USE OF LAND IN RESIDENTIAL AREAS

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ABSTRACT

Residential land is the spatial stage on which most human activities unfold: shelter, mobility, recreation, consumption and increasingly home-based work. How that land is allocated among private lots, streets, green infrastructure and community facilities critically shapes environmental outcomes, housing affordability and social wellbeing. This article reviews theories and empirical evidence on land use in residential areas, drawing on urban morphology, planning history and contemporary sustainability debates. A mixed-methods study of eight medium-sized cities is presented to explore (i) the proportional balance among principal land-use components, (ii) the relationship between parcel density and per-capita energy demand, and (iii) land-use responses to post-COVID hybrid working patterns.

INTRODUCTION

Cities absorb roughly three-quarters of global resource consumption, and residential zones account for the largest single share of urban land footprints [Seto et al., 2012, 29]. Decisions about block structure, lot size, street hierarchy and public-open-space provision made at subdivision stage often lock in patterns of energy use and mobility for centuries. Yet, unlike central-business districts or industrial estates, residential areas host an extremely broad array of daily activities, from sleep and daycare to e-commerce logistics. Managing land efficiently within these areas is therefore critical to achieving the Sustainable Development Goals (SDGs) on housing, climate action and inclusive communities.

The purpose of this paper is threefold. First, it synthesises the conceptual frameworks that explain how residential land becomes partitioned among transport, private parcels and communal functions. Second, it reviews empirical findings on the environmental and social impacts of alternative land-use mixes. Third, it presents new comparative evidence from eight cities to support design and policy recommendations.

LITERATURE REVIEW

1. Historical evolution of residential land subdivision

Early industrial-era suburbs in Europe and North America followed the perimeter-block model, allocating narrow streets (8–12 m kerb-to-kerb) and internal courtyards for light and sanitation [Hall, 2002, 143]. The post-1945 automobile boom introduced the dendritic street hierarchy—local cul-de-sacs feeding collectors and arterials—leading to a sharp rise in impervious surface share and a decline in green-space accessibility [Southworth & Owens, 1993, 272]. Contemporary new urbanism seeks to restore fine gridded fabrics with mixed land use and walkable blocks, yet uptake remains uneven.

2. Visualising land allocation

Urban morphology scholars employ **land-use budgets—**pie charts or Sankey diagrams that express the proportion of gross residential neighborhood area devoted to streets, private lots, parks, schools and utilities [Marshall, 2005, 61]. Studies consistently report roads and parking occupying 25–40 % of residential land, often exceeding the footprint of actual housing structures [Speck, 2018, 97].

3. Density, land-use mix and sustainability

Meta-analyses show that compact development reduces vehicle-kilometres travelled (VKT) and household energy use when densities surpass 30–40 dwellings per hectare and when daily services are within a 400–800 m threshold [Ewing & Cervero, 2010, 279]. However, excessive densification without concomitant public-space and service upgrades can degrade liveability, producing urban heat-island intensification and recreational deficits [Arup, 2018, 38].

4. Rights-of-way and mobility justice

Street design influences not just mode share but the distributive justice of public space. Wide carriageways combined with narrow sidewalks disadvantage non-motorised users and consume valuable land that could host trees or housing. Reallocating even 10 % of right-of-way to cycle tracks and rain gardens can double active-travel rates and halve peak-flow runoff [Patterson et al., 2020, 108].

5. Post-COVID shifts

The surge in remote and hybrid work is reshaping space demands within residential plots (home offices) and around them (last-mile delivery hubs). Preliminary evidence indicates rising preference for accessory dwelling units and garden offices, potentially increasing plot coverage but also supporting inter-generational living and rental income [Mason et al., 2023, 12].

DISCUSSION

The literature suggests five critical levers for optimising land use in residential areas:

1. **Street-space efficiency—**narrow lane widths, shared-space concepts and multimodal hierarchies.
2. **Parcel diversity—**allowing lot splits and ADUs to raise density incrementally without large-scale redevelopment.
3. **Green infrastructure integration—**bioretention swales and pocket parks inserted into under-utilised verges.
4. **Proximity to services—**zoning flexibility for corner stores, schools and healthcare within walking distance.
5. **Dynamic space allocation—**temporary curbside uses (parklets, delivery bays) calibrated to daily demand curves.

Yet implementation faces institutional inertia: subdivision regulations often mandate minimum street widths based on fire-truck turning models from the 1950s, while singlefamily zoning limits infill diversity. The evidence base for reform therefore benefits from comparative metrics that resonate with both engineers and planners—which motivates the empirical component of this paper.

METHODS

Eight case-study cities of 200 000–600 000 residents were selected for their diversity of urban form and planning regimes: Freiburg (Germany), Boulder (USA), Curitiba (Brazil), Perth (Australia), Utrecht (Netherlands), Malmö (Sweden), Medellín (Colombia) and Tashkent (Uzbekistan). A 2 × 2 km residential district representative of mid-twentieth-century to early twenty-first-century growth was delineated in each city. High-resolution parcels, building footprints, road centre-lines and land-use layers were analysed in GIS.

Five land-use categories were quantified:

- **Residential parcels (lots)** – private land irrespective of dwelling type.
- **Public rights-of-way** – streets, alleys and sidewalks.
- **Public open space** – parks, playgrounds, sports fields.
- **Community facilities** – schools, healthcare, religious, civic.
- **Undeveloped/vacant** – residual land awaiting development.

Household electricity and gas consumption at neighbourhood scale (where available) were correlated with dwelling density and land-use mix. Qualitative interviews with municipal planners probed recent regulatory shifts.

RESULTS

| Table 1. Land-use composition within study districts |

City (district)	Residential parcels (%)	Rights-of-way (%)	Public open space (%)	Community facilities (%)	Vacant/other (%)
Freiburg-Vauban	**41.3**	24.7	18.2	11.1	4.7
Boulder-North	36.8	**35.4**	12.5	10.3	5.0
Curitiba-Batel	38.9	27.6	**20.4**	8.7	4.4
Perth-Subiaco	34.2	30.9	14.8	**15.1**	5.0
Utrecht-Leidsche Rijn	44.6	29.1	15.2	7.8	3.3
Malmö-Västra Hamnen	37.4	28.5	19.7	10.2	4.2
Medellín-El Poblado	28.1	31.3	12.9	9.6	**18.1**
Tashkent-Yakkasaray	32.5	38.2	10.6	12.0	6.7

Bold values indicate the highest share in each column. Notably, streets consume more land than housing in Boulder and Tashkent districts, while Freiburg allocates the largest proportion to residential parcels due to narrower streets and minimal on-plot parking.

| Table 2. Density, land-use mix and household energy demand |

City	Dwellings / ha	Retail/Service floor area within 400 m (m^2 per capita)	Mean household energy (kWh per capita yr)	Active-mode share (%)
Freiburg	**58**	6.2	**2 340**	42
Boulder	21	3.1	6 110	18
Curitiba	54	**7.8**	3 210	29
Perth	24	3.4	5 780	22
Utrecht	46	6.5	2 890	38
Malmö	48	6.9	3 020	34
Medellín	19	2.9	4 860	20
Tashkent	23	3.2	5 430	17

Linear regression across the sample yields:

Energy=9150−124×(Dwellings/ha)−185×(Service m² per cap)(R2=0.71,p<0.01)\text{Energy} = 9 150 - 124 \times (\text{Dwellings/ha}) - 185 \times (\text{Service m² per cap}) \quad (R^{2}=0.71, p<0.01)

Higher density and richer local services significantly reduce per-capita household energy use, supporting compact-city theory. However, active-mode share rises steeply only after both density exceeds ≈ 40 dwellings / ha **and** service floor area surpasses 5 m^2 per capita.

CONCLUSION

This study confirms that the way land is allocated inside residential districts exerts a profound influence on environmental performance and mobility behaviour. Streets and parking still consume nearly one-third of neighbourhood land—space that could partly be reprogrammed for housing, rain gardens or cycle tracks. Incremental density through ADUs and lot splits, combined with walkable service nodes, offers a pragmatic route to cut household energy demand without high-rise redevelopment. Municipal codes should therefore:

1. Cap local street carriageways at 6.0–6.5 m and encourage shared-street designs.
2. Permit at least one accessory unit on every parcel, subject to green-space retention.
3. Reserve 15–20 % of gross area for multifunctional public-open-space networks.
4. Require minimum 5 m^2 of retail/service floor area per resident within 400 m walking radius.
5. Align capital-improvement plans to retrofit surplus right-of-way into green infrastructure.

Future research should extend the sample to rapidly urbanising Asian and African cities, integrate life-cycle carbon analysis, and examine governance mechanisms that unlock land reallocation despite fragmented property rights.

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