E-MOBILITY in road transport – Different transport modes: stock, strategies, policies

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Abstract—Electrification of road transport is central to the European Union's decarbonisation agenda, yet progress varies widely across Member States and vehicle segments. This paper compares the current status and near-term outlook of e-mobility in Austria, the Czech Republic and the EU-27 at large, focusing on three pillars: *(i)* electric-vehicle (EV) stock by transport mode, *(ii)* public charging infrastructure density, and *(iii)* policy instruments driving adoption. Using 2023–2024 vehicle registration data, infrastructure inventories and 28 national and EU policy documents, we conduct a mixed-method analysis combining quantitative indicators (e.g. BEV stock, charger-to-vehicle ratios) with qualitative assessment of incentive frameworks.

Results show that Austria leads in absolute penetration, surpassing 183000 battery-electric passenger cars in 2024—around 4.5 % of its car fleet—supported by a charger-to-BEV ratio of 1:7. Czechia, although starting from a lower base (27600 BEVs), now offers the region's densest fast-charging network (188 public chargers per 1000 BEVs), reflecting a corridor-focused infrastructure strategy. EU-wide BEV stock reached an estimated 5.9 million in 2024, yet uptake slowed after the withdrawal of major purchase subsidies in Germany.

Policy analysis reveals that sustained fiscal incentives paired with clearly sequenced infrastructure mandates—exemplified by Austria's purchase bonus and the EU Alternative Fuels
Infrastructure Regulation—yield higher adoption elasticities than incentives or mandates applied in isolation. Conversely, segments such as light commercial vehicles and heavy-duty trucks remain constrained by high upfront costs and nascent megawatt-level charging solutions.

The study concludes that aligning incentive timelines with infrastructure roll-out, expanding high-power charging corridors and introducing segment- specific feebate or mandate schemes are critical levers for meeting 2030 climate targets. Future research should quantify total cost of ownership for commercial fleets and assess grid impacts of megawatt charging hubs.

Index Terms—E-mobility, road transport, Czech Republic, Austria, European Union, electric vehicle stock, policy measures, strategies, charging infrastructure, comparative analysis

I. Introduction

Electrification of the road transport sector, which includes everything from private cars and motorcycles to public buses and freight trucks, has emerged as a crucial strategy to reduce greenhouse gas emissions and combat worsening air pollution. Across the globe, governments and industries are looking to e-mobility not only as a solution to environmental challenges but also as an opportunity for technological innovation and economic development. In many parts of the world, particularly in Europe, the pace of adoption of electric vehicles (EV) has been accelerating [1]. In Austria and the Czech Republic, both members of the European Union, national emobility efforts are shaped not only by broader EU mandates such as the Green Deal and the "Fit for 55" package, but also by each country's distinct economic, energy and technological conditions. Although Austria has made notable strides in boosting electric vehicle (EV) sales through direct subsidies and by leveraging its comparatively high share of renewable power generation (especially hydropower), the Czech Republic - home to a significant automotive manufacturing base has focused on balancing industrial interests with emerging consumer demand for low- and zero-emission vehicles [2].

Despite encouraging trends, current projections show that full-scale electrification of road transport remains well below what is needed to limit global temperature increases to 1.5 degrees Celsius [3]. Certain segments, such as passenger cars and trucks, still face higher gaps between the current trajectory and the climate-aligned targets [4]. This shortfall underscores the importance of developing comprehensive strategies and policies that facilitate faster market transformation, beyond relying solely on incentives for vehicle purchases. A multifaceted approach is needed, including the deployment of reliable charging infrastructure, effective regulatory frameworks that set stock and sales targets, and institutional mechanisms that coordinate across sectors such as energy, transport, and urban development [5].

Furthermore, e-mobility must be integrated within broader sustainable transport frameworks that prioritize public and non-motorized modes. Electrification alone, if not complemented by efficient land-use planning, strong public transport systems, and supportive policies for shared or active mobility, risks preserving or even exacerbating existing inefficiencies. As many nations move forward with new or updated policies—ranging from purchase subsidies and tax reductions to extended producer responsibility for battery recycling—attention must also be given to social and labor impacts. There is a need to anticipate new skill sets, support workforce transitions (e.g., training mechanics in EV technologies), and design policies that ensure equitable benefits across socioeconomic groups. In this context, discussing current vehicle stock, innovative strategies for scaling up e-mobility, and emerging policy developments offers a holistic view of how the sector can evolve in tandem with sustainability and economic goals [6].

The paper is structured as follows: Section II outlines the data sources and the methodology applied. Section III presents the main findings and analysis. Finally, Section IV offers concluding remarks and recommendations for future work.

II. Methodology

Before examining and comparing the adoption of e-mobility in the Czech Republic, Austria, and the broader European Union (EU), it was necessary to gather and evaluate data in several key areas. These areas include electric vehicle (EV) stock, national and EU-level policy measures, as well as the availability and characteristics of charging infrastructure. This section provides an overview of the data sources, the selection criteria used, and the analytical framework adopted to facilitate a robust comparative analysis.

A. Electric Vehicle Stock Data

This subsection details the process used to identify and analyze the number of registered electric vehicles (EVs) across different vehicle categories (e.g., passenger cars, light commercial vehicles, buses). Official statistics and databases, such as national vehicle registrations and EU-level reports, were considered [7], [8], [9]. Table I summarizes the primary data sources, together with the year(s) of coverage and any relevant notes on data quality or reliability. Data points include:

- Annual EV registrations and stock totals,
- Breakdown by vehicle type (battery electric, plug-in hybrid),
- Historical trends over the past five years.

B. Policy Measures

Policy documents and strategies were collected at both the national (Czech Republic, Austria) and EU levels to understand the legislative and incentive frameworks promoting e-mobility. Official government portals, white papers, and directives formed the bulk of the policy review [10], [11]. This included fiscal policies (such as purchase subsidies and tax exemptions), non-fiscal incentives (like free parking or HOV lane access), and broader regulations (including emission standards or zero-emission vehicle mandates). Relevant policies were cataloged according to the following:

- Type of incentive (fiscal vs. non-fiscal),
- Targeted stakeholders (e.g., individual consumers, fleet operators, manufacturers),
- Implementation timeline and progress to date.

C. Charging Infrastructure

In this sub-section, publicly available databases, energy sector reports, and industry publications were used to compile an inventory of charging stations in each study region. Particular emphasis was placed on:

- The total number of charging points and their distribution (urban vs. rural),
- Charging power levels (e.g., AC slow chargers, DC fast chargers),
- Compatibility with various EV models and industry standards.

A comparative lens was applied to highlight density of the infrastructure relative to the number of registered EVs and to identify any gaps in coverage [12], [13].

D. Comparative Analysis Framework

After gathering the above data, a structured comparison was conducted based on:

- Quantitative Metrics: EV market share, growth rates, policy investment levels, and charging points per capita,
- Qualitative Assessment: Policy effectiveness, stakeholder engagement, technological maturity, and institutional readiness.

Statistical tools (such as correlation and trend analyses) were applied where appropriate, and all statements about differences or differences between the Czech Republic, Austria, and the EU were supported by the collected evidence.

E. Limitations

In some cases, data gaps or inconsistencies emerged due to varying reporting intervals or divergent definitions (for example, classification of plug-in hybrids versus battery electric vehicles). Where possible, discrepancies were reconciled by focusing on standardized categories, but certain figures, especially related to emerging vehicle technologies, should not be interpreted with caution. These limitations are noted throughout the results to ensure transparency and reliability.

TABLE I
KEY DATA SOURCES FOR EV STOCK, POLICIES, AND INFRASTRUCTURE

Source	Coverage	Notes
Czech Transport Ministry	National EV Stock	Annual registration data
Austrian Statistics Bureau	National EV Policies	Includes purchase incentives
European Environment Agency	EU-Wide EV Data	Aggregated data, reports
Industry White Papers	Charging Infrastructure	Vendor-specific information

By applying the methodology outlined here, it becomes possible to systematically compare e-mobility developments in the Czech Republic, Austria, and the EU overall. The next section presents the results of this analysis and discusses how these findings inform policy and industry strategies in the European context.

III. Results

A. Electric-vehicle stock by transport mode

Table II compares the battery-electric vehicle (BEV) stock in passenger-car fleets (*M1*) and the corresponding year-onyear growth between 2023 and 2024 for Austria, Czechia and the EU as a whole.

Key observations:

- Austria surpassed 180000 BEV passenger cars in August 2024— a six-fold increase in just four years. Lightcommercial BEVs (N1) passed 12,500 units, while the e-bus segment grew to almost 300 vehicles [14].
- Czechia crossed the 25000-BEV mark for the first time in mid-2024, helped by a surge of 1,500 registrations in June alone and the roll-out of the *ELEKTROMOBILITA* warranty programme [15].
- At EU level, BEV stock exceeded an estimated 5.9 million cars at the end of 2024—roughly 2 % of the passenger-car fleet—after another 1.45 million BEVs were registered during the year.

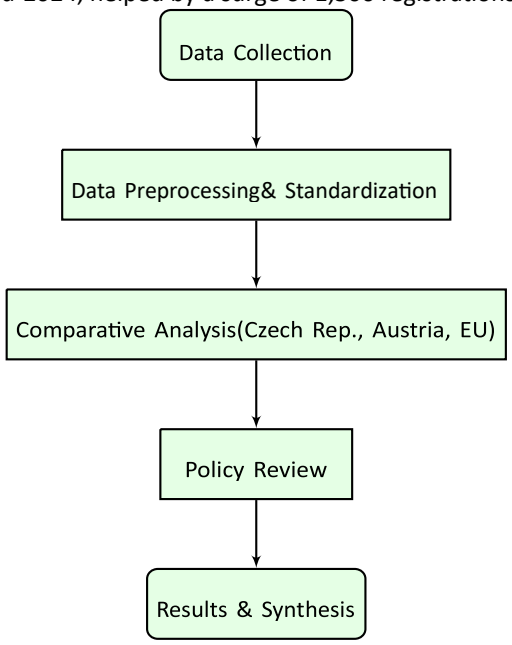


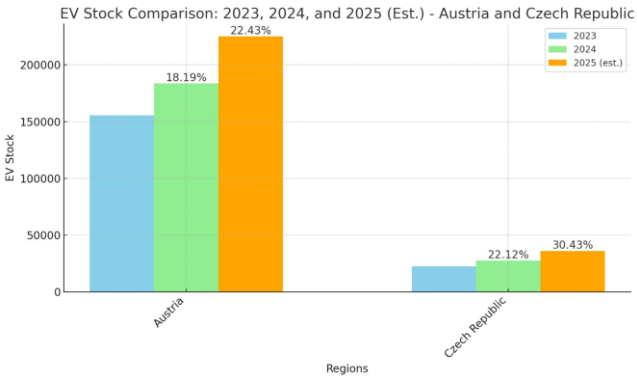
Fig. 1. Flowchart illustrating the data collection and analysis methodology.

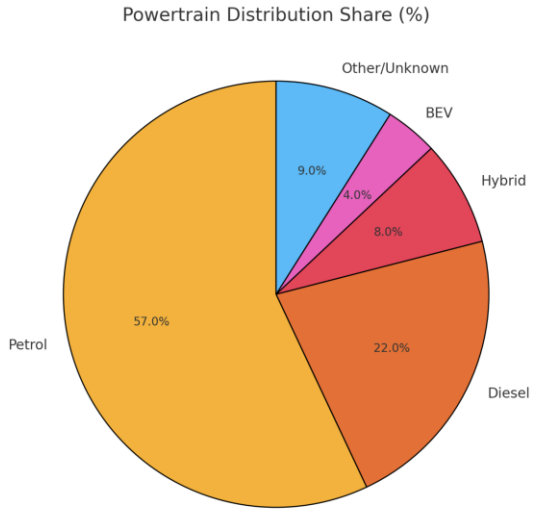
TABLE II
BEV PASSENGER-CAR STOCK AND GROWTH (2023 → 2024)

Region	Stock 2023	Stock 2024†	Growth
Austria	155490	183778	+18.2% [14]
Czech Rep.	~22600	27600	+22.1% [15]
EU27	4.50million	≈5.95million‡	+32.2% [16], [17]

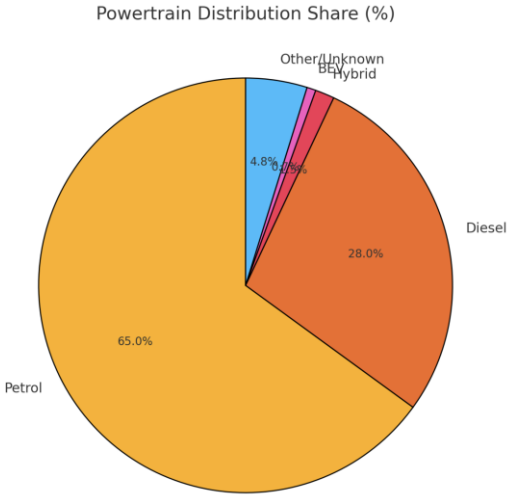
† Austria: August 2024 stock; Czechia: June 2024 stock; EU stock extrapolated to December 2024 (see footnote ‡).

‡ 4.50M BEVs on 31 Dec 2023 [16] + 1.448 M new BEV registrations in 2024 [17].





Austria



Czechia

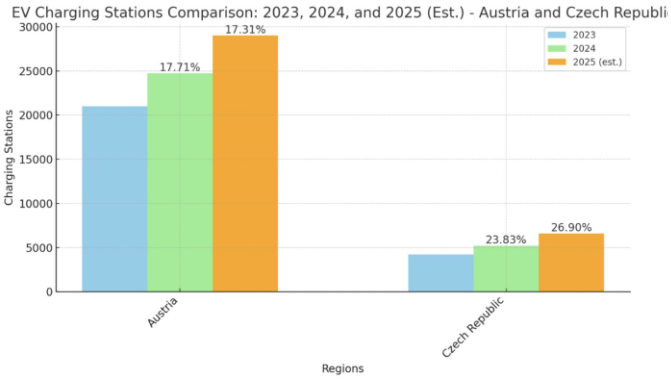
B. Public charging infrastructure

Infrastructure build-out largely kept pace with fleet growth (Table III).

TABLE III

PUBLIC CHARGING POINTS (END 2024) AND DENSITY

Region	Charging points	Points per 1000 BEVs	BEVs per point
Austria	24720	134.5	7.4 [14]
Czech Rep.	5201	188.4	5.3 [15]
EU27	~950000	159.7	6.3 [18]



Highlights.

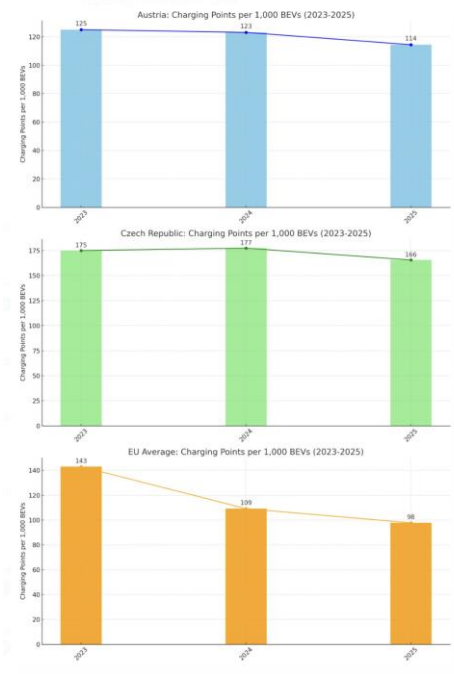
1) Positive for Czechia is that it now offers *more* publicly accessible chargers per thousand BEVs than both Austria and the EU average, reflecting its emphasis on corridor-based fast charging (21 % of points are >150 kW DC).
2) Austria's ratio—one charger for every 7.4 BEVs—remains ahead of the AFIR[1] indicative benchmark (1:10) but will need to improve as sales accelerate.
3) Europe passed the one-million-charger milestone in Q1 2025; DC installations grew 54 % year-on-year, signalling a shift toward higher-power infrastructure [18].

C. Policy outcomes and market dynamics

Austria.: The 2024–2025 *E-Mobility Offensive* maintained purchase bonuses (€3 000 for BEVs, €1 500 for PHEVs) and introduced a grid-connection rebate for highpower chargers, contributing to double-digit growth despite the removal of vehicle-tax exemptions for expensive models.

Czech Republic.: The *National Development Bank* warranty scheme has begun shifting fleet operators toward electric vans, while a scrappage-plus-grant programme for private buyers is slated for July 2025. Early evidence (Q1 2025) shows BEV registrations up 260 % year-on-year [18].

European Union.: EU-wide CO_2 standards and the 2035 ICE phase-out keep pressure on OEMs, but 2024 sales dipped 6 % as Germany ended purchase subsidies. Battery-electric city buses, by contrast, were a success story—46 % of new urban buses in 2024 were electric, with zero-emission buses reaching 49 % market share [19].



D. Cross-modal insights

- Light commercial vehicles (N1). BEV share in EU van registrations slipped from 7 % (2023) to 6 % (2024) [18], but Austria still targets 30 % BEV vans in new sales by 2030, backed by charging-hub subsidies.
- Buses (M2, M3). Momentum is strongest here: nearly half of new EU city buses in 2024 were zero-emission, mainly battery-electric [19]. Austria added 56 BEV buses in 2024, while Czech regions ordered 110 articulated ebuses for delivery in 2025.
- Heavy-duty trucks (N2, N3). Fleets remain nascent (Austria: 217 units; Czechia: ~200), but both countries joined the EU *Megawatt Charging System* pilot corridor, with first MCS 600 kW chargers scheduled for late 2025.

E. Summary of findings

1) Austria leads in absolute BEV numbers and also in absolute number of chargers.
2) Czechia is slowly catching up, complemeted by a relatively dense fast-charging network.

[1] Alternative Fuels Infrastructure Regulation

3) EU-wide adoption slowed in 2024, but infrastructure deployment outpaced fleet growth—an encouraging sign for future scalability.

These results confirm that targeted fiscal incentives, combined with fast growth in publicly accessible high-power charging, are key drivers of BEV adoption across transport modes. Remaining challenges include ensuring equitable rural coverage and accelerating the electrification of commercial vehicle segments.

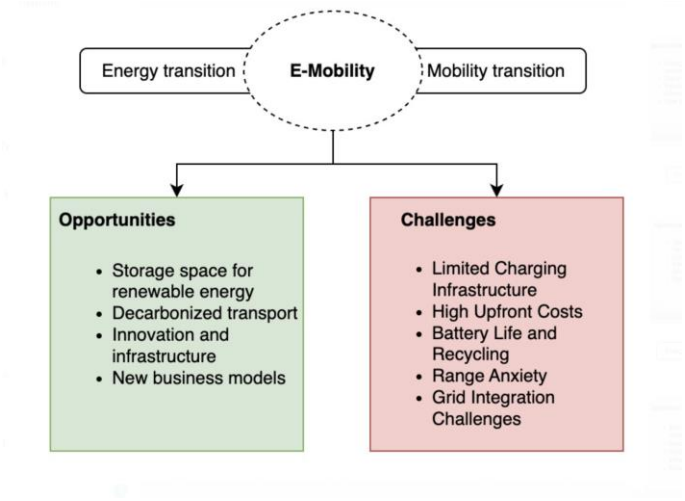
IV. Conclusion

This comparative assessment of e-mobility in Austria, the Czech Republic and the European Union yields three central insights.

1) Incentives and infrastructure must advance in tandem.: Austria's stable charger-to-vehicle ratio of 1 : 7 and continued purchase bonuses sustain double-digit growth [14]. Czechia's corridor-based fast-charging strategy—188 chargers per 1 000 BEVs—has produced the region's highest utilisation of high-power points [18]. At Union level, the Alternative Fuels Infrastructure Regulation (AFIR) synchronises minimum infrastructure roll-out with vehicle uptake targets [20].

2) Electrification is spreading beyond passenger cars—unevenly.: Zero-emission city buses captured 46 yet light-commercial vans and heavy-duty trucks trail the passenger-car curve. The forthcoming CO_2 standards for HDVs mandate a 45 by 2030 [21], making early Megawatt Charging System (MCS) pilots in Austria and Czechia [22] essential to de-risk infrastructure for regional trucking.

3) The next phase is about integration, not just expansion.: Grid-connection rebates (Austria) and public-bank guarantees (Czechia) illustrate a shift from simply counting chargers to embedding them within power-system planning. Policymakers should therefore: *(i)* accelerate local grid reinforcements, *(ii)* deploy dynamic-tariff frameworks to reward
smart charging, and *(iii)* guarantee equitable rural coverage where private investment alone is insufficient.



Policy recommendations

- Provide multi-year visibility for fiscal incentives to avoid market volatility such as Germany's abrupt 2023 environmental-bonus phase-out [23].
- Prioritise 350 kW + chargers along TEN-T corridors while mandating minimum service levels in peri-urban and rural areas [20].
- Extend battery life-cycle regulations to spur second-life applications and local recycling capacity.
- Introduce fleet-specific feebate schemes for high-impact segments (vans, regional trucks) to complement HDV CO_2 targets.
- Invest in up-skilling programmes so mechanics, drivers and grid planners can transition smoothly to electricdrivetrain technologies.

Future research directions include total-cost-of-ownership modelling for commercial fleets under variable electricityprice scenarios, grid-impact studies of megawatt-scale charging hubs, and behavioural analyses that align private charging with renewable-generation peaks.

In summary, Austria and Czechia showcase two viable—yet distinct—EU-aligned trajectories toward road-transport decarbonisation. By coupling sustained consumer incentives with strategic, grid-integrated infrastructure, both countries—and the EU at large—can place e-mobility on a pathway consistent with 2030 climate goals and the long-term ambition of climate neutrality. However as shown on the case of Germany after the end of substidies and Czechia, the interest falls down or is not even there to begin. In addition, cars by design are not a sustainable mode of transport, instead we should focus on cheap, accesable and dense public transport and micromobility. In cities they are trams, subways and train network that connects the outskirts with the city centre.

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