% report that EV transport between Belgrade and Zlatibor would increase their likelihood of choosing the route.
- The most frequently cited motivators include sustainable tourism promotion (29%), environmental concern (28%), and reduced energy costs (22%).

Adventure tourism preferences further reinforce this trend. A large share of respondents selected hiking, nature visitation and active outdoor experiences as preferred activities, signaling compatibility between EV mobility, and nature-oriented adventure tourism.

The demographic characteristics of the sample (younger average age, strong domestic participation, multi-seasonal patterns) suggest a stable market segment that is likely to support future low-carbon tourism initiatives.

These behavioral results echo patterns observed in Western European alpine destinations, where EV mobility has proven effective in attracting environmentally conscious visitors (Scuttari & Isetti, 2019; Meyer-Cech & Probstl, 2006; Ajzen, 1991).



Stakeholder perspectives and institutional readiness

Qualitative evidence from interviews with local tourism operators, eco-accommodation owners, and municipal representatives highlights several structural challenges:

- limited availability of charging infrastructure outside urban nodes,
- insufficient technical capacity for EV maintenance in rural areas,
- lack of coordinated regional planning for low-carbon tourism mobility,
- modest awareness of EV-related benefits among smaller tourism providers.

Despite these barriers, stakeholders express positive attitudes toward electrification, citing opportunities for destination differentiation, improved visitor experience, and alignment with global sustainability trends.

This indicates a favorable institutional climate, but one that requires strategic planning, public–private cooperation and targeted financial support (Institut za ekonomske nauke, 2022).

Implications for sustainable and adventure tourism development

Findings demonstrate substantial synergies between electric mobility and adventure tourism:

- EVs enable low-impact access to hiking routes, viewpoints, and natural attractions.
- Reducing noise and air pollution improves visitor experience in sensitive landscapes.
- Charging locations positioned near trailheads, parks, or eco-lodges could strengthen the tourism product.

Similar EV-supported tourism models implemented in Alpine destinations have demonstrated measurable emission reductions and improved destination sustainability performance (Gühnemann *et al.*, 2021; Isetti *et al.*, 2020; Hall, 2019).

For Zlatibor and western Serbia, integrating EV mobility into adventure and nature-based tourism could support:

- diversification of tourism products,
- year-round visitation,
- reduced pressure on protected areas,
- increased competitiveness in the regional market.



Policy implications for low-carbon transit tourism

The combined results generate several key implications:

- (1) Strategic infrastructure investment - Adding DC fast chargers at one or two missing segments (Ljig–Preljina; Čačak–Užice) would close the infrastructural gap and align the corridor with EU AFIR standards.
- (2) Public–private partnerships (PPP) - Destination management organizations, local governments, and private operators (hotels, ski resorts, attractions) should cooperate to co-finance chargers at high-demand nodes.
- (3) Integration into tourism development plans - EV corridors should be included in regional spatial plans, adventure tourism strategies, and marketing platforms as “green routes”.
- (4) Targeted incentives - Subsidies for accommodation providers installing chargers and communicating environmental benefits and the convenience of EV travel can jointly accelerate EV adoption among tourism providers and visitors. These recommendations correspond with European best practices (UNWTO 2022; EC 2020) and are aligned with Serbia’s tourism development goals (Vlada Republike Srbije, 2016).

Synthesis of findings

Overall, the results demonstrate that the Belgrade–Zlatibor corridor is a promising candidate for low-carbon transition through EV integration.

The feasibility analysis, behavioral data, and stakeholder perspectives converge on three main conclusions:

1. Environmental impact - EVs can substantially reduce transport-related emissions in one of Serbia’s most intensively used tourism corridors.
2. Market readiness - Tourists exhibit a high willingness to adopt EV-based mobility, particularly those oriented towards adventure and nature tourism.
3. Infrastructural gap - The corridor requires relatively modest but strategically placed infrastructure upgrades to operate as a functional EV tourism route.

These findings highlight the potential of electric mobility to act as a catalyst for sustainable tourism, regional development, and climate policy alignment in Southeast Europe.



CONCLUSION

This study examined the feasibility and potential benefits of integrating electric mobility into the Belgrade–Zlatibor transit corridor, one of Serbia’s most intensively used tourism routes. By combining spatial analysis, life-cycle-based emission estimates, and primary data collected from 500 visitors, the research provides the first empirical evidence on the environmental, infrastructural, and behavioral dimensions of EV-supported transit tourism in the country.

The findings demonstrate that substituting internal combustion engine vehicles with electric vehicles could reduce route-specific transport emissions by approximately 25–40% (20–30 kg CO₂ per trip), confirming that significant decarbonization gains can be achieved even under the current electricity-mix conditions. Visitor data further indicate a strong market foundation for low-carbon travel: more than half of surveyed tourists expressed willingness to adopt EV mobility, and environmentally conscious behavior is particularly pronounced among adventure-oriented visitors.

However, the study also identifies major infrastructural constraints. The spatial distribution of charging stations is highly uneven, with pronounced gaps between Čačak and Užice that hinder the operational reliability of EV travel along the corridor. Addressing these deficiencies through targeted investment and public–private cooperation is essential for enabling a functional and attractive EV-based tourism model.

Overall, the results highlight three core contributions. First, the corridor is environmentally promising and can meaningfully reduce tourism-related emissions with relatively modest infrastructural upgrades. Second, the behavioral readiness of tourists indicates strong potential demand for low-carbon mobility solutions. Third, the study provides actionable policy insights for developing EV-supported tourism corridors in Southeast Europe, including alignment with the European Green Deal and national sustainable tourism strategies.

Future research should incorporate detailed charging-demand modelling, analyze life-cycle emissions under evolving electricity-mix scenarios, and explore socio-economic effects of scaling EV infrastructure across multiple tourism regions. Strengthening these analytical dimensions will further support evidence-based policymaking for low-carbon tourism development.

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PROCENA POTENCIJALA KORIŠĆENJA ELEKTRIČNIH VOZILA ZA NISKOUGLJENIČNI TRANZITNI TURIZAM: SLUČAJ KORIDORA BEOGRAD-ZLATIBOR

Rezime:

Tranzitni turizam u planinskim regionima generiše značajan ugljeni otisak zbog dominantne upotrebe vozila sa unutrašnjim sagorevanjem, posebno duž intenzivno korišćenih ruta, kao što je koridor Beograd-Zlatibor. Iako korišćenje električnih vozila nudi potencijal za smanjenje emisija povezanih sa transportom, njen značaj za tranzitni turizam u Srbiji nije sistematski ispitan. Ova studija popunjava ovaj nedostatak integrisanjem procene postojeće infrastrukture za punjenje, ankete putnika sprovedene na Zlatiboru (N=500) i poređenja električnih i konvencionalnih vozila koristeći utvrđene podatke o proceni životnog ciklusa (LCA). Cilj je proceniti u kojoj meri električna mobilnost može podržati prelazak na tranzitni turizam sa nižom emisijom ugljenika duž ovog koridora. Rezultati pokazuju da aktivnosti zasnovane na avanturama i prirodi predstavljaju primarnu motivaciju za putovanje, povećavajući značaj održivih transportnih rešenja u ekološki osetljivim planinskim destinacijama. Rezultati ankete dodatno ukazuju na to da bi više od polovine ispitanika bilo spremno da koristi električna vozila, ako bi infrastruktura za punjenje bila pristupačnija i prostorno raspoređena duž čitave rute. U skladu sa međunarodnim dokazima, utvrđeni podaci o proceni životnog ciklusa dosledno pokazuju znatno niže emisije CO₂ tokom životnog ciklusa električnih vozila u odnosu na konvencionalna vozila, u zavisnosti od energetske miksa i segmenta vozila. Generalno, studija ističe električnu mobilnost kao izvodljiv način za smanjenje emisija povezanih sa tranzitnim turizmom i jačanje planiranja održivosti destinacije.

Ključne reči:

niskougljenični transport;
održiva mobilnost;
infrastruktura električnih vozila.

JEL klasifikacija:

O33, Z 32