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Spatial justice in the transition to electric vehicle infrastructure

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As global cities rapidly expand EVs charging networks to promote decarbonization, an often-overlooked trade-off is emerging: during the transitional stage before universal adoption, the mandatory "green-exclusive" occupation of limited public parking spaces may engender spatial exclusion among non-EVs users. While we support decarbonisation and the reduction of automobile dependence, its concern lies in implementing electrification infrastructure in a fair manner avoiding "green gentrification" reproduction in the transformation process.

The invisible trade-off of vehicle electrification

Global transportation electrification is rapidly moving from the policy-guided stage to the stage of large-scale expansion[1]. Electric vehicles are no longer a niche technology, and they are gradually becoming an important infrastructure for reshaping urban transportation and public spaces. This transformation is particularly evident in China. According to the "China Automotive Industry Yearbook 2025", the sales and stock of new energy vehicles have continued to grow rapidly in recent years (production and sales in 2024 were 12.888 million and 12.866 million units, respectively), with a market penetration rate of 40.9%, among which pure electric vehicles have become the dominant form. Electrification thus shifts from being a 'demonstrative innovation' to a 'routine system,' and its spatial consequences are no longer limited to the technical level but begin to be systematically embedded in the logic of urban road, parking, and curb space allocation[2]. Against this backdrop, the issue of how to handle the redistribution of public space while advancing decarbonization has become a reality that needs to be addressed but is often underestimated.

This article clearly supports the electrification of transportation and its key role in emission reduction, and also agrees with reducing overall dependence on private cars. Only by systematically strengthening electrification in combination with low-carbon modes such as public transportation, walking, and cycling can cities achieve higher-quality accessibility and well-being while reducing emissions[3]. However, it is precisely during this transitional phase of rapid transformation that an implicit spatial trade-off begins to emerge: in the context of an institutional legacy still highly dependent on automobiles, the newly added electric vehicle charging infrastructure is often implemented primarily by reconfiguring existing parking spaces, thereby further fragmenting and privatizing already highly strained public parking resources.

However, in the era of automobile dependence, the redistribution of public space has generated some tensions that warrants serious attention[4–6]. For example, existing research has long pointed out that the parking system has effectively privatized large amounts of public space, thereby encroaching on resources available for public transportation, bicycles, walking and public Spaces[4]. However, with the advent of the new energy era, new spatial issues have been further refined. Specifically, scarce traditional parking spaces are designated exclusively and permanently for charging purposes, without temporal flexibility, functional adaptability, or spatial balance aligned with actual demand[7]. In high-density urban areas, this kind of 'rigid exclusivity' may not only lead to temporary underuse during off-peak periods[8], but also amplify the sense of exclusion for other users during peak demand periods, thereby creating real pressures on both efficiency and fairness.

This should not be read as a negation of electrification, but rather as a critical reflection on its implementation pathway: how can we avoid turning a "green upgrade" into a "new exclusion", that is, the spatial reproduction of "green gentrification" (referring to the reproduction of spatial privilege under the guise of environmental sustainability). Henderson (2009) and Thorpe (2020) already highlight the current problem of excessive allocation of public space to Internal Combustion Engine (ICE) vehicles[9,10]. However, when the redistribution of public spaces lacks institutional design oriented towards public interest and justice, even progressive goals may, in practice, change the composition of beneficiaries and those who are disadvantaged. Moreover, as a new element within urban street space, the siting, governance, and accessibility of electric vehicle (EV) charging facilities may reproduce, or even exacerbate, existing spatial inequalities[11]. These critiques further suggest that replacing "inclusive publicness" with the "exclusive rights of new technology" does not resolve mobility inequalities; the spatial privileges historically associated with internal combustion engine vehicles may continue in another form during the transition period.

Based on the above practical stage and research context, we further contend that the issue does not lie in whether EV infrastructure should be developed, but in how to prevent it from reproducing spatial exclusion through "exclusive allocation." A recent report by the consultancy Stonehaven warns that disparities in the accessibility and affordability of electric vehicle charging infrastructure raise concerns about "uneven provision"[12]. In addition, through the observation of some practical situations, it can be found that in certain specific periods of the city, dedicated fixed charging spots exhibit periodic low utilization, which contrasts with the tight availability of surrounding general parking spaces[13]. This stark contrast is particularly noticeable in high-density neighbourhoods. The literature on green gentrification further demonstrates that when "green qualities" are capitalised as locational advantages, the absence of institutional safeguards can easily give rise to the paradox of "green as exclusion," thereby weakening the

social foundation for transformation[14]. We therefore stress the importance of attending to the justice of planning procedures and design logics.

It is precisely in this context, we observe that, during certain periods, designated kerbside charging bays suffer from intermittently low utilisation, in stark contrast to the acute shortage of surrounding general parking spaces. This contrast is particularly pronounced in high-density urban districts. Accordingly, this paper calls for a justice-oriented pathway to electrification: while expanding the public charging network, cities should pursue time-based sharing arrangements, demand-responsive allocation, evidence-driven siting, integration with public transport, walking and cycling, and prioritised deployment with differentiated subsidies in communities facing higher barriers to transition. Only by placing decarbonisation goals and the principles of spatial justice on an equal footing can cities avoid reproducing new inequalities during the transition and transform scarce public space into genuine public benefit.

Who is being left behind?

Transport electrification is often framed as an unequivocal public good[15], yet in practice its implementation pathways may generate exclusionary effects for certain groups. Crucially, such exclusion does not arise from whether individuals continue to drive conventional internal combustion vehicles, but rather from the barriers different populations face during the transition. For many urban residents, the difficulty of shifting to electric vehicles lies not in willingness but in feasibility. For instance, those without access to private parking spaces or home charging facilities are often unable to benefit from the convenience of low-cost overnight charging[16]; long-distance commuters and shift workers may encounter heightened uncertainty where charging opportunities do not align with their time schedules. At the same time, the purchase and long-term operating costs of electric vehicles continue to impose significant burdens on low-income groups, who are frequently concentrated in communities already underserved by public transport and non-motorised mobility infrastructure[17].

In this context, the fixed and exclusive allocation of electric vehicle charging facilities may further exacerbate inequalities during the transition period[18]. On the one hand, those facing higher barriers to transition are compelled to shoulder greater travel costs and time pressures; On the other hand, some charging bays display intermittently low utilisation during off-peak periods or across different user groups, rendering scarce public space resources both inefficient and inequitable[19]. In other words, the marginalised are not "owners of conventional vehicles" as a social category, but rather those who, owing to residential conditions, work patterns, economic capacity, and community environments, encounter greater difficulty in making the transition.

To better identify these hidden disparities, cities can adopt a simplified framework of equity diagnosis in the planning process: residential-condition thresholds (e.g. lack of private parking spaces or the inability to install home chargers), economic thresholds (e.g. high purchase costs and constraints on credit availability), and temporal or modal thresholds (e.g. misalignment between charging schedules and the needs of night-shift workers or long-distance commuters). These dimensions help to explain why certain groups are "unable or unwilling" to transition, while also offering operational entry points for future policy and research. Without consciously lowering such transition barriers during planning, the process of electrification risks reproducing existing injustices under a "green" guise, and may even undermine broader societal support for decarbonisation[20].

Planning for fairness and functionality

To mitigate the equity challenges associated with the expansion of electric vehicle infrastructure, good intentions alone are insufficient; cities require a more strategic and forward-looking planning approach to ensure that technological progress advances in parallel with spatial inclusion. First, planning decisions must be grounded in evidence. The siting and allocation of charging facilities should not be determined solely by technical feasibility or investment returns, but should be informed by fine-grained analyses of travel behaviour, parking bay usage patterns, and community demographics. Employing tools such as geographic information systems to spatially map the potential impacts on different groups can help decision-makers to anticipate risks before infrastructure is constructed. Furthermore, by embedding equity impact assessment frameworks into the planning process, public interests and the needs of vulnerable populations can be systematically incorporated into decision-making.

Second, infrastructure design should embed flexibility rather than being fixed to a single purpose. Rather than creating "exclusive" spaces through rigid designation, cities should adopt approaches of time-based sharing and dynamic management, enabling the same space to serve different needs at different times of day. Institutional mechanisms such as reservation systems, differentiated pricing, and utilisation thresholds can both safeguard the charging needs of electric vehicles and enhance the overall turnover efficiency of parking spaces, thereby reducing idle waste during off-peak periods.

Third, the planning of charging infrastructure must be subordinated to higher-order priorities in the transport hierarchy. According to the Avoid–Shift–Improve (A–S–I) framework, a truly sustainable transport transition should first avoid unnecessary travel demand, then shift mobility towards active and low-carbon modes such as walking, cycling, and public transport, and only thereafter improve the energy efficiency of private cars[21,22]. Yet, with the overlapping demands of food delivery and on-demand services, ride-hailing, and electric vehicle infrastructure, competition for kerbside resources has intensified, revealing the kerb not merely as a physical space but as a political arena of distributive power[23]. These authors argue that the use of the kerb is undergoing a process of "re-coding": the redefinition of priorities and legitimacy for different uses through the restructuring of institutions and rules[23]. This perspective reminds us that any additional facilities must be introduced on the condition that they do not weaken the functions of active and sustainable transport, thereby ensuring that the electrification process does not come at the expense of the public interest.

Correspondingly, cities should establish synergistic objectives and baseline indicators. For example, target communities should meet defined thresholds for public transport frequency. Walking and cycling networks should achieve specified standards of continuity. And accessibility within a 15-min neighbourhood should reach benchmark levels. Only once these baselines for active and sustainable transport are secured should additional kerbside charging bays be introduced. In this way, electrification is situated within a systematic framework of transport priorities, rather than pursued as the isolated expansion of "automobile space."

Importantly, electrification infrastructure must not be planned in isolation from other modes of transport, but should instead be deployed in coordination with public transport, walking, and cycling networks[24]. Only through integrated layouts that link rail and bus hubs, neighbourhood living circles, and employment centres can rigid dependence on private cars be effectively reduced, enabling complementarity and symbiosis among sustainable modes of travel. On this basis, cities should pay particular attention to communities facing higher transition barriers, prioritising the deployment of public fast-charging facilities in these areas and reducing entry costs for vulnerable groups through differentiated subsidies and targeted support.

Finally, innovation in governance models is equally indispensable. Municipal governments need to establish clear responsibilities and accountability mechanisms with charging operators, for instance, by setting key performance indicators such as utilisation rates, availability, and fault rates through service-level agreements, and by enhancing transparency and public oversight via data openness and regular disclosure. Only through a cyclical mechanism of "piloting, evaluation, adjustment, and scaling-up" can the deployment of electric vehicle infrastructure continually self-correct and improve in practice.

Planning beyond carbon

Electrification is undoubtedly a central pillar of urban climate strategies, yet its success depends not only on the achievement of emission reduction targets but also on the ability to safeguard and expand the inclusiveness of public space[25]. If the expansion of electric vehicle charging facilities proceeds in a rigidly exclusive manner without consideration of spatial justice, scarce urban public resources risk being reconfigured into new mechanisms of exclusion under the banner of green transition[26]. This would not only undermine the equal right of different groups to access urban space, but could also, through inefficiency and declining social acceptance, in turn impede the decarbonisation process itself.

This comment's concern, therefore, is not with electrification itself, but with implementation pathways that lack inclusivity and an evidence-based foundation. The real challenge lies in how cities can forge a robust connection between decarbonisation and equity, ensuring that the green transition does not devolve into green gentrification. A just transition requires us to move beyond technology and infrastructure, confronting the structural barriers different groups face during the process, and employing institutionalised planning instruments to reduce these obstacles. In this sense, equity should not be treated as an auxiliary consideration, but as a foundational condition for advancing sustainable transition.

Data availability

No datasets were generated or analysed during the current study.

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Author contributions

Z. Wang wrote the conceptual framework. Z. Wang and H. Chen wrote the main text. Z. Wang, H. Chen and S. Deng revised the main text. All authors have read and approved the manuscript.

Competing interests

The authors declare no competing interests.

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