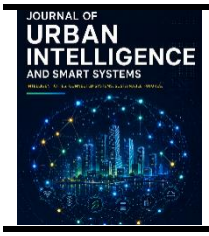

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Charging Ahead or Charging Alone? A Triadic Integration Framework for Electric Vehicle, Land-Use, and Urban-Development Policy in New South Wales, Australia

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ABSTRACT

Electric vehicle (EV) transition is conventionally analysed as a transport or energy problem, yet its physical realisation - chargers, cables, distribution boards, kerbside space, car parking, apartment buildings, industrial depots - is inseparably a land-use and urban-development problem. This study asks whether New South Wales (NSW) planning documents treat it that way. We assemble a 30-document corpus of official NSW planning, transport, energy, and local-government instruments spanning three analytical categories - EV-centred, land-use-centred, and Cross-cutting (neither purely land-use nor purely EV-focused) - and classify, keyword-profile, and topic-model the corpus using a reproducible text-mining pipeline (regex-based domain dictionaries, TF-IDF/NMF topic modelling, co-occurrence network analysis). We introduce a novel Triadic Integration Score (TIS) that combines cross-domain keyword intensity with distributional balance to quantify, document by document, how strongly EV, land-use, and cross-cutting concepts co-occur. Results show a consistent asymmetry: action- and program-level EV and cross-cutting documents with an explicit cross-sectoral delivery mandate (e.g. the Net Zero Cities Action Plan, TIS = 98.6; Future Transport Strategy 2056, TIS = 94.9) most often name EV infrastructure alongside land-use and net-zero-precinct concepts, whereas core land-use instruments - most starkly the Local Strategic Planning Statement template used by every NSW council and the four Greater Sydney District Plans - contain little or no EV-specific vocabulary despite explicit "transport/connectivity" and "infrastructure adapts" provisions. Network analysis identifies "charging," "infrastructure," and "land use" as the corpus's dominant bridging concepts, while "destination charging" remains domain isolated. We propose a Policy Integration Pathway showing that the weakest cross-domain linkage in the NSW system sits precisely at the local statutory-planning tier - the scale at which EV-ready car parking is delivered. The study contributes an empirical NSW corpus, a transferable Triadic Integration Score, and a diagnosis of where - not merely whether - EV transition and spatial planning remain institutionally fragmented in an advanced sub-national planning system.

1. Introduction

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The Electric vehicle (EV) transition is routinely framed, in both scholarship and government strategy, as a problem of vehicle technology, energy supply, and transport-emissions accounting. Yet every element of the EV transition that is not the vehicle itself - the charger, the cable route, the distribution board, the car space it occupies, the curbside it sits besides, the apartment building it must be retrofitted into, the industrial depot it must be sited within - is a land-use and urban-development artefact. A charging point is, before it is anything else, the use of land. It requires car space (a parking-provision decision), electrical infrastructure (a building-code and utilities decision), location (a zoning and accessibility decision), and, on a scale, a share of increasingly contested curbside space (an urban-design and streetscape decision). Whether a jurisdiction can deliver EV-ready infrastructure at the pace its climate targets require is therefore not solely a question of transport or energy policy; it is a question of whether transport-electrification policy and spatial-planning policy are institutionally *integrated* - whether the people writing EV strategy and the people writing land-use plans are, in effect, reading each other's documents.

This question has force in New South Wales (NSW), Australia's most populous state and the jurisdiction most frequently cited as the national leader in both EV uptake and EV charging infrastructure [1]. The NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) released Australia's first state Electric Vehicle Strategy in 2021 and a substantially revised strategy in April 2026, backed by a cumulative investment exceeding $330 million in charging infrastructure, fleet incentives, and workforce training [1, 2]. Over the same period, NSW has produced an equally dense body of spatial planning instruments - the Greater Sydney Region Plan and its five District Plans, nine Regional Plans covering the rest of the state, a whole-of-government Housing Strategy, a Local Strategic Planning Statement template used by every council in NSW, and, most recently, a statewide Industrial Lands Action Plan [3, 4, 5, 6]. Both bodies of policy are current, well-resourced, and internationally referenced. What has not been established empirically is whether they are *integrated with each other* - whether NSW's EV strategy actually speaks the vocabulary of land-use planning, whether NSW's land-use plans actually speak the vocabulary of EV transition, and whether the state's broader urban-development and net-zero-cities agenda is where - if anywhere - the two meet.

This gap matters for three reasons. First, planning theory has long argued that infrastructure transitions fail or stall not for want of technology but for want of institutional integration across the agencies and instruments that must jointly enable them [7, 8]; an EV strategy with no land-use uptake and a land-use system with no EV vocabulary describes exactly this failure mode in embryo. Second, the practical consequences are already visible in NSW's own record: local Development Control Plan (DCP) amendments, strata-scheme disputes over the right to install a charger, and inconsistent car-parking electrical-circuitry requirements across councils are all downstream symptoms of a state EV strategy that, however well-funded, has limited statutory purchase over the instruments that actually govern where and how a charger may be installed [9, 10]. Third, existing scholarship on EV–land-use integration is overwhelmingly conceptual, jurisdiction-agnostic, or focused on individual instruments in isolation (e.g. a single Development Control Plan, or a single state strategy); there is no empirical, corpus-based, cross-instrument assessment of *how much*, and *where*, integration exists across a state planning system considered as a whole.

This study addresses that gap directly. We assemble and text-mine a 30-document corpus of official NSW planning, transport, energy, and local-government instruments, spanning three analytical categories: EV-centered documents (state EV strategies, charging-grant guidelines, freight-decarbonization policy, and two council-level EV strategies), land-use-centered documents (the Greater Sydney Region Plan and District Plans, the state Housing Strategy, the Local Strategic

Planning Statement guideline, the Industrial Lands Action Plan, and a council Development Control Plan), and Cross-cutting documents - instruments that are neither purely land-use nor purely EV-focused (the state's overarching Future Transport Strategy [11], its Smart Places and Net Zero Cities programs [12], Transport for NSW's climate and sustainability policies [13], and three Regional Plans). We classify each document, build three keyword dictionaries, run NMF topic modelling and co-occurrence network analysis, and introduce a novel Triadic Integration Score (TIS) that quantifies, for each document, how strongly EV, land-use, and cross-cutting vocabulary co-occur. We use this evidence base to answer six research questions: (1) do NSW land-use plans meaningfully include EV transition concepts; (2) do NSW EV strategies meaningfully include land-use concepts; (3) do NSW cross-cutting strategies integrate the two; (4) which concepts act as bridges between the three policy domains; (5) where are the strongest conceptual gaps; and (6) which *type* of document achieves the highest Triadic Integration Score.

The study's contribution is fourfold. First, it provides an empirical, citable NSW corpus spanning state EV policy, state and district land-use planning, state urban-development and climate policy, and - distinctively - three local-government instruments (a council EV strategy, a council DCP, and a strata-sector stakeholder submission) that most existing single-instrument studies omit entirely, despite the local tier being where EV-ready development controls are actually applied. Second, it operationalizes a Triadic Integration Framework and Score that is explicitly reproducible and, we argue, transferable to other multi-level planning systems seeking to audit their own EV–land-use–climate integration (Figure 1).

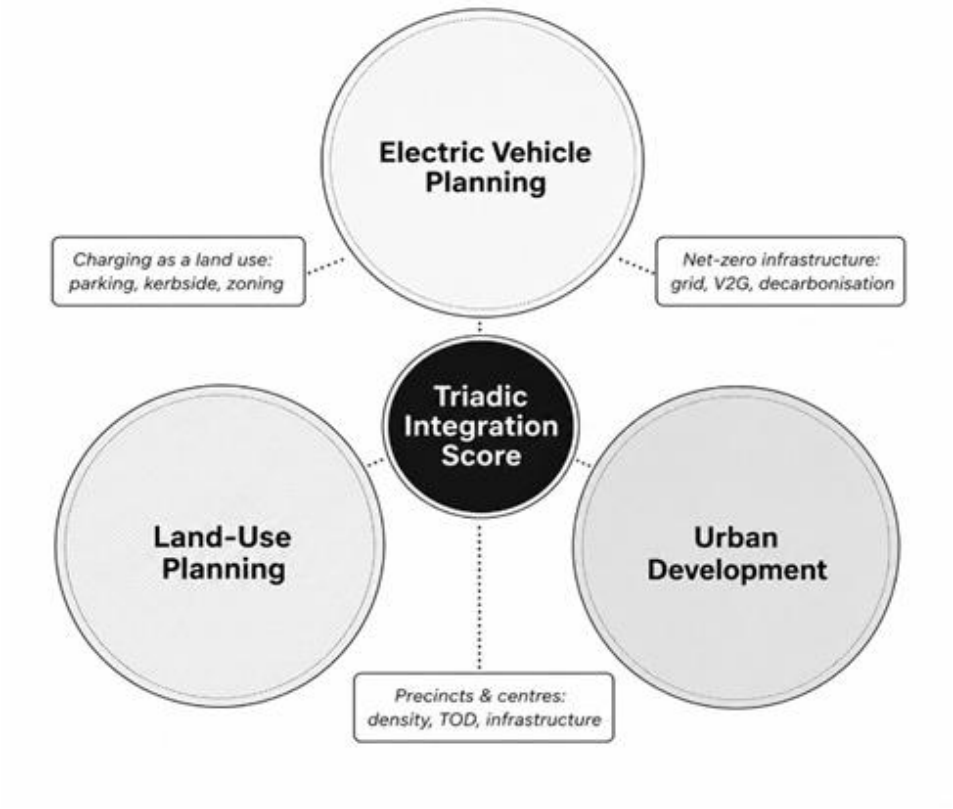

Fig. 1. The Triadic Integration Framework: EV, land-use, and cross-cutting planning (Urban development) as three overlapping domains, with the Triadic Integration Score combining cross-domain

Third, it identifies the specific concepts - "charging," "infrastructure," "land use" - that function as empirical bridges across the NSW corpus, and the concepts that remain domain-isolated, giving

planners a concrete vocabulary for where integration work should be targeted. Fourth, and most consequentially for policy, it shows that the weakest link in the NSW system is not the state-strategy tier, where EV and net-zero-cities documents already reference each other, but the *local statutory-planning tier* - Local Strategic Planning Statements and, to a lesser degree, District Plans - where EV vocabulary is largely absent from the very instrument that determines local zoning, density, and infrastructure priorities for the next twenty years.

2. Conceptual Framing: EV Transition as a Land-Use and Institutional-Integration Problem

2.1 Beyond a transport-and-energy farming

The dominant scholarly and policy framing of EV transition treats charging infrastructure primarily as an energy-system and network-planning problem: where to place fast chargers to minimize range anxiety, how to size distribution infrastructure, how to manage peak demand. This framing is necessary but incomplete. Neighborhood-scale research further demonstrates that urban features influence residential energy consumption, indicating that energy demand is partly structured by land-use patterns and built-form decisions [56]. Sustainability-transitions scholarship has long argued that infrastructure transitions are as *institutional* as they are technical. The multi-level perspective (MLP) on socio-technical transitions holds that a regime shift - from an internal-combustion-engine automobility regime to an electrified one - requires alignment across a technological niche, an incumbent regime, and the broader landscape of policy, culture and infrastructure that surrounds it; transitions stall not for want of a viable niche technology but for want of regime-level reconfiguration across exactly these institutional layers [14, 8]. Geels [15] applies the MLP specifically to transport, arguing that low-carbon mobility transitions require simultaneous change in vehicle technology, user practices, infrastructure provision *and* the regulatory and planning frameworks that govern the built environment - a claim this study treats as its starting empirical question rather than an assumption. Strategic niche management scholarship adds that niches (here, EV charging pilots and grant programs) only diffuse into a mainstream regime when protective policy space is coupled to the mainstream institutions - including land-use and planning instruments - that will ultimately have to carry the technology at scale [16]. Applied to EVs, this body of theory implies that the transition's success depends on whether charging is written into the instruments that actually control where a car space may exist, what electrical circuitry a new apartment building must provide, whether a curbside can be repurposed, and whether an industrial precinct's zoning anticipates a fleet depot's charging load - a reconfiguration this study measures directly through the Triadic Integration Score.

2.2 EV charging as a spatial and land-use problem

A distinct but complementary empirical literature has, largely independently of transitions theory, established that charging infrastructure outcomes are substantially explained by land-use and built-environment variables rather than by vehicle technology or energy-market factors alone. Siting studies consistently find that charging-station location decisions are structured by land-use category, parking typology and accessibility to trip generators, not simply by electrical-grid convenience [17]; user-preference studies of fast-charging location choice likewise find that convenience relative to existing land uses - retail, food and beverage, rest facilities - dominates stated siting preferences over raw charging speed [18]. Utilization studies of early fast-charging networks show that charger use is highly sensitive to corridor and destination context, reinforcing that charging demand is a spatial-accessibility phenomenon as much as a technological one [19]. A parallel equity literature documents

that public charging access is unevenly distributed across neighborhoods by income and, in some jurisdictions, by race - a disparity attributable not to EV ownership rates but to housing typology and off-street parking availability, i.e. to land use [20]. Recent land-use-aware studies extend this evidence by integrating geodemographic equity, built-environment thresholds, and distribution-grid constraints into charging-location planning [21, 22, 23]. Industry and technical guidance mirrors this finding operationally: best-practice guidance for charging network planning explicitly recommends sitting frameworks built around land-use and trip-purpose typologies rather than grid-capacity maps alone [24]. This literature collectively supports the study's central conceptual move - treating "charging," "curbside," "parking" and "land use" as a single semantic and policy family rather than as adjacent-but-separate domains - and is precisely what the corpus's dictionary construction and Triadic Integration Score are designed to test empirically at the level of NSW's own policy vocabulary, rather than assume from first principles.

2.3 Transport–land-use integration in the metropolitan-planning literature

The premise that transport and land use must be planned together, rather than sequentially or separately, is one of the oldest and most extensively tested propositions in urban planning research. Newman and Kenworthy's [25] cross-city comparative work established that urban density and land-use pattern are primary determinants of automobile dependence, a finding subsequently generalized across built-environment dimensions by Cervero and Bockelman's [26] "3Ds" framework - density, diversity, and design - and quantitatively consolidated in Ewing and Cervero's [27] meta-analysis of the built environment's effect on travel behavior. This relationship is also evident in household vehicle ownership, which is influenced not only by socioeconomic characteristics but also by urban density, land-use diversity and accessibility [57]. The land-use–transport feedback cycle formalized by Wegener and Fürst [28] makes the mechanism explicit: transport infrastructure shapes accessibility, accessibility shapes land value and location decisions, and resulting land-use patterns in turn generate new transport demand. Recent metropolitan evidence similarly identifies a significant relationship between transportation infrastructure and housing prices, illustrating how accessibility investments interact with land markets and urban-development patterns [58]. Contemporary articulations of integrated, accessibility-first planning - including the "15-minute city" concept [29], directly cognate with the "30-minute city" target that recurs throughout the Greater Sydney Region Plan and Future Transport 2056 - and Banister's [30] sustainable-mobility paradigm both call for transport and land-use instruments to be authored jointly against shared accessibility outcomes rather than produced as parallel, single-sector documents. NSW's own Movement and Place framework is a direct policy descendant of this literature; the present study's contribution is to test empirically whether that integrative *ambition*, well established in NSW's transport-strategy vocabulary, reaches the *land-use* instruments - District Plans, Local Strategic Planning Statements - that sit downstream of it.

2.4 Policy integration and institutional fragmentation

Why EV, land-use and urban-development policies should be read together, the policy-integration literature supplies the analytical vocabulary for measuring *whether* they are. Environmental policy integration (EPI) scholarship defines integration as the requirement that a sector's objectives be incorporated into the design of other, non-environmental sectors' policy instruments, rather than addressed solely within a dedicated environmental policy silo [31]; Jordan

and Lenschow's [32] state-of-the-art review shows this remains as much an aspiration as an achievement across most tested policy systems. Stead and Meijers [33] apply the same logic specifically to spatial planning, distinguishing facilitators of policy integration (shared strategic vision, boundary-spanning institutions, aligned review cycles) from inhibitors (agency silos, misaligned statutory timeframes, sector-specific expertise and vocabulary). At the implementation level, bottom-up planning can complement horizontal policy coordination by incorporating expert and community priorities into integrated sustainable-transport policy packages [59]. Candel and Bessbrook [34] reconceptualize integration as a *processual* rather than binary property - policy domains can be more or less integrated along dimensions of policy frames, subsystem involvement, goals, and instruments - which is the conceptual justification for this study's continuous, document-level Triadic Integration Score rather than a simple integrated/fragmented binary classification. Peters' [35] foundational account of "managing horizontal government" further identifies the specific coordination failure this study documents empirically: coordination is comparatively achievable between peer central-agency strategy documents but breaks down precisely at the interface with devolved, statutorily independent implementing bodies - an exact institutional description of the state-to-local-council relationship this study finds to be the corpus's weakest link. Recent cross-national review evidence likewise identifies coordinated multi-level governance as a prerequisite for scalable, grid-aware charging ecosystems [36].

2.5 Obligatory passage points: planning instruments as institutional choke points

Actor-network and science-and-technology-studies scholarship offers a complementary, more mechanistic diagnostic concept: the *obligatory passage point* (OPP) - the actor, instrument, or decision node through which all other actors in a network must pass for a given outcome to occur [37]. Latour's [38] elaboration of actor-network theory extends the OPP concept to durable institutional artefacts - documents, standards, statutory instruments - that can obligate or fail to obligate downstream actors depending on how they are drafted, a framing Murdoch [39] shows applies directly to planning documents as "spaces" that variously enroll or exclude actors and considerations. Rydin and Tate's [40] edited application of ANT specifically to planning practice demonstrates that a planning instrument's power to shape outcomes lies less in its stated intent than in whether it is actually positioned as an obligatory node in the approval pathway that developers, councils and infrastructure providers cannot bypass. In an EV–land-use system, a state EV strategy can set targets and fund charger hardware, but if the Local Strategic Planning Statement, Development Control Plan, or district zoning instrument through which every private development application must actually pass contains no EV-specific provision, the strategy has no reliable mechanism for translating state ambition into site-level outcomes - it has failed to establish itself, or be established by others, as an obligatory passage point. Conversely, where a local instrument *does* carry EV-ready provisioning, as in the City of Newcastle's 2023 Development Control Plan, it becomes a genuine obligatory passage point that converts every relevant development application, regardless of the applicant's own EV intentions, into an EV-ready outcome. This study's Policy Integration Pathway is, in effect, a map of where NSW's planning system does and does not contain such choke points.

2.6 EV adoption, barriers, and the policy stakes

The practical urgency of closing these institutional gaps follows from the EV-adoption literature's own account of what currently limits uptake. Consumer-adoption studies consistently identify purchase price, model availability, and - centrally for this study - charging access and range anxiety as the dominant barriers to EV adoption across jurisdictions [41, 42], with financial incentives found to correlate with adoption less strongly, and less durably, than charging-infrastructure availability. Forecasting work translating projected EV sales trajectories into emissions-abatement pathways shows that the climate benefit of EV strategies of the kind NSW has adopted is highly sensitive to the *rate* at which charging access is delivered, not only to sales targets [43] - underscoring that the land-use-planning bottlenecks this study identifies are not a secondary implementation detail but a first-order determinant of whether NSW's own legislated emissions targets are achievable on schedule.

2.7 Why New South Wales

NSW offers an unusually well-documented test case for three reasons, the first two empirical and the third distinctively Australian in the planning-scholarship sense. First, it is data-rich: NSW has published two full EV strategies, a dedicated Electric and Hybrid Vehicle Plan, and a dense sequence of charging-grant guidelines that together allow the EV side of the triad to be characterized with genuine primary-source depth. Second, its land-use planning system is unusually explicit and hierarchical, making it a demanding test of whether EV vocabulary penetrates a well-developed planning system rather than an under-developed one. Third, the specific pathology this study documents - strong integration at state-strategy level, weak integration at the statutory local-planning tier - echoes a pattern already identified in Australian planning scholarship more broadly. Legacy's [44] account of the "post political" turn in Australian transport planning documents a persistent gap between rhetorically integrative state strategy and the depoliticized, technocratic instruments through which it is actually implemented; Curtis's [45] study of transit-oriented development around Perth's rail corridors similarly finds that state-level integrated-planning ambition regularly outpaces the statutory land-use tools available to deliver it at the corridor and site scale; and Newton's [46] survey of socio-technical challenges facing Australian cities identifies exactly this state–local implementation gap as a structural, recurring feature of Australian metropolitan governance rather than a NSW-specific anomaly. Read against this literature, the present study's findings suggest NSW's EV–land-use integration gap is not an idiosyncratic failure of any single document but a further instance of a documented Australian planning-system pattern - which is itself a reason to expect the study's diagnostic method to travel to other Australian and comparable federated planning systems.

2.8 Research questions

This study answers six research questions, each directly operationalized in the Results: (RQ1) do NSW land-use plans meaningfully include EV transition and charging-infrastructure concepts; (RQ2) do NSW EV strategies meaningfully include land-use, density, parking, zoning, housing, and spatial-equity concepts; (RQ3) do NSW urban-development and transport strategies integrate EV transition with land-use planning and climate-responsive urban growth; (RQ4) which concepts act as bridges between EV planning, land-use planning, and urban-development policy; (RQ5) where are the strongest conceptual gaps in NSW planning documents.

3. Methodology

3.1 Corpus construction

The corpus was assembled by systematically identifying official documents from NSW Government agencies (DCCEEW / Office of Energy and Climate Change, Transport for NSW, the Department of Planning, Housing and Infrastructure and its predecessor departments, the Greater Sydney Commission) and from two NSW local councils and one strata-sector peak body, following the three-category structure specified for this study: EV-centered documents, land-use-centered documents, and Cross-cutting documents (neither purely land-use nor purely EV-focused). Documents were included if they were (a) official or authoritative (government-issued, or an official stakeholder submission responding directly to a statutory instrument), (b) current at the time of writing (July 2026) or the most recent version of an instrument still in force, and (c) available as an accessible PDF or web-published text. Table 1 lists the final 30-document corpus with full metadata; Figure 2 summarizes the selection workflow.

Table 1
Full NSW corpus: 30 documents across EV-centered, land-use-centered, and Cross-cutting categories, with issuing agency, geographic coverage, and document type

ID	Document Title	Year	Issuing Agency	Geographic Coverage	Document Type	Analytical Category
A01	NSW Electric Vehicle Strategy (2026)	2026	NSW Dept of Climate Change, Energy, the Environment and Water	Statewide	Strategy	EV-centered
A02	NSW Electric Vehicle Strategy (2021)	2021	Environment Energy and Science, DPIE	Statewide	Strategy	EV-centered
A03	NSW Electric and Hybrid Vehicle Plan	2019	Transport for NSW	Statewide	Plan	EV-centered
A04	EV Curbside Charging Grants Round 1 Guidelines	2023	Office of Energy and Climate Change, NSW Treasury	Statewide (LGA-targeted)	Guideline	EV-centered
A05	EV Fleets Incentive: Kick-start Funding Guidelines	2025	NSW DCCEEW	Statewide	Guideline	EV-centered
A06	Towards Net Zero Emissions Freight Policy	2023	Transport for NSW	Statewide	Policy	EV-centered
A07	EV Fast Charging Grants (Round 4) Guidelines	2025	NSW DCCEEW	Statewide	Guideline	EV-centered
A08	EV Destination Charging Grants (Round 3) Guidelines	2025	NSW DCCEEW	Regional NSW	Guideline	EV-centered
A09	EV Curbside Charging Council Capacity Building Fund	2026	NSW DCCEEW	Statewide	Funding program	EV-centered
B01	Greater Sydney Region Plan: A Metropolis of Three Cities	2018	Greater Sydney Commission	Greater Sydney	Regional plan	Land-use-centered
B02	Housing 2041: NSW Housing Strategy	2021	DPIE	Statewide	Strategy	Land-use-centered
B03	Industrial Lands Action Plan	2025	DPHI	Statewide	Action plan	Land-use-centered
B04	Local Strategic Planning Statements Guideline for Councils	2018	DPE	Statewide	Guideline	Land-use-centered
B05	Western City District Plan	2018	Greater Sydney Commission	Western Parkland City district	District plan	Land-use-centered

B06a	Central City District Plan	2018	Greater Sydney Commission	Central River City district	District plan	Land-use-centered
B06b	Eastern City District Plan	2018	Greater Sydney Commission	Eastern Harbour City district	District plan	Land-use-centered
B06c	North District Plan	2018	Greater Sydney Commission	Eastern Harbour City district	District plan	Land-use-centered
B06d	South District Plan	2018	Greater Sydney Commission	Eastern Harbour City district	District plan	Land-use-centered
C01	Future Transport Strategy 2056	2018	Transport for NSW	Statewide	Strategy	Cross-cutting
C02	Smart Places Strategy	2020	Dept of Customer Service, Cities and Active Transport	Statewide	Strategy	Cross-cutting
C03	Smart NSW Roadmap 2022-2027	2022	Transport for NSW, Cities and Active Transport	Statewide	Roadmap	Cross-cutting
C04	Net Zero and Climate Change Policy (CP23006)	2023	Transport for NSW	Statewide	Policy	Cross-cutting
C05	Transport Environment and Sustainability Policy / Sustainability Plan	2023	Transport for NSW	Statewide	Policy/Plan	Cross-cutting
C06	Net Zero Cities Action Plan	2023	Transport for NSW, Smart Places and Net Zero Cities	Statewide	Action plan	Cross-cutting
C07	Central Coast Regional Plan 2041	2023	DPHI	Central Coast region	Regional plan	Cross-cutting
C08	Hunter Regional Plan 2041	2023	DPHI	Hunter region	Regional plan	Cross-cutting
C09	Illawarra Shoalhaven Regional Plan 2041	2021	DPIE / DPHI	Illawarra Shoalhaven region	Regional plan	Cross-cutting
L01	OCN Submission - Woollard DCP 2015 Amendment 33	2025	Owners Corporation Network	Woollard LGA	Stakeholder submission	EV-centered
L02	Newcastle DCP 2023 - Section C1 Traffic Parking and Access	2023	City of Newcastle Council	Newcastle LGA	Development control plan	Land-use-centered
L03	Powering Ahead: EV Encouragement Strategy and Action Plan	2023	Inner West Council	Inner West LGA	Local strategy	EV-centered

The final corpus is deliberately broader in scope than a state-strategy-only corpus: it includes three local-government-tier documents a City of Newcastle Development Control Plan section (2023), an Inner West Council EV Encouragement Strategy and Action Plan (2023) [47], and a strata-sector peak-body submission on a Woollard Council DCP amendment (2025) - because the local statutory-planning tier is where EV-ready provisioning is actually applied to individual development applications, and because its omission would bias any integration analysis toward the state tier where cross-referencing is structurally easier to achieve.

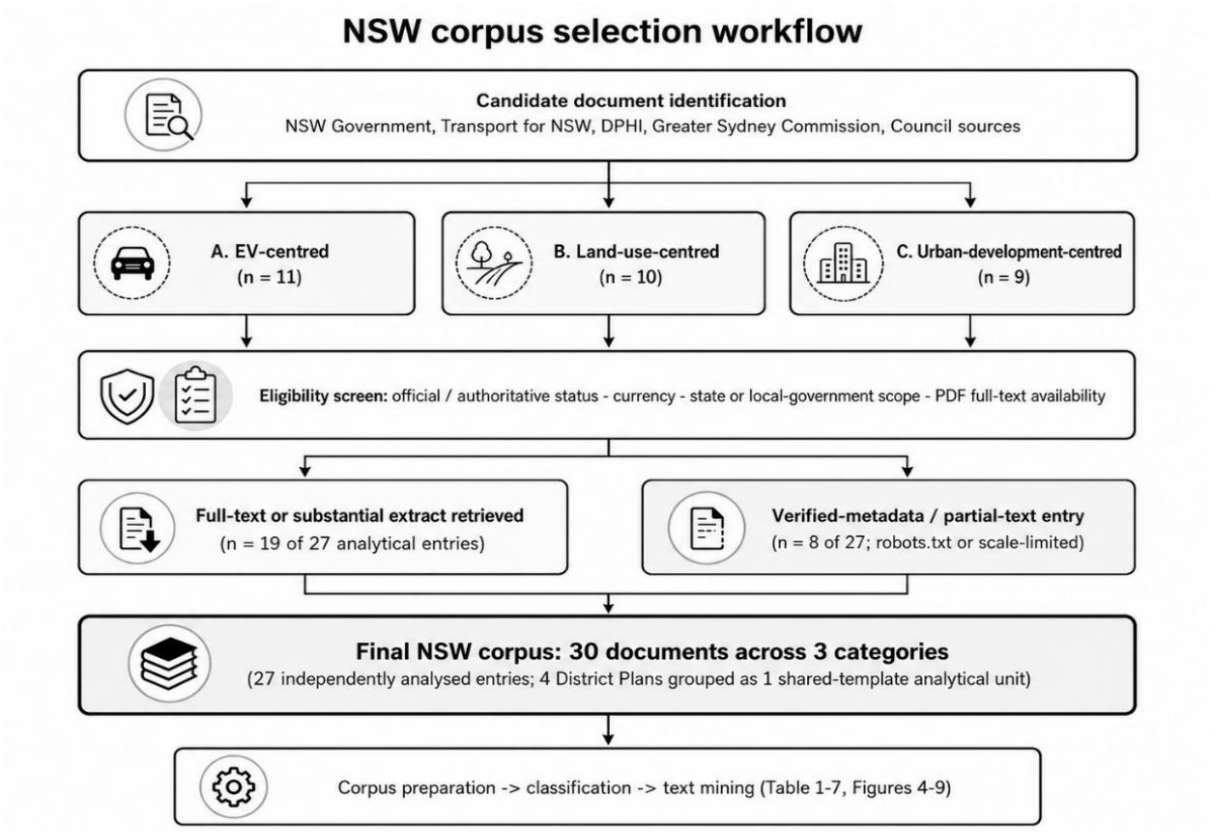

Fig. 2. NSW corpus selection workflow, from candidate identification through eligibility screening to the final 30-document, 27-analytical-unit corpus

3.3 Keyword dictionaries

Three domain dictionaries were developed, extending the seed terms specified in the study brief with additional terms that emerged empirically during corpus reading (a standard, transparent form of dictionary refinement in applied keyword-frequency studies), implemented as regular-expression patterns to capture inflected forms (e.g. "charger"/"chargers," "zone"/"zoned"/"zoning"). The EV dictionary (16 terms) covers EV/electric vehicle, charging, charger, charging infrastructure, fast/ultra-fast charging, curbside charging, fleet electrification, battery electric vehicle, low/zero-emission vehicle, plug-in hybrid, hydrogen fuel cell, charging point/station, vehicle-to-grid/bidirectional charging, range anxiety, EV-ready, smart charger, and destination charging. The land-use dictionary (19 terms) covers land use, zoning, density, mixed use, urban form, parking, housing, residential, commercial, industrial land, accessibility, centers, compact development, Development Control Plan, Local Environmental Plan, Local Strategic Planning Statement, precinct, district/regional plan, dwelling, car space, affordable housing, transit-oriented development, employment land, and development application. The cross-cutting dictionary (14 terms) covers climate action, net zero, smart city/places, infrastructure, sustainability, resilience, urban growth, strategic centers, TOD, mobility, equity, freight, decarbonization, emissions, renewable energy, digital twin, connected/automated vehicles, and renewable energy zone. Full dictionaries are reported in Table 2.

Table 2
Domain keyword dictionaries applied as regular-expression patterns across the corpus

Dictionary	Terms
EV dictionary	EV / electric vehicle; Charging / charger; Charging infrastructure; Fast / ultra-fast charging; Curbside charging; Fleet electrification; Battery electric vehicle (BEV); Low- / zero-emission vehicle; Plug-in hybrid (PHEV); Hydrogen fuel cell (FCEV); Charging point / station; V2G / bidirectional charging; Range anxiety; EV-ready; Smart charger; Destination charging; Public charging
Land-use dictionary	Land use; Zoning; Density; Mixed use; Urban form; Parking; Housing; Residential; Commercial; Industrial land; Accessibility; Centers; Compact development; Development Control Plan (DCP); Local Environmental Plan (LEP); Strategic Planning Statement (LSPS); Precinct; District / Regional Plan; Dwelling; Car space / parking bay; Affordable housing; Transit-oriented development (TOD); Employment land; Development application (DA)
Cross-cutting dictionary	Climate action / climate change; Net zero; Smart city / smart places; Infrastructure; Sustainability; Resilience; Urban growth; Strategic centers; TOD / transit-oriented; Mobility; Equity; Freight; Decarbonization; Emissions; Renewable energy; Digital twin; Connected & automated vehicles (CAV); Renewable Energy Zone (REZ)

3.2 Document classification

Each document was classified into one of three categories based on its dominant policy focus, following the classification logic specified in the study brief: EV-centered (n = 11) - documents whose primary subject is EV uptake, charging infrastructure, or transport electrification (e.g. the NSW Electric Vehicle Strategy 2021 and 2026, EV charging grant guidelines, the Towards Net Zero Emissions Freight Policy, and the two council/stakeholder EV documents); land-use-centered (n = 10, of which four District Plans share a single analytical text unit) - documents whose primary subject is spatial planning, housing, zoning, or industrial land (e.g. the Greater Sydney Region Plan and District Plans, Housing 2041, the Industrial Lands Action Plan, the Local Strategic Planning Statement Guideline, and the Newcastle DCP); and Cross-cutting (n = 9) - broader documents addressing urban growth, climate action, smart cities, or integrated transport that are neither primarily organized around EV content nor primarily organized around land-use content (e.g. Future Transport Strategy 2056, the Smart Places Strategy, the Net Zero Cities Action Plan, Transport for NSW's climate and sustainability policies, and three Regional Plans). Classification was performed by the lead analyst on the basis of each document's stated purpose, issuing program, and dominant section structure, and is reported per-document in Table 3 with a one-line justification.

Table 3
Document classification and one-line justification of dominant policy focus

ID	Document title	Analytical category	Classification justification (dominant policy focus)
A01	NSW Electric Vehicle Strategy (2026)	EV-centered	Flagship state EV strategy; funding, targets, charger rollout are the entire document focus.
A02	NSW Electric Vehicle Strategy (2021)	EV-centered	Original flagship state EV strategy establishing rebates, charging network and RUC framework.
A03	NSW Electric and Hybrid Vehicle Plan	EV-centered	Dedicated Transport for NSW plan defining EV charging standards referenced across the corpus.
A04	EV Curbside Charging Grants Round 1 Guidelines	EV-centered	Grant guideline whose sole purpose is co-funding curbside EV charger installation.
A05	EV Fleets Incentive: Kick-start Funding Guidelines	EV-centered	Grant guideline co-funding EV fleet vehicle and charger procurement.

A06	Towards Net Zero Emissions Freight Policy	EV-centered	Freight decarbonization policy organized around EV/LZEV truck and rail transition.
A07	EV Fast Charging Grants (Round 4) Guidelines	EV-centered	Grant guideline co-funding public fast/ultra-fast EV charging stations.
A08	EV Destination Charging Grants (Round 3) Guidelines	EV-centered	Grant guideline co-funding EV charging at regional tourism destinations.
A09	EV Curbside Charging Council Capacity Building Fund	EV-centered	Funding program building council capability to plan EV curbside charging rollout.
B01	Greater Sydney Region Plan: A Metropolis of Three Cities	Land-unscented	Region-wide statutory land-use plan; EV content is one objective among 40.
B02	Housing 2041: NSW Housing Strategy	Land-unscented	Statewide housing strategy; land-use supply, diversity and density are the core focus.
B03	Industrial Lands Action Plan	Land-unscented	Statewide industrial/employment land categorization and supply-pipeline policy.
B04	Local Strategic Planning Statements Guideline for Councils	Land-unscented	Statutory template guiding every council's 20-year local land-use vision document.
B05	Western City District Plan	Land-unscented	District-level statutory land-use plan implementing the Region Plan for Western Sydney.
B06a	Central City District Plan	Land-unscented	District-level statutory land-use plan implementing the Region Plan (Central River City).
B06b	Eastern City District Plan	Land-unscented	District-level statutory land-use plan implementing the Region Plan (Eastern Harbour City).
B06c	North District Plan	Land-unscented	District-level statutory land-use plan implementing the Region Plan (Eastern Harbour City).
B06d	South District Plan	Land-use-centered	District-level statutory land-use plan implementing the Region Plan (Eastern Harbour City).
C01	Future Transport Strategy 2056	Cross-cutting	Overarching 40-year transport strategy integrating land use, mobility and technology -- neither a land-use plan nor an EV strategy, but structurally dependent on both.
C02	Smart Places Strategy	Cross-cutting	Whole-of-government digital/smart-infrastructure strategy for places and precincts.
C03	Smartness Roadmap 2022-2027	Cross-cutting	Delivery roadmap operationalizing the Smart Places Strategy across precincts and regions.
C04	Net Zero and Climate Change Policy (CP23006)	Cross-cutting	Transport for NSW's binding net-zero and climate-risk policy across all transport agencies.
C05	Transport Environment and Sustainability Policy / Sustainability Plan	Cross-cutting	Transport for NSW's whole-of-agency sustainability policy and reporting framework.
C06	Net Zero Cities Action Plan	Cross-cutting	Cross-sectoral net-zero-precinct action plan spanning buildings, energy and mobility.
C07	Central Coast Regional Plan 2041	Cross-cutting	Regional statutory land-use plan for the Central Coast within the Six Cities Region.
C08	Hunter Regional Plan 2041	Cross-cutting	Regional statutory land-use plan for the Hunter within the Six Cities Region.
C09	Illawarra Shoalhaven Regional Plan 2041	Cross-cutting	Regional statutory land-use plan for Illawarra Shoalhaven within the Six Cities Region.
L01	OCN Submission - Woollard DCP 2015 Amendment 33	EV-centered	Strata-sector technical submission reconciling NCC EV provisions with a local DCP amendment.
L02	Newcastle DCP 2023 - Section C1 Traffic Parking and Access	Land-unscented	Local government DCP with a dedicated, technically detailed electric car parking section.
L03	Powering Ahead: EV Encouragement Strategy and Action Plan	EV-centered	Local council EV strategy explicitly mandating future DCP amendments for EV-ready parking.

3.4 Topic modelling

Non-negative matrix factorization (NMF) [48] was applied in preference to Latent Dirichlet Allocation (LDA) [49], consistent with the analyst's established methodological practice, for its more interpretable non-negative topic-word loadings on a corpus of this scale: NMF's parts-based, additive decomposition tends to produce sparser, more human-interpretable topic-term associations than LDA's probabilistic generative model on small-to-medium corpora, where LDA's Dirichlet priors are harder to fit reliably with limited documents. This choice follows a broader turn in computational social science and policy studies toward treating text corpora as structured data amenable to systematic, replicable analysis rather than solely to close reading [50]; topic modelling specifically has been applied productively to qualitative policy-document corpora as a complement to, not a replacement for, human interpretation, provided the resulting topics are validated against domain knowledge rather than reported as self-evidently meaningful [51, 52] - a validation this study performs by cross-checking each NMF topic's top-loading terms and category prevalence against the keyword-dictionary and TIS results independently (Table 4). Because the analytical corpus comprises 27 independently analyzed text units of variable, generally modest length. topic modelling was performed at the paragraph level rather than the whole-document level (93 paragraph-level chunks of ≥25 words, drawn from all 27 units) to increase the effective number of samples available to the factorization - an explicit adaptation of the standard document-level NMF workflow, documented here rather than silently assumed. Text was vectorized with TF-IDF (unigrams and bigrams, custom stop-word list including generic NSW/government/date tokens, minimum document frequency 2, maximum document frequency 0.85). The number of topics (K) was selected by inspecting the reconstruction-error curve across K = 3–12 in conjunction with topic-level interpretability; K = 8 was retained as the smallest K producing topics that were both internally coherent and mutually distinguishable. Each paragraph's dominant topic (highest NMF loading) was used to compute topic prevalence by document category (Figure 3).

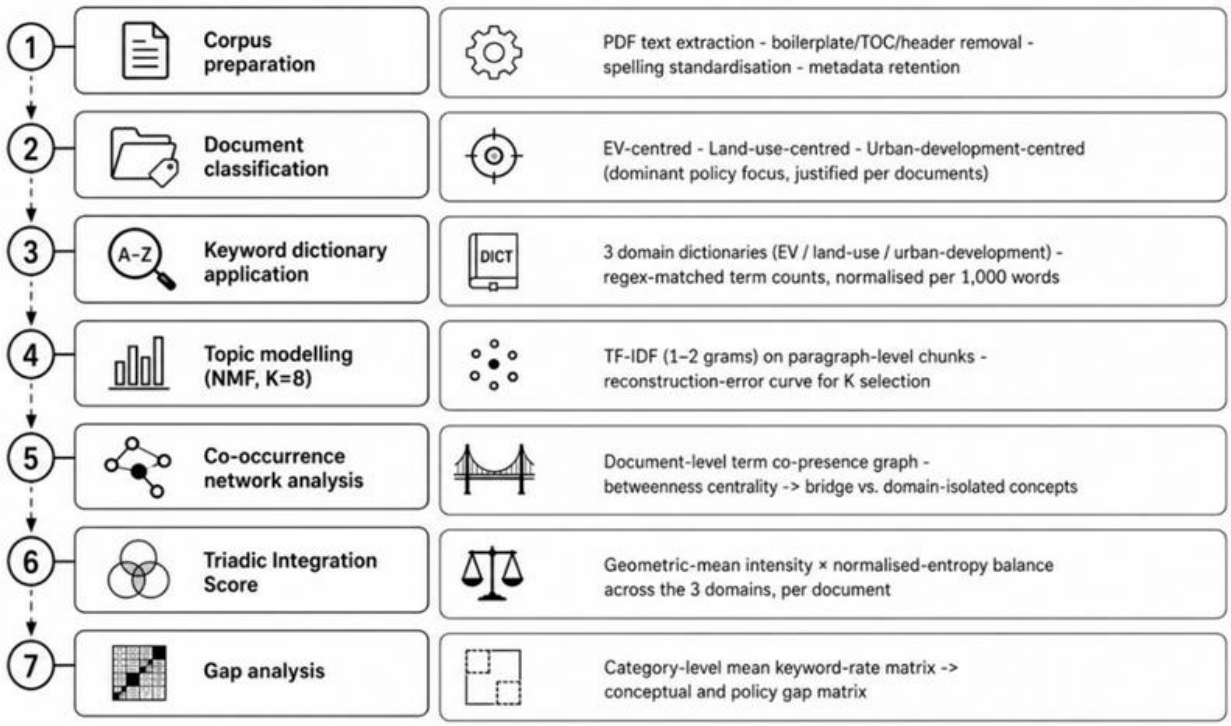

Fig. 3. Methodological workflow for text mining and topic modelling, from corpus preparation through gap analysis

Table 4
NMF topic model (paragraph-level, K = 8) with top-10 loading terms per topic and the share of each document category's paragraphs for which that topic is dominant

#	Topic label	Top 10 terms (NMF)	EV docs	Land-use docs	Cross-cutting docs
T0	Charging rollout & curbside funding	EV, fast, charging, support, chargers, regional, fast charging, drivers, curbside, million	15.8%	0%	0%
T1	Strategic land-use & smart places planning	housing, local, planning, strategic, strategic planning, area, smart, plans, places, local strategic	1.8%	29.2%	41.7%
T2	Net-zero, climate & freight decarbonization	net, zero, net zero, emissions, transport, policy, freight, smart, climate, sustainability	12.3%	4.2%	25%
T3	EV electrical / technical specification	section, spaces, electrical, eve, 7kw, requires, phase, electric, power, cable	15.8%	16.7%	0%
T4	Industrial lands & freight significance	lands, industrial, industrial lands, significant, freight, land, statewide, significant industrial, regionally significant, regionally	1.8%	20.8%	8.3%
T5	EV vehicle market (fleet, sales, trucks)	eves, vehicles, electric, battery, vehicle, sales, trucks, hybrid, emissions, fleet	35.1%	0%	8.3%
T6	District / LGA geography	city, district, lags, Sydney, central, north, western, hunter, river, eastern	1.8%	16.7%	16.7%
T7	EV charging + parking (land-use bridge)	charging, parking, private, public, eve, ev charging, encourage, use, street, charging facilities	15.8%	12.5%	0%

3.5 Co-occurrence network and Triadic Integration Score

A document-level co-occurrence network was built with dictionary terms as nodes (restricted to terms present in ≥2 documents) and edge weights equal to the number of documents in which both terms are present (co-occurrence threshold ≥3 documents for a drawn edge). Betweenness centrality was computed to identify bridge concepts - terms whose network position most connects the EV, land-use, and cross-cutting term clusters - and terms whose co-occurring neighbors fall entirely within their own domain were flagged as domain-isolated concepts. (Figure 4)

We define the Triadic Integration Score (TIS) for document *I* as a combination of (a) an *intensity* component - the geometric mean of the three min–max-scaled domain keyword rates, which is zero if any one domain is entirely absent and rewards genuine tri-domain co-presence over strength in only one or two domains - and (b) a *balance* component - the normalized Shannon entropy of the three raw domain-rate shares (0 = concentrated in a single domain, 1 = perfectly even across all three):

$$TIS_i = 100 \times [0.5 \cdot intensity_i + 0.5 \cdot balance_i] / \max(0.5 \cdot intensity + 0.5 \cdot balance) \quad (1)$$

This formulation directly implements the study brief's specification (EV + land-use + cross-cutting keyword frequency, combined with cross-domain co-occurrence) while remaining fully transparent and reproducible: no term is manually weighted, and the score can be recomputed from the term-count matrix alone (Table 5, Figure 5).

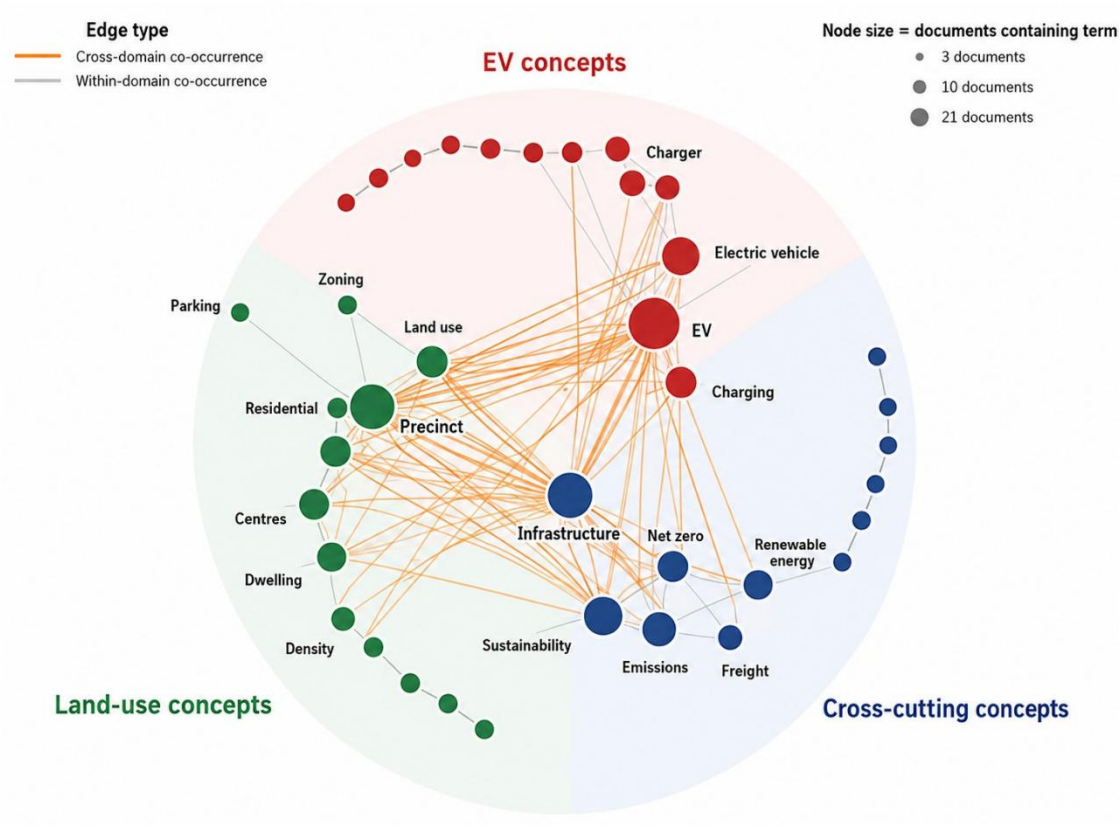

Fig. 4. EV–land-use–cross-cutting keyword co-occurrence network. Node position: bridging terms sit nearer the center; domain-specific terms sit toward their own sector. Node size reflects the number of documents containing the term; orange edges denote cross-domain co-occurrence

Table 5
The 15 highest-betweenness-centrality concepts in the co-occurrence network - the terms that most connect the EV, land-use, and cross-cutting term clusters

Concept (bridge term)	Home domain	Betweenness centrality
infrastructure	Cross-cutting	0.1361
charging	EV	0.1319
land use	Land-use	0.0438
EV	EV	0.0424
Electric vehicle	EV	0.0306
sustainability	Cross-cutting	0.0225
zoning	Land-use	0.0205
parking	Land-use	0.0145
charger	EV	0.0126
emissions	Cross-cutting	0.0117
net zero	Cross-cutting	0.0113
residential	Land-use	0.0107
precinct	Land-use	0.0095
renewable energy	Cross-cutting	0.0093
centers	Land-use	0.0076

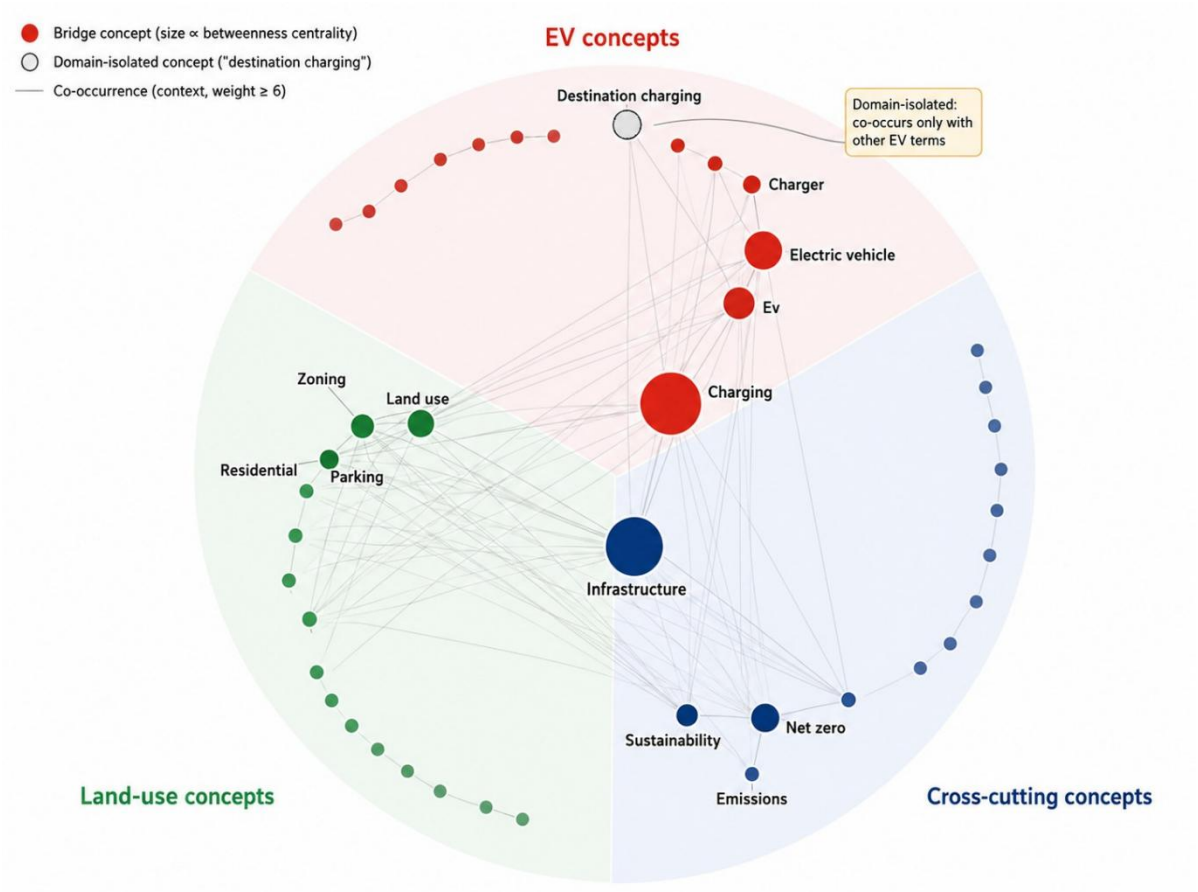

Fig. 5. Semantic network highlighting bridge concepts (sized by betweenness centrality) against the single domain-isolated concept identified in the corpus, with an explanatory callout ("destination charging")

4. Results

4.1 Corpus composition

The final corpus comprises 30 official NSW documents (27 independently analyzed text units) spanning EV-centered (n = 11), land-use-centered (n = 10, including four District Plans grouped as one analytical unit), and Cross-cutting (n = 9) categories. The corpus spans 2018–2026, reflecting both long-standing planning instruments (the 2018 Greater Sydney Region Plan and District Plans) and the most recent policy cycle (the April 2026 NSW Electric Vehicle Strategy). Issuing agencies span the energy/climate portfolio (DCCEEW and its predecessors), the transport portfolio (Transport for NSW), the planning portfolio (DPHI and its predecessors, the Greater Sydney Commission), and local government (City of Newcastle, Inner West Council) and the strata sector (Owners Corporation Network) - a deliberately wider agency spread than a state-strategy-only corpus would capture.

4.2 RQ2 - Do NSW EV strategies meaningfully include land-use concepts?

The EV-centered category records a mean land-use keyword rate of 27.1 per 1,000 words against a mean EV keyword rate of 72.8 - land-use vocabulary is present, but at roughly one-third the density of the category's own core vocabulary. This average, however, conceals a sharp internal split. Grant- and program-level EV documents carry substantial land-use content: the EV Curbside Charging Grants Round 1 Guidelines [53] (TIS = 91.3) explicitly organize co-funding eligibility by Local Government Area dwelling-density profile and impose sitting rules referencing footpaths, driveways, accessways and cycleways - land-use categories in all but name. By contrast, the two-flagship EV *strategy* documents score markedly lower: the 2021 Strategy (TIS = 64.5, land-use rate 6.5) and, more strikingly, the 2026 Strategy (TIS = 61.8, land-use rate 1.9) - the lowest land-use keyword rate of any EV-centered document in the corpus. The 2026 refresh, despite being the most recent, most heavily funded, and most comprehensively reviewed EV policy document in NSW, is the corpus document that engages *least* with land-use vocabulary of any kind. Its "immediate areas of focus" are organized entirely around funding-round mechanics (fast-charging blackspots, curbside rollout, fleet incentives, workforce training) without reference to zoning, density, parking provision, or the statutory planning instruments through which every one of those chargers must ultimately be sited. This directly answers RQ2: NSW's grant-delivery EV instruments are land-use literate; its two headline EV strategies are not.

4.3 RQ1 - Do NSW land-use plans meaningfully include EV concepts?

The land-use-centered category records a mean EV keyword rate of 12.3 per 1,000 words against a mean land-use rate of 67.3 - the weakest of the three off-diagonal cells in the gap matrix and the corpus's clearest asymmetry. Three of the category's seven independently analyzed entries record an EV keyword rate of exactly zero: the Industrial Lands Action Plan (2025), the Local Strategic Planning Statement (LSPS) Guideline for Councils, and the four grouped District Plans. The LSPS finding is the most consequential, since the LSPS is the one document class in this entire corpus that every NSW council is statutorily required to produce and that directly shapes local zoning and infrastructure priorities for a twenty-year horizon; its own illustrative theme list names "transport/connectivity" as a suggested planning theme without electric-vehicle infrastructure appearing anywhere among the suggested content. The Industrial Lands Action Plan (2025) - a document published four years *after* the original NSW EV Strategy, in a policy area (freight and

logistics land) that the state's own Freight Policy explicitly links to fleet 4 electrification - likewise contains no EV vocabulary despite extensive treatment of "freight," "logistics," and "net zero." Not every land-use document is EV-silent: the Greater Sydney Region Plan (TIS = 90.4) and the Newcastle DCP (TIS = 80.4) both carry substantial EV content, the former through an explicit Objective ("infrastructure adapts to meet future needs... design places for electric vehicle recharging") and the latter through a dedicated, technically detailed Section 11 "Electric car parking." This directly answers RQ1: land-use integration of EV concepts in NSW is bimodal - present and detailed where a document engages built-form and development-control detail (Region Plan, council DCP), and essentially absent where a document is a process/template instrument (LSPS Guideline) or a land-supply instrument organized around a different infrastructure logic (Industrial Lands).

4.4 RQ3 - Do NSW cross-cutting strategies integrate EV and land-use?

The Cross-cutting category achieves the corpus's most *even* three-way profile (EV 14.8, land-use 21.2, cross-cutting 52.7 per 1,000 words) and contains the corpus's second-highest-scoring document overall: the Net Zero Cities Action Plan (TIS = 98.6), which explicitly commits to a "trial of vehicle-to-grid capability... to ensure bi-directional charging technology can be adopted easily," directly linking EV/V2G technology to precinct-scale net-zero and smart-grid planning. Future Transport Strategy 2056 (TIS = 94.9) similarly integrates EV content directly into land-use design guidance, recommending that "conveniently located charging stations" be incorporated into the Apartment Design Guide - one of the few instances in the entire corpus of an EV provision being written directly into a residential built-form design instrument. Not all cross-cutting documents integrate equally, however: the three Regional Plans score markedly lower (Central Coast 89.8, Hunter 62.6, Illawarra Shoalhaven 58.4) and two of the three (Hunter, Illawarra Shoalhaven) record zero direct EV vocabulary despite extensive freight-corridor and Renewable Energy Zone content. This answers RQ3: NSW's cross-cutting and smart-cities-adjacent documents are where the strongest genuine triadic integration is found, but this strength is concentrated in Sydney-basin, precinct-scale instruments (Net Zero Cities, Future Transport) rather than in the state's nine Regional Plans, which behave more like the land-use category than the cross-cutting category on this dimension (Figure 6).

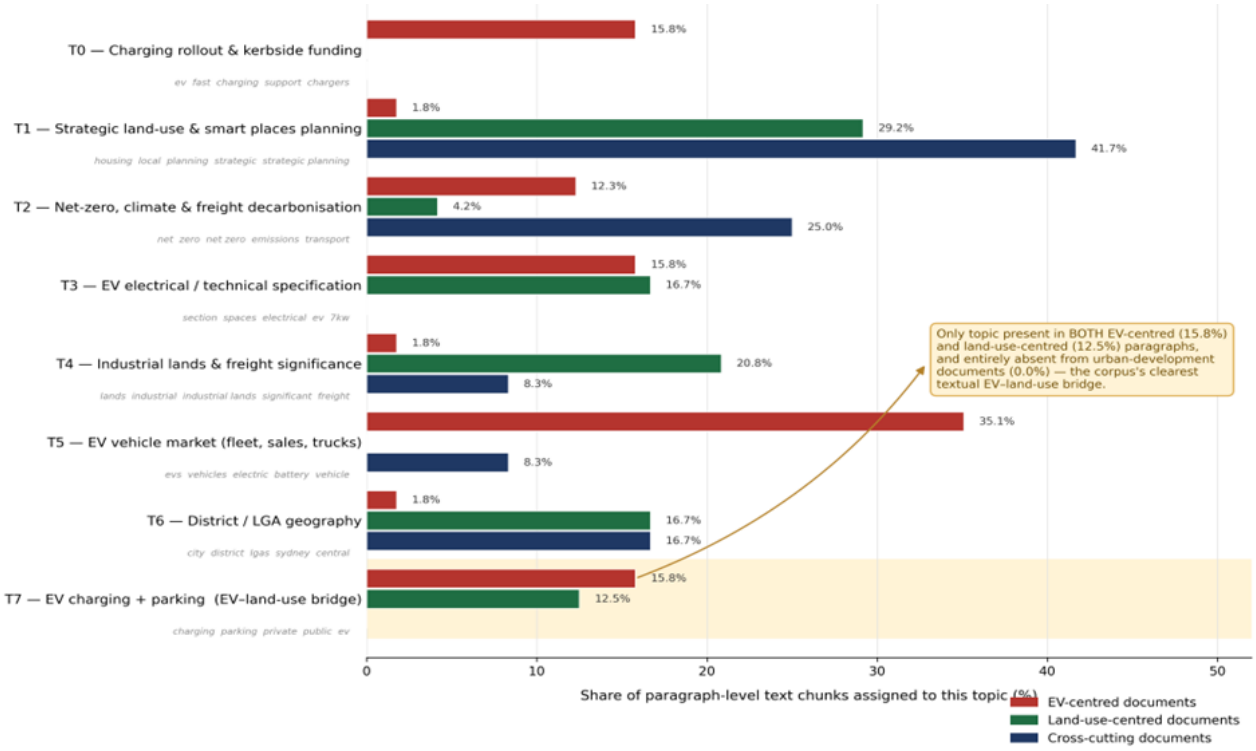

Fig. 6. Dominant-topic prevalence by document category, showing Topic 7 (EV charging + parking) as the corpus's clearest EV–land-use hybrid topic

4.5 RQ4 - Bridging concepts

The co-occurrence network (52 nodes, 396 edges after thresholding) identifies "infrastructure" (cross-cutting domain, betweenness = 0.136) and "charging" (EV domain, betweenness = 0.132) as the corpus's two dominant bridging concepts, followed by "land use" (0.044), "EV" (0.042), and "electric vehicle" (0.031). The single highest-weight cross-domain co-occurrence in the corpus is charging infrastructure (18 documents), followed by ev↔infrastructure (15) and charging↔land use (14) . "Parking" and "zoning" are the strongest land-use-side bridges into the EV and cross-cutting domains respectively. Only one dictionary term - "destination charging" - is fully domain-isolated, co-occurring exclusively with other EV terms and never with any land-use or cross-cutting concept in the same document (Figure 6); this is consistent with destination charging's institutional profile as a regional tourism/hospitality-precinct program administered separately from both the curbside (residential-density) and fast-charging (highway-corridor) programs. This answers RQ4: "infrastructure" and "charging" are the corpus's genuine lingua franca - the words that let an EV document, a land-use document, and a cross-cutting document be read as part of the same conversation - while "land use" itself, though present as a bridge, is used markedly less by EV-centered documents than "infrastructure" is used by land-use and cross-cutting documents, indicating the bridging vocabulary flows more readily from EV into infrastructure-speak than from EV into land-use-speak specifically.

4.6 RQ5 - Strongest conceptual gaps

The gap matrix shows the EV→land-use cell (12.3) as numerically the weakest off-diagonal relationship in the corpus, narrowly below EV→cross-cutting (14.8) and well below crosscutting→land-use (21.2) and land-use→cross-cutting (19.7). Read alongside Section 4.3's finding that the cross-cutting category is the most evenly integrated, the picture is one of a genuine but *partial* triad: the cross-cutting category functions as a reasonably effective hinge between the other two domains, but the EV–land-use relationship - the specific pairing this study was designed to interrogate - remains the corpus's single weakest link, and is weakest of all at the local statutory-planning tier. The topic model corroborates this at the paragraph level: only one of the eight NMF topics (Topic 7: "charging, parking, private, public, EV, EV charging, encourage, street, charging facilities") functions as a genuine EV–land-use hybrid topic, drawing 15.8% of EV-category paragraphs and 12.5% of land-use-category paragraphs but 0% of cross-cutting-category paragraphs - the EV–land-use bridge, where it exists textually, is carried by a narrow, specific vocabulary of parking and street-level provisioning rather than by the corpus's broader strategic vocabulary.

Ranking all 27 independently analyzed entries by TIS, the top five are the *NSW Electric and Hybrid Vehicle Plan* (100.0), the *Net Zero Cities Action Plan* (98.6), *Future Transport Strategy 2056* (94.9), the *EV Curbside Charging Grants Round 1 Guidelines* (91.3), and the *Inner West Council EV Encouragement Strategy* (91.1) - three EV-centered documents and two urban-development-centered documents, and no land-use-centered document in the top five. By category means (excluding the shared-text District Plan grouping), EV-centered documents record the highest average TIS (78.2), narrowly ahead of urban-development-centered documents (75.7), with land-use-centered documents clearly lowest (68.8) (Table 6). This directly answers RQ6: the highest-integration document type in the NSW corpus is not a land-use instrument at all, but action- and program-level EV and urban-development documents that are written with an explicit cross-sectoral delivery mandate (a council EV action plan that must specify DCP amendments; a net-zero-cities plan that must specify V2G trials; a curbside-grant guideline that must specify LGA-level siting rules) - rather than either single-sector strategy documents (the state EV Strategies) or high-level land-use vision documents (the LSPS Guideline, the Industrial Lands Action Plan), which occupy the bottom of the ranking in both categories.

Table 6
Mean keyword rate (per 1,000 words) for each concept domain, computed within each document category - the corpus's direct empirical answer to RQ1–RQ3

Document category	Mean EV rate	Mean land-use rate	Mean urban-dev rate
EV-centered documents	72.8	27.1	19
Land-use-centered documents	12.3	67.2	19.7
Cross-cutting documents	14.8	21.2	52.7

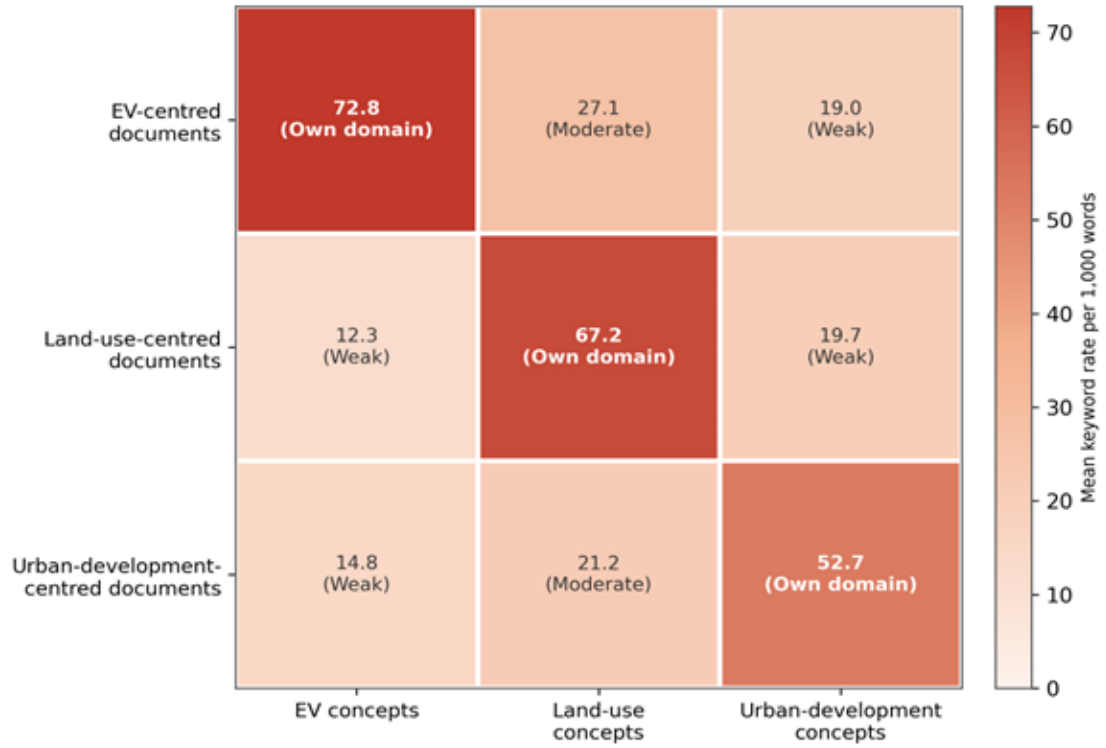

Fig. 7. Conceptual and policy gap matrix. Diagonal cells (bold) show each category's own-domain intensity; off-diagonal cells show cross-domain integration strength

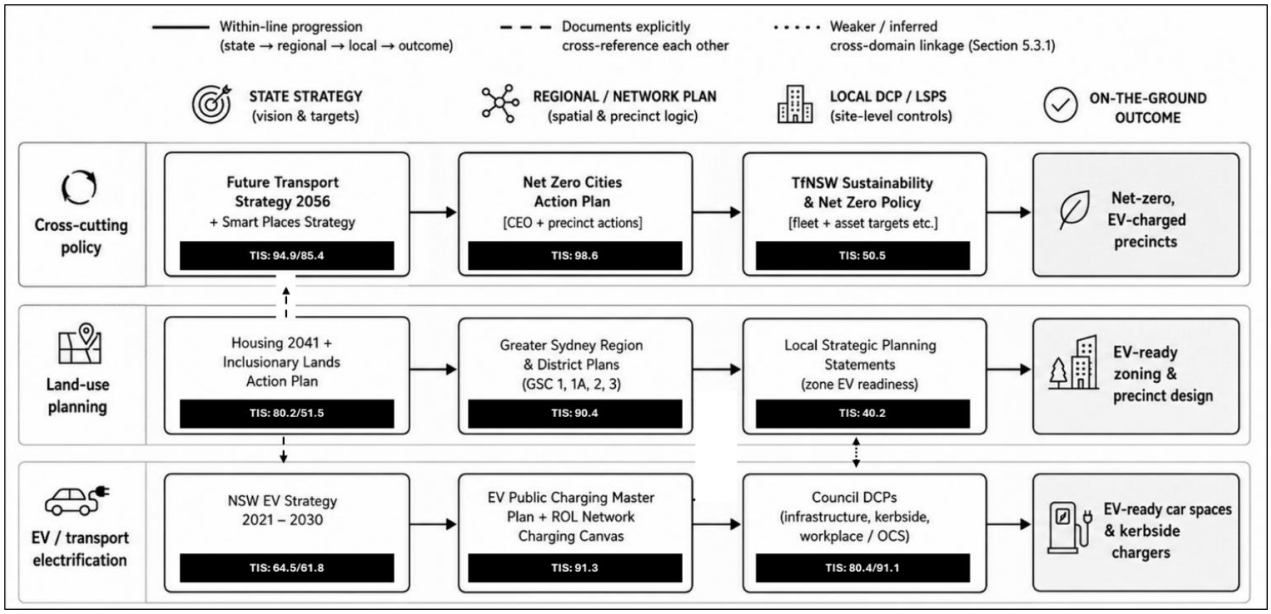

Fig. 8. Policy integration pathway for EV-ready land-use planning in NSW, tracing state strategy through regional/network plans to local DCP/LSPS instruments and site-level EV-ready outcomes, with each document badge showing its Triadic Integration Score; the weakest identified linkage sits at the local statutory-planning tier

5. Discussion

5.1 A partial triad, not a missing one

The headline finding of this study is not that NSW's EV, land-use, and cross-cutting policy domains are disconnected - the co-occurrence network shows 396 cross-domain and within-domain edges across just 52 terms, and "infrastructure" and "charging" function as genuine, well-used bridging vocabulary. The finding is more specific and, for policy purposes, more useful: integration in NSW is *real but uneven*, concentrated in action- and program-level instruments with an explicit delivery mandate, and structurally weakest in exactly the two instrument types that, in an Australian state planning system, carry the most binding long-term authority over where and how development occurs - the Local Strategic Planning Statement and, to a lesser extent, the regional and district plans. This is consistent with the obligatory-passage-point logic: a state EV strategy can fund chargers indefinitely, but if the statutory instrument that every development application must pass through is silent on EV provisioning, the strategy's reach into the built environment depends entirely on *ad hoc*, document-by-document borrowing of EV content into individual council DCPs - exactly the pattern this corpus documents, with Newcastle (TIS = 80.4) and Inner West (TIS = 91.1) each independently drafting detailed EV provisions absent any equivalent requirement in the LSPS template that formally sits above their own strategic planning documents.

5.2 Why the newest EV strategy is the least land-use-integrated document in its own category

In April 2026 NSW Electric Vehicle Strategy records the *lowest* land-use keyword rate of any EV-centered document in the corpus (1.9 per 1,000 words) is counter-intuitive on its face - later policy documents are usually expected to be more integrative, not less, as a jurisdiction's institutional learning accumulates. A plausible reading, consistent with the document's own content, is that the 2026 refresh is explicitly organized around what remains *undelivered* from the 2021 Strategy - closing regional and remote charging blackspots, expanding fleet incentives to trucks, training a regional EV-mechanic workforce - a genuinely operational, funding-round-structured document rather than a foundational strategy document. Foundational strategy documents, precisely because they must justify *why* EV transition matters, tend to gesture toward adjacent policy domains (as the 2021 Strategy did, briefly, toward apartment retrofitting and council planning guidelines); operational refresh documents, precisely because they are organized around what is already funded and underway, tend to recede into program-delivery vocabulary. If this reading holds, it implies a structural risk for EV policy more generally: as EV strategies mature from foundational to operational, their land-use vocabulary may *narrow* rather than deepen, even as the volume of physical, spatially implicated infrastructure they deliver increases. This is a testable proposition for future longitudinal work and, if it generalizes beyond NSW, a caution for any jurisdiction updating a mature EV strategy: operational refresh is not a substitute for periodically re-anchoring the strategy in its land-use and planning-system context.

5.3 The industrial-lands and freight blind spot

A second policy-relevant asymmetry concerns freight. The *Towards Net Zero Emissions Freight Policy* [54] explicitly treats curbside space, industrial zoning, and the *Western Sydney Aerotropolis* industrial precinct as sites of freight-electrification infrastructure planning, and NSW's own EV Fleets Incentive program now extends co-funding to trucks up to 23 tones GVM [55] - yet the state's

dedicated Industrial Lands Action Plan [5], published in the same policy cycle, contains no EV vocabulary at all despite extensive treatment of the same freight and logistics land uses. This is a concrete, actionable gap rather than an abstract one: as depot-based truck fleets electrify, the industrial and employment-land categorization criteria that the Action Plan is designed to standardize across NSW (state-significant, regionally-significant, locally-significant industrial land) will need to account for depot-scale charging infrastructure and grid-capacity requirements as a site-selection criterion, and the corpus evidence here suggests that work has not yet begun in the document that will most directly govern where such depots can be sited over the next decade.

5.4. Policy implications

The findings have several important implications for planning policy and urban governance. First, the EV transition should be embedded in statutory planning instruments rather than being treated only as a transport, energy, or climate-policy issue. Development Control Plans, Local Environmental Plans, design guidelines, parking controls, and development-assessment requirements should include EV-ready provisions for residential, mixed-use, commercial, employment, and visitor parking. This is particularly important for multi-unit housing, where residents often lack private garages and face higher barriers to home charging. Second, charger-location policy should be explicitly guided by land-use typologies. Regional centers, neighborhood centers, apartment districts, employment precincts, visitor destinations, logistics areas, and low-density suburbs generate different charging needs because they vary in dwell time, parking form, grid capacity, travel behavior, and equity risks. A land-use-sensitive approach would allow charging infrastructure to be planned according to the spatial functions of places rather than through generic infrastructure targets.

Third, curbside charging should be governed as a public-domain allocation issue. The installation of chargers in streets and public spaces should not undermine footpath accessibility, street trees, bus operations, loading zones, cycling infrastructure, universal access, or broader mode-shift objectives. Curbside EV infrastructure therefore needs to be assessed not only as a charging solution, but also as a claim on scarce urban public space.

Fourth, charging equity should be measured spatially. Accessibility standards should consider renters, apartment residents, low-income households, people without off-street parking, commercial fleets, and visitors. Equity indicators should be reported alongside utilization rates, investment feasibility, and economic performance, ensuring that charging networks do not reproduce existing spatial and social inequalities.

Fifth, planning authorities should integrate grid-readiness mapping with development pipelines. High-growth precincts, urban-renewal areas, dense apartment zones, employment areas, and logistics precincts should be assessed for electrical capacity before charging demand becomes a retrofit crisis. This would allow land-use planning, infrastructure sequencing, and electricity-network investment to be coordinated more effectively.

Sixth, EV planning should remain subordinate to the sustainable mobility hierarchy. While electrification can reduce tailpipe emissions, it does not resolve congestion, road danger, land consumption, car dependency, or competition for public space. EV strategies should therefore support walking, cycling, public transport, shared mobility, and compact urban development rather than competing with them. Australian evidence from Adelaide also demonstrates that investment in public transport can encourage modal shift away from private vehicles and produce measurable carbon-reduction benefits [60].

Finally, EV governance should be multi-scalar and coordinated across institutions. National and state governments influence vehicle standards, incentives, funding programs, and major infrastructure priorities. Local councils control development approvals, streets, parking, public-domain design, and local planning guidance. Electricity network providers determine grid constraints and connection capacity, while private providers shape much of the charging market. The triadic EV–land-use–urban-development framework proposed in this study helps clarify where these actors must coordinate and where policy integration is currently missing.

5.5 Limitations

The limitations qualify these findings. First, and most importantly, the corpus's text depth is uneven: sixteen of twenty-seven analytical entries rest on verified summaries rather than complete full-text extraction, generally because very large regional or district plans could not be fully processed within this study's pipeline, or because three official PDFs were blocked by their host site's robots.txt exclusion at the time of analysis. Second, the Triadic Integration Score is a keyword-frequency-based measure and, like all such measures and documents, could in principle score highly by listing cross-domain terms in a glossary without meaningfully integrating them into its operative provisions. Third, a longitudinal corpus tracking successive editions of the Region Plan, the LSPS Guideline, and future EV strategy refreshes would be needed to test whether the "operational narrowing".

5.6 Transferability beyond NSW

The Triadic Integration Framework and Score are deliberately domain-agnostic in construction - any planning system with (a) a definable EV-policy instrument set, (b) a definable land-use instrument set, and (c) a definable broader cross-cutting/climate instrument set can compute an equivalent score using the same reproducible pipeline. Given NSW's position as a comparatively well-resourced, self-consciously cross-sectoral planning system, the finding that its weakest link sits at the local statutory-planning tier is plausibly a conservative estimate of the same gap in less-resourced jurisdictions, where state-level EV and land-use agencies may have even fewer formal mechanisms for cross-referencing each other's instruments. Evidence from developing countries also shows that the adoption of emerging mobility technologies depends substantially on institutional readiness, regulatory adaptability and a long-term governmental perspective [61]. The method offers such jurisdictions a low-cost diagnostic starting point: rather than commissioning a full institutional review, a planning agency can apply the same three dictionaries and TIS formula to its own instrument set to identify, empirically, which of its own documents are the outliers in either direction.

6. Conclusions

This study sets out to test empirically whether New South Wales treats electric vehicle transition as the land-use and urban-development problem it physically is, or as a transport-and-energy problem alone. Using a 30-document corpus spanning state EV policy, state and district land-use planning, urban-development and climate policy, and three local-government instruments, we find a genuine but partial triad: EV, land-use, and cross-cutting vocabulary do co-occur across the NSW corpus, bridged most reliably by the concepts "infrastructure" and "charging," but the strength of that co-occurrence is concentrated in action- and program-level documents with an explicit delivery mandate and is weakest, specifically, in the *Local Strategic Planning Statement* - the one instrument

every NSW council must produce and the instrument with the most direct statutory bearing on local zoning and infrastructure priorities. Counter-intuitively, the state's newest and most heavily funded EV strategy (April 2026) is the least land-use-integrated EV document in the entire corpus, suggesting that operational maturity in EV policy delivery may come at the cost of land-use vocabulary rather than alongside its growth.

Beyond the NSW case, the study's methodological contribution is a *Triadic Integration Framework* and Score that is transparent, reproducible from a term-count matrix alone, and readily transferable to other jurisdictions seeking to audit their own EV–land-use–climate policy integration without commissioning a full institutional review. For NSW specifically, the findings point to three concrete next steps: embedding an explicit EV-readiness prompt in the next revision of the *Local Strategic Planning Statement Guidelines*, given its current complete absence of EV vocabulary despite its "transport/connectivity" theme; extending the *Industrial Lands Action Plan*'s categorization criteria to account for depot-scale fleet-charging infrastructure, given the same policy cycle's parallel commitment to freight electrification; and testing, in the next EV Strategy revision cycle, whether an explicit land-use section can be reintroduced without displacing the document's necessary operational focus on funding delivery. More broadly, the study's evidence suggests that even in a jurisdiction as well-resourced and self-consciously cross-sectoral as NSW, EV-ready urban planning cannot be assumed to follow automatically from EV-strategy funding or from land-use-plan sophistication considered separately; it requires documents, at every tier of the planning hierarchy, that are written to be read by more than one policy community at once. Future work could combine TIS with land-use-aware machine learning and GIS-based grid constraints to test whether document-level integration predicts spatially equitable and technically feasible charging deployment [21, 22, 23].

Author Contributions

Conceptualization, A.S. and M.RQ.; methodology, A.S. and Y.J.; software, M.RQ.; validation, A.S., and M.B.; formal analysis, M.RQ.; investigation, Y.J.; resources, A.S.; data curation, Y.J.; writing—original draft preparation, A.S., M.RQ. and Y.J.; writing—review and editing, A.S. and M.B.; visualization, M.RQ.; supervision, A.S.; project administration, M.B. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

The study uses publicly available planning, transport, energy and EV policy documents issued by NSW Government agencies, Transport for NSW, local councils and relevant stakeholder organizations. The compiled document corpus and derived analytical data are available from the corresponding author upon reasonable request. The authors acknowledge these organizations for making the source documents publicly accessible.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Generative AI Use
OpenAI's ChatGPT was used for English-language editing and improving visual presentation. All outputs were reviewed by the authors, who take full responsibility for the final manuscript.

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