(Auto)mobilities in Transition: Future-making and the (Re)production of Movement

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Summary/Zusammenfassung

Summary

This thesis investigates how automobility is challenged and/or reproduced through active and explicit engagements with the future (future-making) and considers the implications for transformative change in socio-technical systems. It connects with an emerging strand within transitions research, which seeks to shift the focus of research into socio-technical change away from the emergence of novelty and innovation towards existing systems and the processes and dynamics through which they destabilise, decline, and are reproduced. Building on this perspective, the research connects to discussions that foreground the future—not as a distant endpoint, but as a site where ideas about the later-than-now are actively shaped in the present. It is argued that such moments during which actors engage in future-making can offer a unique opportunity to those actors to either question (often assumed) stabilities inherited from the past or perpetuate them into the future. Next to the well-established role of the shaping of visions and expectations in processes underpinning the emergence of novelty, I argue future-making is also an important dimension of regime reproduction. To explore this dimension of socio-technical reproduction and change, the thesis focused on four different arenas of mobility future-making, where diverse ideas about what can, will, and should happen in the future are articulated, negotiated, and contested, often in under-appreciated ways. Each contribution delivers its own set of empirical, conceptual, and methodological insights, with the framework paper drawing out a number of cross-cutting themes and avenues for future research.

Zusammenfassung

In dieser Arbeit wird untersucht, wie Automobilität durch die aktive und explizite Gestaltung von Zukunft (sog. *Future-making*) sowohl in Frage gestellt als auch reproduziert wird – und welche Implikationen sich daraus für transformativen Wandel in sozio-technischen Systemen ergeben. Die Arbeit knüpft an aufkommende Diskussionen innerhalb der Transitionsforschung an, die den Fokus weg von der Entstehung von Neuheit und Innovation hin zu bestehenden Systemen und zu den Prozessen verlagern, durch welche diese destabilisiert und abgebaut – oder auch aufrechterhalten werden. Aufbauend auf dieser Perspektive greift die Forschung Diskussionen auf, welche die Zukunft nicht als fernen Endpunkt begreifen, sondern als ein Feld, in dem Vorstellungen über das Später-als-Jetzt in der Gegenwart aktiv gestaltet werden. Es wird argumentiert, dass solche Momente der Zukunftsgestaltung Akteur:innen besondere Gelegenheiten bieten, vermeintliche Stabilitäten – die oft unhinterfragt aus der Vergangenheit übernommen wurden – entweder kritisch zu hinterfragen oder in zukünftige Entwicklungspfade einzuschreiben. Neben der bekannten Rolle, die Visionen und Erwartungen in Innovationsprozessen spielen, wird hier betont, dass Zukunftsgestaltung auch eine zentrale Dimension der Reproduktion bestehender Regime darstellt. Um diese Dimension soziotechnischer Reproduktion und Veränderung zu analysieren, konzentriert sich die Arbeit auf vier unterschiedliche Arenen der Mobilitätszukunftsgestaltung. In diesen Arenen werden unterschiedliche Vorstellungen darüber, was in der Zukunft geschehen kann, wird und sollte, artikuliert, verhandelt und angefochten – oftmals auf bislang wenig beachtete Weise. Jeder Beitrag liefert dabei eigene empirische, konzeptionelle und methodische Erkenntnisse. Das Rahmenpapier bündelt diese und hebt Querschnittsthemen sowie Perspektiven für zukünftige Forschung hervor.

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Introduction

Few topics capture the human imagination like the future of mobility. We are constantly bombarded with images of sleek, futuristic vehicles, hyperloops, drones zipping through the sky, and fanciful visions of how people and goods might move in the city of tomorrow. During a research stay in Melbourne in 2024, I was struck by how often, after sharing my dissertation topic, I was met with the same question: "So, when do we get our flying cars?" One important reason for this obsession with the future of mobility is the prevailing problems associated with mobility systems in their current form. Urban dwellers, in particular, are disproportionately subjected to systematic air and noise pollution, as well as increasing mortality and injury rates due to the mobility system (WHO, 2022). People often find themselves stuck in traffic jams, missing appointments, or unable to reach their destinations. Moreover, urban dwellers are already feeling the impacts of climate change, while emissions from the transport sector continue to rise (Shukla *et al.*, 2022).

However, these problems are much less the result of urban mobility than of urban *auto*mobility. Riding the wave of promises of freedom, progress, and modernity during the 20th century, the car became firmly entrenched—physically, institutionally and culturally—in most urban areas globally, albeit to varying extents (Prieto-Curiel and Ospina, 2024). While these promises have faded, the car remains a ubiquitous feature of urban life. The implication is an urban mobility system that compels people to travel great distances—usually in private, resource-intensive vehicles—not only to get from A to B but also to escape the loud, polluted, and car-centric environments that automobility creates. It marginalises those who do not drive, making cities less accessible and more challenging, or even impossible, to navigate for non-drivers (Sheller and Urry, 2000).

Whatever the reasons, an array of visions for utopian solutions to these problems—often intertwined with hype and hope—prevails in the present. One particularly prominent example is often referred to as connected and automated vehicles (CAV), which is the product of the convergence of automation, electrification, and digitisation (Dangschat and Stickler, 2023). CAVs are portrayed as enabling clean, efficient, seamless, and comfortable travel—whether in private cars or shared shuttles. Media representations promote visions of accident-free, socially inclusive mobility, where transportation is affordable and accessible to all. These "zero-emission" vehicles and intelligent traffic management promise cleaner air and the eradication of congestion (Braun & Randell, 2022).

There are also urban mobility visions that are less centred on technology (see Manderscheid and Cass, 2022). One can imagine a future city with a fundamentally different urban structure where active and collectivised mobilities (cycling, walking, and public transportation) are the predominant modes. Slow forms of mobility are commonplace, not only justified for safety and environmental reasons but also to unmake the economically induced acceleration of everyday life (Rosa, 2003). Mobility planning is governed by logics of commoning rather than scarcity or austerity (Nikolaeva *et al.*, 2019), and deeper political-economic assumptions bound up with movement have been questioned (Schwanen *et al.*, 2011; Cass and Manderscheid, 2018; Schwanen, 2021; Manderscheid and Cass, 2022; Cox, 2023).

These are just two very different (arguably incompatible) imagined mobility futures currently in circulation. Yet such imagined futures are not simply something predetermined "out there" waiting to happen. Rather, futures are "made" (produced, performed, enacted) in the present (Wenzel *et al.*, 2020; Oomen *et al.*, 2021). The resulting expectations, visions, hopes, aspirations and other future-oriented ideas and affects actively shape and coordinate social action in the present (van Lente, 1993; Borup *et al.*, 2006; Beckert, 2016; Oomen *et al.*, 2021). Previous work has demonstrated how the formation of visions and expectations are important processes for recruiting allies and investment, communicating intentions, and creating legitimacy, thereby stabilising particular directions of socio-technical change (Smith *et al.*, 2005; Berkhout, 2006; Borup *et al.*, 2006; Beckert, 2016). Yet precisely why some futures

actually come to play these important roles while others do not remains an important area of investigation. Some contributions have provided helpful answers to questions such as "how do imagined futures become socially performative?" (Oomen *et al.*, 2021), "whose visions and actions count?" (Longhurst and Chilvers, 2019; Beck *et al.*, 2021) or "what makes an imagined future credible?" (Beckert, 2024). While those who posed these questions also provide helpful answers, there are still open questions around why "some social actors are better positioned than others in terms of political access or material or cultural resources necessary to engage in such practices" (Tutton, 2023: 441).

This thesis does not seek to provide answers to these questions directly. Rather, I use this line of thinking to pivot towards discussions within transitions research (Markard *et al.*, 2012; Köhler *et al.*, 2019; Truffer *et al.*, 2022) and research on transformations towards sustainability more broadly (Scoones *et al.*, 2020). I engage with an emerging strand within transitions research which seeks to shift the focus on socio-technical change away from the emergence of novelty and innovation towards existing systems, and the processes, dynamics, and mechanisms that constitute their destabilisation and decline. This shift in perspective invites investigation into the reasons why destabilisation and decline might not be happening despite efforts and encourages closer attention to the mechanisms, dynamics, and underappreciated sources of incumbency that keep systems locked in and allow for their reproduction (Stirling, 2018).

I argue that during moments when actors shift their gaze towards the future to inform decision-making in the present, there is a unique opportunity for those actors to either *question* and *confront* (often assumed) stabilities inherited from the past or *perpetuate* them into the future through the choice of application and deployment of particular practices and techniques to make the future. Moments where actors explicitly engage in future-making[1] constitute, therefore, opportunities for incumbent socio-technical arrangements to either be *challenged* or *reproduced* to varying extents. This contribution takes such moments of future-making as a starting point to explore the implications of these choices for a transformation agenda. As argued below, this does not suggest that actors who engage in future-making have unlimited capacity to imagine otherwise. However, when making the "future", one is arguably not subject to the same discursive limitations as is the case when recounting the past or describing the present (Mische, 2014). There is something inherently more open about the future, which suggests that for those interested in making a different future, moments of future-making require particular scrutiny.

As an empirical focus, I foreground *urban* mobility. The reference here to 'mobility' rather than 'transport' reflects the study of the movement—in this case, of humans—beyond the technical and infrastructural systems facilitating physical movements (roads, tracks, vehicles, networks, etc.) to consider the associated social, cultural, and symbolic meanings.[2] To consider mobility rather than transport is also to account for how movement is experienced, governed, and embedded in power relations and inequalities (Sheller and Urry, 2006). The empirical work is grounded in the Free and Hanseatic City of Hamburg, Germany.

The dissertation is structured in three main parts: (1) Conceptual background, (2) Approach and methodological overview, and (3) Overarching themes and avenues for future research. The *Conceptual background* section is organised into three parts. Throughout, I connect to the case of mobility to help make the transitions concepts more tangible. In the first part, I introduce transitions research and draw on two important and related criticisms of the Multi-Level Perspective (MLP), which informs much of the thinking about possible socio-technical change within the transitions community (Skjølsvold, 2024). The

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[1] As a definition of "future-making", I adopt an older definition of "futuring" from Hajer and Pelzer (2018: 224) as "the activity of actors-in-contexts trying to stabilize or destabilize shared notions of the future."

2 At times I refer to "transport" to reflect a context where it is more appropriate to use this term. Particularly, for the historical investigations, it makes more sense to talk about the "transportation system" rather than the "mobility system".

second part introduces the politics of future-making, drawing on emerging work around the sociologies of the future and neighbouring disciplines which foreground the forming of collective expectations and the specific ways that futures are "made" as an important source of agency and a dimension of the politics of socio-technical change. The third part makes the research gap explicit. I argue that the prevailing criticism that transitions research focuses too heavily on the emergence of novelty also applies to our relationship with the future. Rather than limiting the understanding of the important role of visions and expectations along an innovation journey, I argue that more attention is warranted towards understanding how future-making functions as a force of regime (de)stabilisation.

The section titled *Approach and methodological overview* introduces both the overarching approach and the specific approaches and methodologies for the respective contributions. In appreciation of the contested nature of mobility futures, the approach uses the concept of the *arena* for case delineation. Arenas of future-making can be understood here openly as forums (both literal and metaphorical) where diverse ideas about what can, will, and should happen in the future are articulated, negotiated, and contested. The arena assumes some form of *contestation* and encourages the search for sites, forums, spaces, etc., where automobility is being challenged and reproduced. This led to the development of a range of diverse contributions which focus on arenas such as those that constitute (1) the imagining of the future of mobility in sustainability transitions research, (2) the historical contestation around transport planning in Hamburg, (3) imagined mobility futures among practitioners in Hamburg, and (4) the meanings associated with mobility-transitions related terminology in German public discourse. The respective contributions connect with a range of different academic debates and apply a diversity of methods, reflecting the interdisciplinary nature of this dissertation. An overview of the approaches, methodologies, and key findings of the respective contributions is also provided in this section.

While each individual paper makes its own conceptual, empirical, and methodological contributions, in the last section *Overarching findings and avenues for future research,* some central themes that cut across all four contributions are drawn out with a consideration for future research. First, I argue that the contributions demonstrate that the "future"—or rather temporalities more generally—should be understood as a resource at the disposal of actors to achieve their goals. Second, I argue that it might be productive to pay more attention to spatial differences in the departure away from dominant modes of engagement with the future. Thirdly, I echo previous reminders that transitions researchers should also see themselves as actors in processes of socio-technical change and that time is also a resource at our disposal. I then make some suggestions about how to approach research on mobility futures for transformative change. Finally, I reflect on the limitations of the approach.

1. Conceptual background

The following two chapters provide a conceptual background for the thesis. In doing so, I draw on three main bodies of literature: transitions research, mobilities research, and what can be referred to as 'sociologies of the future'. In the first part, I introduce transitions research and exemplify a key concept within this field, the 'sociotechnical regime', by referencing the established concept of the 'regime of automobility'. I then refer to two ongoing criticisms of the Multi-Level Perspective (MLP). These criticisms highlight a tendency to pay too much attention to the emergence of novelty, which often accompanies a black-boxing of complexities and assumes stability within the regime. This can overlook important mechanisms of reproduction and possible sources of change. In response, a growing body of literature has begun to focus more on established systems and the mechanisms underpinning their (de)stabilisation and reproduction.

The second part focuses on future-making. I first highlight the predominant role of future-making in transitions research, arguing that here too, the relationship with the future is primarily oriented towards the role of visions and expectations in the emergence of novelty. I then refer to a growing body of work that has begun to pay more attention to the underappreciated agency and politics at play when actors engage in future-making. I exemplify the hidden politics of mobility future-making by referencing predict-and-provide models of transport planning, which have been instrumental in the creation and reproduction of automobility but are showing signs of destabilisation. The underlying argument of this background section is that mobility future-making is a particularly important dimension of regime (de)stabilisation. A closer look at the arenas within which particular ideas about possible and desirable mobility futures come to dominate is, therefore, warranted.

1.1 Transitions research: explaining stability and change

In light of the growing pressures to transform diverse areas of human life to mitigate multiple ecological crises (Steffen *et al.*, 2015) and overcome other grand societal challenges, a range of research communities across multiple disciplines have come to focus on questions around transformation: that is, "fundamental changes in structural, functional, relational, and cognitive aspects of socio-technical-ecological systems that lead to new patterns of interactions and outcomes" (Scoones *et al.*, 2020: 65–66). One such community, organised under the title of 'sustainability transitions', brings together a diversity of academic and non-academic perspectives to better understand and support fundamental changes in socio-technical systems (Köhler *et al.*, 2019). There are at least two important distinctive characteristics of transitions research that differentiate it from other research communities focusing explicitly on transformative change. Firstly, transitions research acknowledges that social and technological systems are so deeply intertwined that it is more helpful to consider them collectively. Secondly, transitions research views systems of provision (e.g. food, mobility, housing, energy) as a productive analytical focus for conceptualising and identifying the mechanisms through which radical transformations towards sustainability—in the organisation of these systems—can occur (for other distinctions, see Köhler *et al.*, 2019; Geels, 2024).

A range of concepts commonly referred to within transitions research have been helpful for understanding the stabilising forces that keep systems on a particular trajectory, narrow the scope of change to incremental improvements, and provide explanations for why desired change might not be happening (for an overview, see Geels, 2024). Concepts such as 'lock-in' and 'path dependency' have been useful for grasping the mechanisms underpinning socio-technical stability (Unruh, 2000; van der Vooren *et al.*, 2012; Klitkou *et al.*, 2015; Seto *et al.*, 2016; Simoens *et al.*, 2022). These concepts help account for decisions made and activities in the past that set socio-technical systems on a trajectory

that limits the abilities of actors to depart from that trajectory in the present. Path dependency and lock-in are helpful concepts for focusing on the specific mechanisms that maintain particular directionalities (Graaff *et al.*, 2025) and limit efforts to transform socio-technical systems. However, they do not provide a complete picture. Another important and related concept is the socio-technical 'regime', through which stability is maintained by a semi-coherent set of rules, or the system's 'grammar', that orientates and coordinates the activities of social groups that reproduce the various elements of socio-technical systems, determining which pathways of socio-technical change are prioritised and which are neglected (Dosi, 1982; Rip and Kemp, 1998; Geels, 2011; Fuenfschilling and Truffer, 2014). As an analytical concept, the regime invites investigation into the deep underlying structures—e.g. norms, practical heuristics, routines, standardised procedures, visions, promises, and expectations—that coordinate the activities of actors within a given system and encourages the analyst to consider "what lies underneath the activities of actors who reproduce system elements" (Geels, 2011: 31).

1.1.1 A regime of automobility

Grounding the notion of the regime within a system of provision makes the concept more tangible and provides important context not only about what the regime is, but about how it 'works'. In this context, focusing on *mobility* allows one to expand understandings of the mechanisms of socio-technical reproduction beyond transitions research to consider the substantial body of research that critically examines why people move as they do. This field is known as mobilities research (Sheller, 2014; Manderscheid, 2020b). One important contribution of this community has been the extensive exploration of the rise and persistence of the personal motorised vehicle (the car) as the dominant artefact in transportation systems worldwide. The complexity and intractability of the socio-material arrangements that facilitate and reproduce car-based movement are made apparent in the conceptualisations of *automobility* as a system (Urry, 2004), a regime (Böhm *et al.*, 2006; Geels, 2012), a *dispositif* (Manderscheid, 2014), and an imaginary (Braun and Randell, 2023). There are three particularly notable characteristics of automobility that can be gleaned from these contributions.

Firstly, the artefact of the car is only one element within broader complex arrangements that make automobility possible. These arrangements include elements that can be more material (e.g., roads, car parks, traffic signals), institutional (e.g., design codes, laws), and discursive or ideological (e.g., ideas of freedom, progress, social status, truth). These elements are intertwined with practices and (re)produce the dominance of car-based movement. Geels (2004) provides a helpful heuristic, which Hoffmann *et al.* (2017) adapted to organise such elements according to different dimensions of automobility to grasp the multitude of different types of elements that can be associated with automobility (see Figure 1). Secondly, automobility is *autopoietic*, which means it can self-sustain and reproduce itself through "a set of interlocking features which reinforce each other, and where elements in the system emerge for functional reasons, to 'correct imbalances' or to 'improve performance' of the system as a whole" (Böhm *et al.*, 2006: 5). Thirdly, these contributions recognise that inherent to the reproduction of these arrangements are particular built-in fragilities, antagonisms, and impossibilities which manifest in systemic congestion, environmental degradation, declining natural resources, systematic death and injury, and other health implications (Böhm *et al.*, 2006; Manderscheid, 2014).
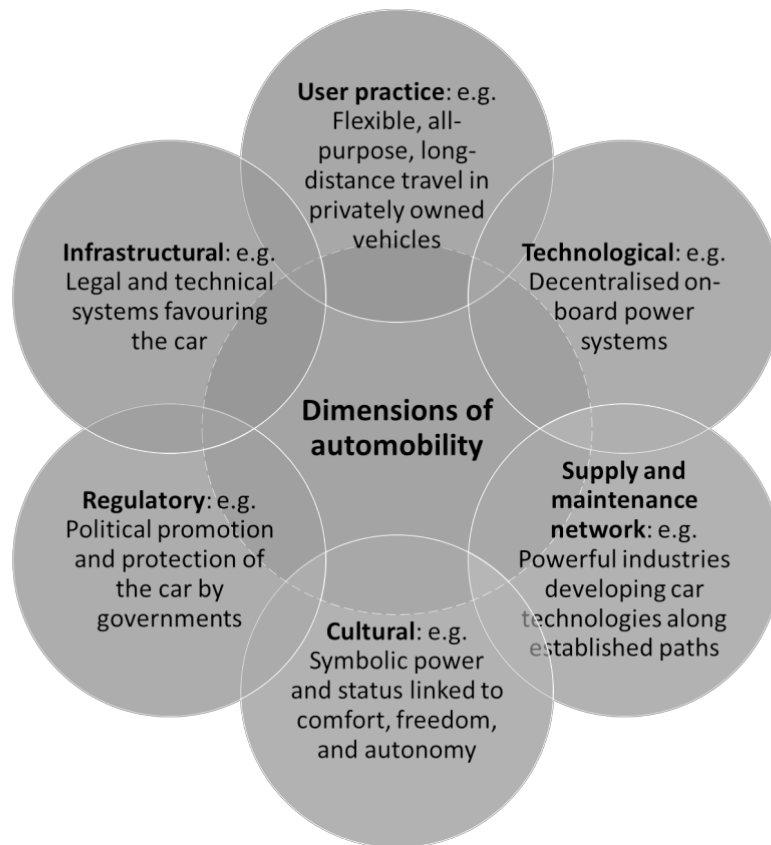
Figure 1 – Dimensions of a socio-technical regime of automobility (adapted from Hoffmann et al., 2017; Geels, 2004, 2012)

These antagonisms are significant. The rise and maintenance of automobility are premised on the externalisation of social, environmental, and economic costs. Since 2000, the number of road traffic fatalities globally has remained relatively constant at around 1.2 million people, with "road injury" remaining the leading cause of death for people aged between 5 and 29 (WHO, 2023). These figures do not include the health impacts related to other stages of the lifecycle of vehicles or fuels. Regarding air pollution, a significant portion of the European urban population continues to be exposed to local air pollutant levels (PM2.5 and NO_2) that exceed WHO air quality guidelines, while road traffic is responsible for a quarter of energy-related greenhouse gas emissions (WHO, 2022). Among member states of the United Nations Economic Commission for Europe (UNECE) and the World Health Organisation (WHO) European Region, at least 20 per cent of inhabitants are exposed to road traffic noise levels harmful to human health, with this number exceeding 50 per cent in urban areas (WHO, 2022). The quantified costs of accidents, pollution, and congestion have been estimated at €502 billion for member states of the European Union (WHO, 2022).

Yet, many of the implications of automobility for urban life are difficult to quantify. In terms of the largely taken-for-granted segregation and induced isolation that 'auto space' creates, it is hard to grasp the true social 'cost' of urban automobility (Freund and Martin, 1993; Sheller and Urry, 2000). Despite these systemic problems, automobility endures and is constantly tinkered with and reinvented to ensure that these antagonisms do not threaten its reproduction. In this sense, I follow Böhm *et al.* (2006) in understanding a *regime* of automobility as "a set of political institutions and practices that seek to organise, accelerate and shape the spatial movements and impacts of automobiles, whilst simultaneously regulating their many consequences" (Böhm *et al.*, 2006: 2).

1.1.2 MLP-thinking and its problems

Taking the regime as a starting point is valuable for understanding stability and incrementalism in socio-technical change. However, the role of the regime, as understood in transition research, is not typically considered in isolation. Rather, it is usually understood in relation to two other counterpart 'levels' ('niche' and 'landscape') in the Multi-level Perspective (MLP), one of the central heuristics within transitions research (Zolfagharian *et al.*, 2019). According to the MLP, fundamental change is said to occur when cracks and tensions emerge in the regime, primarily due to exogenous socio-technical 'landscape' developments, which open up windows of opportunity, and through pressures from (at times radical) 'niche' innovations that, if sufficiently poised and nurtured, can break through, leading to a transition of the socio-technical system into a new constellation (Geels, 2011). The landscape is the "wider context, which influences niche and regime dynamics" and refers to factors such as "spatial structures (e.g. urban layouts), political ideologies, societal values, beliefs, concerns, the media landscape and macro-economic trends" (Geels, 2012: 473). Some examples of niches identified within road transportation might include intermodal travel, cultural and socio-spatial innovations, demand management, public transport innovations, information and communication technologies (ICTs), and green propulsion technologies (Geels, 2012).

The MLP has been helpful in improving the understanding of historical socio-technical change in a variety of systems of provision (Zolfagharian *et al.*, 2019). It also offers a useful heuristic to account for range of possible pathways of transition processes based on different dynamics playing out at the various levels of the MLP (Geels and Schot, 2007). Developments around the MLP have also facilitated the emergence of perspectives that can help make sense of transitions-in-the-making (Farla *et al.*, 2012) and models to support the governance of transformations in more applied areas of research (Loorbach and Rotmans, 2010; Hebinck and Loorbach, 2024). The MLP has, therefore, been very influential in forming an interdisciplinary epistemic community working on understanding and supporting transformations towards sustainability, which has also effectively spilled over into practice and policy circles (Loorbach *et al.*, 2017). However, the MLP has also brought with it a number of criticisms.

Innovation bias

Firstly, transitions research has tended to focus too narrowly on the emergence of innovation and novelty at the expense of other important dimensions of socio-technical change (Berkhout *et al.*, 2004; Shove and Walker, 2007, 2010; Steen and Weaver, 2017; Turnheim and Sovacool, 2020). For example, socio-technical destabilisation and the decline of incumbent socio-technical systems have long been understood as necessary processes within socio-technical change in transitions research. However, these processes have typically been viewed as occurring in the background as a repercussion of—or serving as an opportunity structure for—emergent innovation, rather than warranting investigation in their own right (Turnheim, 2023).

A related issue is that the orientation towards novelty is often accompanied by a 'black-boxing' of regimes or other complexities (Berkhout *et al.*, 2004; Jørgensen, 2012; Steen and Weaver, 2017). This black-boxing assumes stability into the regime while ignoring or obscuring the internal workings or mechanisms occurring inside the 'black box'. This assumed stability can reinforce the belief that the regime cannot be changed except by supporting something new that can puncture and break through the incumbent arrangements when the time is right. The result of this tendency can actually serve to reify the regime and strengthen the prevailing power arrangements through the firming of the belief that intervening to change them is perhaps impossible or undesirable (Stirling, 2018). It should be noted that the MLP does provide scope to consider a wider variety of transition pathways than those that emerge from below and outside existing regimes (Geels, 2011). However, the analytical applications of the MLP

seem to lead to an overemphasis on bottom-up dynamics (Berkhout *et al.*, 2004; Turnheim and Sovacool, 2020).

Assumed stabilities

Secondly, black-boxing the regime can lead to the assumption that the regime is *static*: that if the system is not in transition, it is stable. Regimes are never truly stable but are *dynamically* stable. They are constantly subject to endogenous and exogenous pressures, are constantly maintained, and are constantly being reinvented, building new ties with new and old elements within a socio-technical arrangement (Turnheim, 2023). Overstating stability becomes particularly problematic in light of contributions from political economy to the transitions discourse (e.g. Feola, 2020; Ford and Newell, 2021; Newell, 2021; van Oers *et al.*, 2021; Kalt, 2024). Drawing on the Gramscian concept of *trasformismo,* Newell (2021: 36) articulates a tendency of co-optation that "serves as a strategy for assimilating and domesticating potentially dangerous ideas by adjusting them to the policies of the dominant coalition and can thereby obstruct the formation of organised opposition to established social and political power" (citing Cox, 1983: 166–167). Applied to transitions, *trasformismo* articulates how pressures that could otherwise induce more radical and disruptive change are accommodated and buffered through material, institutional, and discursive power to ensure that changes in socio-technical configurations do not disrupt underlying social relations or the distribution of political power (Newell, 2021). Appreciating the dynamics of *trasformismo* highlights the importance of a clear separation between approaches that question underlying power structures and those that 'black-box' them, thus implicitly assuming they cannot change or should be left in place.

For a research community interested in not only understanding but also *supporting* fundamental transformations towards sustainability, these issues are not only conceptually but also politically problematic. Even if the MLP is not always applied as an analytical framework to understand socio-technical change, MLP-thinking shapes broader assumptions, ontologies, and theories of change that are subscribed to within the transitions community (Skjølsvold, 2024). These criticisms are not new and they are not the only problematic dimensions of accounting for socio-technical change through the lens of the MLP (Geels, 2011). These criticisms and the creative attempts to address them have played an important role in the diversification of the transitions field in terms of the development of new perspectives, concepts, and a productive exchange of ideas with other disciplines (Truffer *et al.*, 2022) that help account for important socio-technical dynamics that MLP-thinking might overlook. This demonstrates the ability of the transitions research community to adapt research practice to incorporate such constructive criticism.

A shift in focus towards established systems and their destabilisation and decline

One such attempt to incorporate and adapt to criticism is a growing body of research that focuses on processes of destabilisation, discontinuation, and decline (for an overview, see Koretsky *et al.*, 2023; Rosenbloom and Rinscheid, 2020). These developments signal a shift in the focus of transitions research away from processes that lead to the emergence of novelty and innovation, seeking to explore and understand how and under what conditions established systems become destabilised, lock-ins are unlocked, and specific technologies or practices decline or are deliberately phased out or abandoned (e.g. Turnheim and Geels, 2012; Geels, 2014; Rosenbloom and Rinscheid, 2020; van Oers *et al.*, 2021; Frank and Schanz, 2022; Koretsky *et al.*, 2023). Rosenbloom and Rinscheid (2020) identify two central research strands within the emerging discussions around destabilisation and its associated concepts. The first focuses on active interventions to weaken socio-technical arrangements and induce destabilisation and decline, referring to concepts such as 'phase out' and 'exnovation' and exploring policies and policy mixes (Rosenbloom and Rinscheid, 2020). The second is more oriented towards

understanding the processes and dynamics that lead to destabilisation and decline, with the goal of developing process-based models building on historical patterns (Rosenbloom and Rinscheid, 2020).

Yet much of the work on destabilisation and decline (and related concepts) tends to focus on systems or system elements around which there has been some formal mandate established to 'phase *x* out' or induce some kind of reduction in *x*. Focusing primarily on destabilisation journeys where such a mandate has been reached will likely overlook important (in)stabilities if the diverse array of possible sources of pressures on incumbent arrangements and the long-term nature of such journeys are accounted for (Turnheim, 2023). Rather, researchers are encouraged to focus more closely on 'intensifying discontinuities' and 'weakening continuities' that can develop, also below the surface (Turnheim, 2023). This perspective also calls for more attention to be paid to underlying mechanisms of regime *reproduction*, inviting enquiry into the power and politics at play in maintaining the stability of locked-in constellations (Avelino, 2017, 2021; Kok *et al.*, 2021) and the search for deeper-lying forms of incumbency (Stirling, 2018).

As I argue in the next section, this shift in focus towards established systems—along with their mechanisms of reproduction and the (often subtle and hidden) dynamics of their unlocking and destabilisation—could be complemented by greater attention to the arenas in which futures are made and contested.

1.2 Politics of future-making

The previous section clarifies the necessity for transitions research to better understand the mechanisms underpinning locked-in socio-technical systems and to question regime stability. This entails research that opens up the black box of the regime to better comprehend the dynamics of (de)stabilisation and reproduction. In this section, I argue that the 'future'—or, more accurately, the making of futures in the present—is an important and underappreciated dimension of regime (de)stabilisation. Considering the politics of future-making raises fundamental questions about knowledge politics, such as who gets to define what counts as credible or legitimate knowledge. To focus on *future*-making is to suggest that there is something inherently more 'open' about 'making' the future compared to 'making' the past or present. As Mische (2014: 438) argues, "while narratives about the past are certainly open to contestation and revision, they are still disciplined by truth claims that they are recounting 'what happened,' which is arguably more rigorous than the discipline of 'what might (or could or should) happen.'" The diversity of possible (re)combinations of temporalities, dimensionalities, end states, and possible ways of reaching them comprises such a vast pluriverse (Escobar, 2018) of possibilities that it is somewhat remarkable that humans can be so effective at coordinating activities in the first place. As will be demonstrated, the hidden politics of future-making have long informed debates in transitions research. However, this has primarily related to the capture of promising 'niche' visions by incumbent arrangements. Less explicit attention has been paid to the ways the future is mobilised to maintain a system's path dependence and facilitate its reproduction.

The 'future' in transitions research

The future has always played an important role in transitions research. The very notion of 'transition' incorporates liminality. When you add the more explicit normative dimension of 'sustainability', it becomes clear that sustainability transitions research is one of the more explicitly future-oriented epistemic communities. The significant role of future-oriented 'expectations' and 'visions' in processes of socio-technical change has been broadly understood since the community's inception (Rohracher and Konrad, 2024). Early work in transitions and transformations research more broadly recognised the

vital role of guiding visions in coordinating action among actors in their attempts to bring about change. Visions can serve as 'prospective structures' around which actors can orientate themselves and may actually lead to the realisation of such visions (van Lente, 1993; van Lente and Rip, 1998). Visions serve various functions, such as mobilising resources, building coalitions, setting and monitoring targets, and negotiating the realms of the possible and desirable among actors (Smith *et al.*, 2005; Berkhout, 2006; Borup *et al.*, 2006). Recognition of these important functions informed conceptual developments within Strategic Niche Management (SNM), Technology Innovation Systems (TIS), and the more explicit governance framework of Transition Management (TM), three of the other key frameworks (alongside the MLP) in transitions research (Zolfagharian *et al.*, 2019; Rohracher and Konrad, 2024).

Thus, the important roles of visions and expectations in the governance of socio-technical change have been long been established in transitions research. However, relatively early in the emergence of the field, there was a recognition that "it is not a feature of the *vision itself* whether it becomes recognised as an image around which agents with effective power choose to organise, but on the cultural and political context in which it is propounded" (Smith *et al.*, 2005: 1507, emphasis in original). This acknowledgment led to calls for caution about the extent to which visions could be strategically deployed as a governance instrument in more managerial approaches to transformative change (Smith *et al.*, 2005; Berkhout, 2006; Späth and Rohracher, 2010). Rather, contributions began to acknowledge that the development and structuration of visions are inherently political, contested, and spatially contingent (Späth and Rohracher, 2010; Longhurst and Chilvers, 2019), and that the "sociomaterial 'setting' in which different visions are produced is at least partly relevant in shaping the particular vision that emerges" (Longhurst and Chilvers, 2019: 985).

Future-making as materially embedded and contested

The above debates resonate with a growing interest in the 'future' across a range of disciplines beyond transitions research, including human geography (e.g. Anderson, 2010), sociology (e.g. Brown *et al.*, 2000; Adam and Groves, 2007; Selin, 2008; Beckert, 2016; Tutton, 2017; Beckert and Suckert, 2021; Altstaedt, 2023), and STS (e.g. Konrad and Böhle, 2019; Lösch *et al.*, 2019). In these discussions, considerable attention is devoted to better understanding the *performativity* of futures—how expectations, visions, hopes, aspirations, and other future-oriented ideas and affects actively shape and coordinate social action in the present (for overviews, see Beckert and Suckert, 2021; Oomen *et al.*, 2021). While contributions improve our understanding of the performative roles futures play in shaping social action, it seems somewhat more challenging to get a grasp on how such collective ideas about the future *come to be performative* (Groves, 2017; Hajer and Pelzer, 2018; Beck *et al.*, 2021; Oomen *et al.*, 2021). This has led to approaches that apply a high-resolution lens to focus more closely on the sites (Mische, 2014) and practices through which futures are made (Reckwitz, 2016; Hajer and Pelzer, 2018; Wenzel *et al.*, 2020; Oomen *et al.*, 2021). Here, too, there is recognition that understanding the performativity of future-making requires looking beyond its discursive dimensions to appreciate that futures are also *materially* enacted—futures become performative through socio-material arrangements and embodied practices that shape the contexts of social action (Groves, 2017).

The concept of socio-technical imaginaries (STIs) effectively captures the role of imagined futures in being *shaped by* and *shaping* action in the present (Jasanoff and Kim, 2015; Rudek, 2022; Kuchler and Stigson, 2024). STIs are defined as "collectively held, institutionally stabilized, and publicly performed visions of desirable futures" (Jasanoff and Kim, 2015: 4). Viewing through this lens appreciates that action in the present and the shaping of ideas about the future develop in a two-way relationship: the prevailing imaginaries evolve dynamically through the co-production of shared understandings, values, and interests alongside institutions, technologies, and the material world (Jasanoff and Kim, 2015; Beck *et al.*, 2021; Stirling *et al.*, 2023).

Compared with 'visions', STIs are characterised by a deeper embeddedness in societal structures; they are "institutionally stabilised". As we argue in **Contribution 3**, the definition of STIs as being "collectively held" might be misleading, as it suggests the existence of a shared 'consensus vision' among all individuals within a given context. However, it is widely acknowledged that "multiple imaginaries can coexist within a society in tension or in a productive dialectical relationship" (Jasanoff and Kim, 2015: 4). Imaginaries can also vary in terms of scale to the same extent as the collectives that produce them, ranging from a somewhat global imaginary of 'sustainability' (Beck *et al.*, 2021) to a more localised, breakaway utopian community (Jasanoff and Simmet, 2021). This potential diversity of collectives has led others to ask what constitutes the 'collective' in socio-technical imaginaries (Kuchler and Stigson, 2024). In light of the risks of reification of dominant imaginaries through research, this is an important question to consider (Stirling *et al.*, 2023). This is also demonstrated by the common reference to 'dominant' next to 'alternative' imaginaries (Delina, 2018; Longhurst and Chilvers, 2019; Rudek, 2022). Thus, imaginaries are not usually monothetic but rather polythetic and contested. This means that "it often falls to legislatures, courts, the media, or other institutions of power to elevate some imagined futures above others, according to them a dominant position for policy purposes" (Jasanoff and Kim, 2015: 4).

1.2.1 Contested (auto)mobility futures

A number of contributions have helped to outline a scope of plausible mobility futures. For example, Manderscheid (2020a) distinguishes between a drivetrain transition (*Antriebswende*), modal transition (*Verkehrswende*), and mobility transition (*Mobilitätswende*). In the first, change is mainly confined to replacing vehicle drivetrains. The second entails a modal shift, with car trips replaced by more sustainable alternatives. The third involves more profound changes in mobility patterns, including reducing travel demand and creating conditions that allow people to be less mobile overall (see also Wentland, 2017; Haas, 2020; Ertelt and Hawxwell, 2025). Other contributions have pluralised possible mobility transitions at the local scale (Nikolaeva *et al.*, 2019; Schwanen, 2021).

What becomes clear through these contributions is the often mutual incompatibility of imagined mobility futures when applied to a specific space or mobility system. For example, maintaining car-centric urban design would be a prerequisite for a purely drivetrain-focused transition but would hinder significant modal shifts, as the necessary infrastructural transformations to make alternative modes attractive enough for large-scale adoption would be lacking. Additionally, the political-economic implications of a mobility transformation that allows people freedom to be less mobile and works against the ongoing acceleration of everyday life (Rosa, 2003) would be profoundly incompatible with a pure drivetrain transition.

Such imagined futures (or rather the proponents thereof) must contend, not only with each other but also with the material, institutional, and cultural realities inherited from the past. Reference is commonly made to a range of different types of lock-in and path dependency built into the transport system in its current form, which makes a fundamental departure difficult (Unruh, 2000; Klitkou *et al.*, 2015; Seto *et al.*, 2016; Haarstad *et al.*, 2022). There is no doubt that aspects such as sunk costs, prevailing habitual practices, cultural norms and preferences, institutions, urban form, road infrastructures, and so forth are hugely significant reasons why imagining (and reconfiguring) space beyond automobility is such a challenge. Yet it is not only these 'facts on the ground' that those seeking to make post-automobility futures need to overcome. These path dependencies are an important stabilising force for the regime of automobility, but they are not sufficient for its reproduction. There is also important ongoing work and human *agency* at play to keep a system 'locked-in' and enable its reproduction (Ampe *et al.*, 2021).

Perpetuating path dependencies through future-making: the example of predict-and-provide

The contributions that do account for agency in the reproduction of automobility tend to focus on incumbent private firms or other powerful actors who have a clear vested interest in maintaining their privileged position, utilising a wide variety of strategies to do so (Wells and Nieuwenhuis, 2012; Hoffmann *et al.*, 2017; Wells, 2023). However, there are other, less obvious ways in which actors shape the speed and directionality of change. I argue that an important dimension of this agency relates to the ability of actors to draw on structural factors, such as path dependency, and perpetuate them into the future through future-making.

> *"'What do we have to do today to ensure that people in Germany in 2040 are mobile and that goods can reach their destinations? The answer must be based on a traffic forecast, which has now been presented on the basis of data and facts for the year 2040. The result: traffic in Germany will grow significantly". – Volker Wissing (BMDV, 2024 - own translation).*

Volker Wissing, the former Federal Minister for Digital and Transport of Germany, along with his colleagues at the ministry, provide a good example of this perpetuated path dependency. Wissing has drawn on path dependencies inherited from the past and enacted their extension into the future through the choice and execution of this particular approach to future-making. In doing so, a future 'fact' is created: "traffic in Germany *will* grow significantly" and "the car *will* remain the backbone of mobility in Germany" (BMDV, 2024), with the implication that there is nothing the German government can do about it. Rather than framing this as a warning or something that can and should be avoided, it is produced and framed as an inevitability, sending a clear signal of the ministry's intensions to not use their power to intervene, but rather fulfil the prophecy. Without considering the problematic assumptions embedded in the models that produced the scenarios, it is evident from the outset that the chosen approach to future-making is not 'fit-for-purpose' (Mangnus *et al.*, 2021). That is especially true if the broadly accepted imperative to transform the country's transportation system is to be accounted for, along with the diverse trade-offs and conflicting values that such a transformation would entail (Ryghaug *et al.*, 2023). On the other hand, if the purpose was to stabilise the automobility regime during turbulent times, it was absolutely fit for purpose.

This approach to making mobility futures has a long history and has played an important role in the expansion of car-based automobility (Goodwin, 1999; Banister, 2008; Schwanen *et al.*, 2011). This tradition of so-called 'predict-and-provide' approaches to transportation development utilises aggregate and deterministic sequential modelling systems, following the established steps of trip generation, trip distribution, mode choice, and route assignment (Schwanen *et al.*, 2011). Traffic 'performance' or 'efficiency' was narrowly defined in terms of movement fluidity, prompting transport planners to prioritise traffic flow, congestion reduction, travel time optimisation, and overall system capacity (Banister, 2008). The resulting expansion of road infrastructure itself became a self-fulfilling prophecy by inducing further traffic growth, reducing the appeal of alternatives, and further entrenching automobility as the dominant mode of transport. These models largely overlooked the complexities of human behaviour, assuming that users were rational and well-informed in their choices, optimising time and costs accordingly. While these modelling approaches have evolved and improved since their inception, path dependencies persist in dominant approaches to transport future-making, shaped by the broader 'predict-and-provide' paradigm (Schwanen *et al.*, 2011).

These arguments suggest strong *structural* dimensions of mobility future-making when viewed at the national level in Germany. It should not be overlooked that predict-and-provide is deeply embedded in the governmentalities of neoliberalism and ecological modernisation which produce an inherently

techno-optimistic stance and generate futures with a very narrow scope of possibilities (Schwanen *et al.*, 2011). Furthermore, broader acceptance of the logics of predict-and-provide was made possible and legitimate in contexts where automobility was connected with normative notions such as "the dream of a good life with a home, a garden, and, of course, a car" (Canzler *et al.*, 2018: 52). The car became a symbol of modernity, a pledge of freedom, a promise of self-determination, and an expression of individualism (Jörg, 2024). How else could the German government justify its response to rapidly rising transport-related fatality rates between 1957 and 1961 with the slogan "What we lack are roads" (*Was fehlt sind Straßen*)? (Canzler *et al.*, 2018: 53)

Yet these cultural forces are shifting (Wells and Xenias, 2015; Canzler *et al.*, 2018). The approach taken by the German government should not be understood as inevitable. There has been significant critique from a range of organisations directed towards the German government following the publication of the plan referred to above. This reflects a broader awareness of the problematic nature of choosing this approach to future-making. Furthermore, others have observed that despite its persistence, predict-and-provide logics to transport planning have been shifting (Owens, 1995; Geels, 2012). Importantly, as will be elaborated in this thesis, examining the shifts away from predict-and-provide at the *urban* scale tells a very different story. There appear to be underappreciated sources of agency in reconfiguring or tweaking such future-making configurations to generate different prisms that refract different future possibilities, with implications for socio-technical stability and change (Oomen *et al.*, 2021). Future-making can generate moments of 'suspended disbelief' (Ezrahi, 2012), where commitments that have historically propped up particular sociotechnical arrangements can be questioned in an imagined future state of affairs. From a transformations perspective, these moments therefore warrant particular scrutiny.

1.3   Research gap: the future as a source of regime (in)stability

As has been argued above, future-making is well established as serving a variety of important functions in socio-technical transitions (see section 1.2). However, the vast majority of the work devoted to better understanding the performative functions of future-making has focused on its role in the emergence of novelty or innovation. It would be remiss to suggest that because the focus is typically oriented towards niche developments, the regime dynamics and politics that influence future-making are overlooked. Contributions in transitions research have highlighted how struggles and politics shape which ideas about the future become dominant over others (e.g. Späth and Rohracher, 2010; Späth *et al.*, 2016; Avelino, 2017; Beck and Mahony, 2018; Hajer and Pelzer, 2018; Hebinck *et al.*, 2018; Longhurst and Chilvers, 2019; van Oers *et al.*, 2020; Yuana *et al.*, 2020; Jasanoff and Simmet, 2021; Mangnus *et al.*, 2021; Cairns *et al.*, 2022; Madsen *et al.*, 2022; Mangnus *et al.*, 2022; Muiderman *et al.*, 2022; Mutter and Rohracher, 2022; Rudek, 2022; Stirling *et al.*, 2023; Friedrich and Hendriks, 2024; Hendriks, 2024). The politics of the future is clearly an emerging and productive theme within transitions research.

Yet, a shift in focus towards established systems and the processes and mechanisms of their destabilisation and decline within transitions research (see section 1.1) invites a more explicit focus on the role of future-making as a mechanism of regime (de)stabilisation and reproduction. The example of predict-and-provide demonstrates it as a crucial mechanism for the reproduction of automobility. To simply see such institutionalised future-making practices as barriers to be overcome along an innovation journey, or leave them hidden within a black-boxed socio-technical regime as another example of normalised routines governed by prevailing rules, might assume too much stability. There may be, in some cases, much more agency for actors to diverge from these rules during moments when sights are explicitly set towards the future than is often assumed. This overlooks a dimension of the regime that is more amenable to change than notions such as 'path dependency' and 'lock-in' might suggest. Better

understanding how imagined futures become performative is not only beneficial for understanding how to stabilise alternatives (e.g. 'niches'), but can also be helpful in accounting for how future-making can become an extension of the resources of incumbents to keep path-dependencies on track. I argue, therefore, that a helpful entry point to account for socio-technical (de)stabilisation and reproduction of automobility is to look to the diverse arenas within which mobility futures are (re)produced and contested.

2. Approach and methodological overview

This thesis starts from the premise that particular openings can emerge when actors explicitly shift their gaze towards the future and engage in future-making. This creates an opportunity structure to either challenge or perpetuate the material, institutional, and cultural legacies of the past into the future. The overarching objective of this thesis is, therefore, to investigate **how automobility is challenged and reproduced through future-making.**

I approached this question in an open and exploratory manner but benefited from some helpful conceptual guidance. The concepts related to 'future-making' as outlined above—such as future-making practices, dramaturgical regimes, visions, expectations, and (Techniques of) Futuring—were always guiding the search for interesting lines of inquiry and strongly informed the research design, although they played different roles and featured more or less prominently in the respective contributions. Their role can, therefore, be best understood as that of sensitising concepts (Clarke *et al.*, 2018). It is often unclear how particular imagined futures come to shape action in the present, except many complex processes are at play (Milkoreit, 2017; Engels *et al.*, 2020). The predict-and-provide paradigm, which was used above to exemplify a dominant approach to making mobility futures, is just one example. (Auto)mobility futures are articulated, staged, performed and sequenced through a myriad of decentralised activities, both in the public domain and behind closed doors (Hajer and Versteeg, 2019). This means that the determination of which future-making activities can be deemed important, and thus justify investigation, is highly context- and case-specific. I approached these decisions inductively, through following interesting lines of enquiry.

2.1 Arenas of future-making

Another important concept that helped guide the search was that of the 'arena'. In the search for cases, the goal was to identify spaces, forums, and other sites of contestation where automobility was being challenged and reproduced. There is, therefore, a deliberate attempt to centre contestation. By focusing on these points of contestation, the research aimed to provide insights into the dynamics shaping how different imagined mobility futures are negotiated, stabilised, and challenged. The concept of the *arena* of mobility future-making proved particularly suitable in this regard. Arenas are understood here as forums (both literal and metaphorical) where diverse ideas about what can, will, and should happen in the future are articulated, negotiated, and contested.

Thinking in terms of arenas of future-making is inspired by a perspective on transitions proposed as an alternative to the MLP, known as Arenas of Development (AoD) (Jørgensen and Sørensen, 2002; Jørgensen, 2012). AoD can be understood, to some extent, as a response to some of the criticisms of the MLP that I outline in section 1.1, including the tendency to black-box potentially important complexities. AoD draws on traditions from Actor-Network Theory and the work on Social Worlds (Clarke, 1991; Clarke *et al.*, 2018), as well as on insights from the same conceptual developments around governance and innovation studies that inspired the MLP (Jørgensen, 2012). An important ontological distinction from the MLP is that AoD does not apply predefined classifications of social structures and institutions into hierarchical levels (e.g. niche, regime, and landscape). Rather, the ontology is 'flat', with researchers encouraged to search for the spaces of socio-material interactions and their boundaries. These boundaries are "in flux and continuously reproduced, based on processes of ordering and stabilisation as well as restructuring" (Jørgensen, 2012: 997). Boundaries and the constitution of an arena "may expand or shrink, depending on the performances that actors engage in when attempting to stabilise, transform or even destabilise existing actor-worlds present on the arena" (Jørgensen, 2012: 1001).

Using AoD in the search for arenas of future-making helped to make a deliberate effort to emphasise difference and contestation around future-making. It allows for examining the *edges* of an assumed regime to shed light on the work of actors in imagining otherwise. The notion of the arena also facilitates movement between scales and highlights particular dimensions of conflict and contestation. Each arena is, therefore, characterised by tensions between forces that are pulling development in one direction or another, with these forces defined relationally. Each arena investigated in this thesis is different in its constitution ranging from academic discourse, to public discourse, to urban transportation planning institutions, to the imaginations of planners.

Table 1 – Case selection: Arenas of Future-making

Contribution	Arena	Research Question
1. Transformative or incumbent futures? How the future of mobility is imagined in sustainability transitions research	Imagining the future of mobility in sustainability transitions research	To what extent and how are automobility futures challenged and reproduced through future-making in sustainability transitions research?
2. Mapping destabilisation journeys in urban mobility systems: the case of Hamburg	Historical contestation around transport planning in Hamburg	To what extent is car-based automobility destabilising in Hamburg?
3. Interrogating Transition Imaginaries: mapping present futures of urban (auto)mobilities	Imagined mobility futures according to practitioners in Hamburg	How is the 'mobility transition' in Hamburg envisioned among the actors working towards its realisation?
4. The polysemous nature of the German Verkehrswende: Examining the role of floating signifiers in shaping mobility futures	Meanings associated with terminology related to mobility transitions in German public discourse	How is the 'mobility transition' framed in public discourse in Germany, and how has this changed between 2018 and 2023?

A few caveats bear mentioning. Firstly, particularly in the case of the outcomes of **Contribution 1** and **Contribution 4**, the emergent lines of enquiry, as well as hurdles along the research journey, meant that the approaches taken within the respective contributions would not typically be associated with an AoD approach. Rather, the underlying research philosophy that underpins AoD and the concept of the 'arena' was central to the processes of case delineation and played a more prominent role in the empirical work in Hamburg. Secondly, a 'regime' ontology is certainly present in my approach, which might diverge from other applications of AoD. The knowledge of how the regime of automobility 'works' and the mechanisms of reproduction were instrumental in defining the important sites where it is being contested. The interfaces between the regime and the arena were of particular importance, as they bring to the fore the (more or less metaphorical) spaces where the regime is being challenged and reproduced. Finally, I had no intention of investigating all possible arenas through which dominant ideas about the future of mobility come into being, nor did I intend to investigate the most important arenas of mobility future-making. However, it is argued that the outcomes of the contestation that occurs in the arenas brought under investigation in this thesis will be instrumental in shaping urban mobility in a given context in one way or another.

The contestation that is characteristic of the *arena* as I have described it here allows for consideration of how automobility is *challenged* and *reproduced* through future-making. The notions of *challenging* and *reproducing* automobility do not present clear categories for operationalisation. Therefore, in this regard, my approach takes a relational and interpretative stance to identify where these two hypothetical, rival, and mutually exclusive imagined mobility futures come into contact with one another and create tensions: one future trajectory in which automobility is reproduced, and the other in which it is challenged. This dichotomy acknowledges that regimes are never completely stable or static but are rather dynamically stable, constantly exposed to pressures, and in constant change (see section 1.1). Therefore, interventions through future-making will always either challenge or reproduce automobility (to varying extents and for better or for worse). Thinking in terms of challenging and reproducing thus presents a helpful heuristic for the critical investigation of future-making practices. The dichotomy of challenging and reproducing presents ideal types, and what they might look like in practice is not always so clear-cut. In accounting for ambivalences, the work defining and describing a quasi-antonym to automobility (autonomobility) has been helpful for negotiating differences (Cass and Manderscheid, 2018; Manderscheid and Cass, 2022; also see **Contribution 3**).

2.2 Grounding contestation: mobility futures in Hamburg

While **Contribution 1** and **4** are orientated towards higher governance levels with the contestation having a more discursive constitution, **Contribution 2** and **3** have a clear spatial orientation through empirical investigation in one urban area: The Free and Hanseatic City of Hamburg, Germany. There are three main reasons why Hamburg is a suitable case for investigating contestation around imagined mobility futures. (1) Hamburg is one of Germany's three city-states (*Stadtstaaten*), functioning both as a city and a federal state (*Land*). This unique status grants it significant autonomy, including legislative, administrative, and judicial powers comparable to those of larger federal states. This means that, compared to other urban areas, much of the contestation around the future of urban mobility occurs within the formal boundaries of the municipality rather than simply flowing down from other governance levels. (2) Hamburg exemplifies an urban area characterised by long-standing tensions between economic growth and environmental protection, making it particularly relevant for studying such conflicts in urban (mobility) governance (Bauriedl and Wissen, 2002). As an important hub in the European trade and transportation network, Hamburg's port has historically shaped the city physically, economically, and culturally (Lieber, 2018). With an economy built to some extent on the acceleration and organisation of the movement of goods, planning logics have been well aligned with automobility for some time (see **Contribution 2**). At the same time, the city aspires to maintain and improve its image as a "green," "inclusive," and "growing" waterfront metropolis (FHH, 2014). This ambition encompasses not only preserving and enhancing urban green spaces and natural areas but also pursuing broader sustainability goals that earned it recognition as the 2011 European Green Capital. (3) A clear mandate for fundamental change in the mobility system has emerged in recent years. Symbolically, city authorities have committed to a mobility transition by renaming the department of transportation and the transportation development plan to include the term 'mobility transition' (*Mobilitätswende*), signalling a clear intention to depart from the status quo. City authorities have also articulated and institutionalised commitments to be a leader in intelligent transportation systems (ITS) (see **Contribution 2** and **3**; Späth and Knieling, 2020). These features of this case make it a suitable urban area to investigate contestation around the future of urban mobility. While it does present limitations in terms of generalisability to other urban areas, I see the case more as a microcosm of broader, more diffuse contestation around imagined urban mobility futures.

2.3   Overview, approach and key findings of individual contributions

Contribution 1: Transformative or incumbent futures? How the future of mobility is imagined in sustainability transitions research

Co-authored with Abe Hendriks and Philipp Späth, **Contribution 1** (Hawxwell *et al.,* 2024), published in *Futures*, offers a conceptual entry point into discussions around the politics of the future and the prevailing incumbencies inherited from the past. In this case, the arena was the academic discourse of transitions research, where ideas about possible and desirable mobility futures are regularly articulated. Because we were interested in the less conscious ways in which automobility is reproduced through future-making, we chose not to investigate forums of future-making in which there is more obvious political influence, such as formal policy-making processes. Rather, our goal was to inquire into the extent to which and how researchers are able to negotiate pressures to deliver plausible and 'realistic' futures, in light of the need to imagine fundamentally different alternatives implied by the objective of the research community to not only *understand* but also *support* transformative change. We can expect the tensions between challenging and reproducing automobility to be particularly stark in relation to other academic communities and other societal actors.

Conceptually, an important outcome was the notion of *scope incumbency*, which describes a tendency for the scope of possible and desirable futures to be narrowed by the prevailing power arrangements inherited from the past. However, the contribution also provides some empirical and practical insights. We analysed the mobility and transport futures produced in academic contributions within sustainability transitions research over the last 20 years. These imagined futures explicitly articulate possible, probable, and/or desirable mobility futures. We treated these academic contributions as artefacts produced through future-making practices. We applied a systematic approach to identifying contributions and used an abductive coding methodology (Charmaz *et al.*, 2018) to draw out categories and identify different types of future-making 'functions' that the contributions seemed to be fulfilling.

We found that a substantial portion of the contributions limit the scope of the plausible to automobile-centric futures and often reproduce underlying automobility logics in the proposed alternatives. Considering the dominance of car-based mobility globally, it is not surprising that this is also projected into imagined futures. However, there were a number of important exceptions to this tendency, where academic contributions were able to articulate post-automobility futures or at least question the possibility and desirability of perpetual automobility. An important outcome of the contribution is a typology of functions of future-making for transformative change aimed at working against scope incumbency. This perspective moves beyond perceived divides between qualitative versus quantitative future-making and normative (desirable) versus probability-oriented (likely) futures. Instead, we emphasise a dialectic between hegemonic and counter-hegemonic futures. By linking the analysed imagined futures to our typology, we assessed each contribution's role in transformative change— whether by imagining or stabilising an alternative to automobility, or by questioning, deconstructing, and destituting automobility futures, or both. The resulting typology complements existing frameworks designed to foster critical reflection and improve futures literacy (Muiderman *et al.*, 2020; Mangnus *et al.*, 2021), while explicitly prompting consideration of historically embedded power arrangements.

Contribution 2: Mapping destabilisation journeys in urban mobility systems: the case of Hamburg

Contribution 2 (Hawxwell, 2024), published in the edited volume *Conflicts in Urban Future-Making* (Grubbauer et al., 2024) touches down spatially through empirical investigation in Hamburg. The arena under consideration is the historical contestation around transport planning in the city. I build on arguments suggesting that there are 'cracks' in the regime of automobility (Geels, 2012; Ruhrort, 2020) and connect this to the observation that, in particular urban areas, these 'cracks' appear to be much more evident than if one limits the understanding of the regime concept to the national or sectoral level. In the case of Hamburg, the proportion of cars in the modal split has been in decline since 2000, and formal commitments have recently been made to transition the city's mobility system. In light of these developments, the research aimed to investigate when this decline began: was there a historical turning point characterised by a shift away from the expansion of automobility to contraction, or was it something else? As an entry point to answering this question, I examined transport development plans (artefacts of future-making) that were typically produced every 10 years. The plans were analysed and triangulated with semi-structured interviews with practitioners and other professionals involved in urban and transportation development. The approach to coding was also conducted abductively (Charmaz et al., 2018).

The research identified a turning point in the late 1970s, when the unchecked expansion of car-based automobility began to wane. This shift was signalled by strong public opposition to a plan that foresaw the development of large-scale urban motorways. However, this moment was not followed by a decline in the centrality of the car in the transportation system; pressures for continuity (e.g. growing motorisation and suburbanisation) and change (transport-induced death and injury, air quality, etc.) had to be negotiated by planners and decision-makers alike. The research focused on the responses of these incumbent actors to these pressures. Based on notable shifts in incumbents' reactions to the growing pressures, four strategic modes of incumbent response were distinguished: 1) *accommodating* the pressure (incremental changes to maintain the system as it is), 2) *ignoring* the pressure (pretending there are no problems), 3) *mobilising* the pressure (embracing the pressure for material change), and 4) *diverting* the pressure (reframing the problem as an opportunity).

The research demonstrates an expanding coalition of actors working to challenge the dominant car-centric arrangements, coinciding with shifts in the foundational logics governing transport planning. These shifts were captured to some extent in the artefacts produced through the mobility future-making practices of the past. However, the analysis was significantly enriched by the contextualisation offered by the perspectives of actors who engaged with these artefacts. More broadly, this study emphasises that certain aspects of the entrenched automobility system—and particular openings for its transformation—are distinctly urban. It argues that conceptual approaches to understanding destabilisation should account for the multi-scalar and nested nature of these processes.

Contribution 3: Interrogating transition imaginaries: mapping present futures of urban (auto)mobilities

Co-authored with Philipp Späth, **Contribution 3** (Hawxwell and Späth, 2025) maintains its empirical focus in Hamburg but shifts the gaze from the past to the future. More precisely, it explores how professionals who are shaping the future of mobility in their day-to-day work envision this future. We draw on arguments in mobilities and transitions research regarding the need to account for the plurality of possible mobility transitions (Temenos et al., 2017; Nikolaeva et al., 2019; Manderscheid, 2020a; Schwanen, 2021). Rather than merely presenting a dichotomy of status quo versus transition, which is often implied by references to 'the' mobility transition, these researchers highlight that there are multiple

possible manifestations of a hypothetical mobility transition, each with significant implications for sustainability, justice, and desirability. Nevertheless, once the term 'transition' leaves academic circles and enters broader political and practice discourses, it becomes subject to various pressures that shape its meaning. Acknowledging the contestation involved in defining such terms, this contribution treats 'transition' as a floating signifier (Laclau, 2005), a term that provides coherence to a range of different meanings while offering a veneer of agreement among a diversity of perspectives. By collecting and analysing the associations that different groups in a specific context have with this notion, we develop an approach to understanding the plurality of imagined futures that prevail. Unlike the other contributions in this thesis, where mobility future-making practices or their outcomes were the primary objects of analysis, this contribution is itself an attempt at future-making. Taking the findings of **Contribution 1** into account, the goal was to design an engagement with the future that takes the problem of *scope incumbency* seriously, while still allowing for futures that professionals conceive of as plausible enough to engage with in a meaningful way.

We used Q method (Brown, 1993; Sneegas et al., 2021) to investigate inter-subjective associations among participants based on patterns in how they sorted a selection of common statements. The study involved 46 professionals working in urban development and transportation planning in Hamburg. To ensure a balanced spectrum of statements for ranking, we applied an approach we term 'negation', drawing on two hypothetical, interdependent, and archetypical imaginaries of mobility futures. The first represents a continuation or evolution of the prevailing automobility regime, while the second builds on Cass and Manderscheid's (2018) concept of autonomobility as a true alternative that actively seeks to challenge the core assumptions underpinning automobility. Statements for the concourse were sourced from parliamentary debates, newspaper articles, strategic documents, city mobility council protocols, and stakeholder interviews.

Through the applied Q method, three distinct imagined mobility futures emerged based on divergences in aggregated participant rankings. The results reveal a plurality of divergent and conflicting perspectives on what the mobility transition can and should achieve—even among actors actively working towards its realisation in their daily work. Notably, these variations exist not only between organisations but also within them. Beyond simply exploring this dimension of the politics of transitions in the Hamburg case, we consider the approach potentially useful if adapted for other contexts with different sectoral foci.

Contribution 4: The polysemous nature of the German Verkehrswende: Examining the role of floating signifiers in shaping mobility futures

Co-authored with Sophie-Marie Ertelt and published in *Environmental Innovation and Sustainability Transitions* (EIST), Contribution 4 (Ertelt and Hawxwell, 2025) investigates the contestation around the framing of transformation-oriented notions associated with the transport sector that have become established within the German public discourse. Germany is a particularly poignant case for exploring contested mobility futures because of the deep entanglement of the car industry within the national economy. This has manifested in the presence of powerful actors with a clear vested interest in steering towards particular imagined mobility futures and away from others (Wells and Nieuwenhuis, 2012; Richter and Smith Stegen, 2022). However, automobility in Germany is also highly contested. The prevailing situation in Germany can be understood as an (arranged) 'love' affair on the rocks (Canzler *et al.,* 2018). There is broad acceptance that the existing system is unsustainable and that there is a need for some kind of fundamental change, but there are highly divergent views regarding what that change should look like (Manderscheid, 2020a; Ruhrort, 2022).

This contribution builds on the same arguments as **Contribution 3**: that there is a plurality of meanings associated with a term such as *transition.* We therefore sought to explore how particular meanings are

connected with the terms *Mobilitätswende* and *Verkehrswende* in the German public discourse over time. The study drew on a dataset of 456 German newspaper articles published between 2018 and mid-2023. Discourse Network Analysis (DNA) was used to examine the development of the public debate and the actor networks connected through specific storylines. DNA combines content analysis with social network analysis tools (Leifeld, 2017). In the first step, actor statements on the German mobility transition are identified through content analysis and then aggregated into networks. We focused on three key dimensions: 1) shifts in framings of sustainable mobility over time and the events that drive these changes, 2) the roles of various actors, their discursive strategies, and coalition-building efforts in shaping mobility discourse, and 3) the evolving dominance of certain framings that favour particular dimensions of imagined mobility futures.

We delivered a synthesis of several different conceptual contributions that provide important disambiguation between the possible forms a mobility transition might take (Wentland, 2017; Haas, 2020; Manderscheid, 2020a). The three hypothetical mobility transitions—Car Continuity, Modal Transition, and Mobility Transformation—were helpful in mapping the plurality of meanings associated with the terms *Mobilitätswende* and *Verkehrswende.* Yet the research demonstrates the messy contestation that occurs as actors struggle to impart meaning to such terms in the public discourse. We identified three important dynamics shaping this contestation. Firstly, we identified shifting connections between actors and meanings associated with the *Verkehrswende* over time, with greater consensus between storylines deployed by actors in the early stages becoming more polarised. Secondly, we identified several ways that entrenched actors both co-opt and delegitimise storylines connected to more transformative futures. Thirdly, the research demonstrates how the discursive dynamics change in response to external shocks, such as the Russian invasion of Ukraine or the COVID-19 pandemic, which coincides with a shift in discursive strategies. This contribution thus demonstrates the utility of examining imagined futures through the lens of the floating signifier (Laclau, 2005) for revealing contradictions and antagonistic relationships within and between imagined futures.

Table 2: Publication overview

Contribution	Arena	Methodology	Research Question	Publication
1. Transformative or incumbent futures? How the future of mobility is imagined in sustainability transitions research	Imagining the future of mobility in sustainability transitions research	Literature review; Document analysis; Abductive Coding	To what extent and how are automobility futures challenged and reproduced through future-making in sustainability transitions research?	Hawxwell, Tom; Hendriks, Abe; Späth, Philipp (2024): Transformative or incumbent futures? How the future of mobility is imagined in sustainability transitions research. In *Futures* 159, 103325. DOI: 10.1016/j.futures.2024.103325.
2. Mapping destabilisation journeys in urban mobility systems: the case of Hamburg	The historical destabilisation of automobility in Hamburg	Case study; Document analysis; Semi-structured interviews; Abductive Coding	To what extent is car-based automobility destabilising in Hamburg?	Hawxwell, Tom (2024): Mapping destabilisation journeys in urban mobility systems. the case of Hamburg. In Monika Grubbauer, Alessandra Manganelli, Louis Volont (Eds.): *Conflicts in Urban Future-Making. Governance, Institutions, and Transformative Change*. pp. 179-205, Bielefeld: Transcript Verlag. DOI: 10.1515/9783839474679-008
3. Interrogating Transition Imaginaries: mapping present futures of urban (auto)mobilities	Imagined mobility futures according to practitioners in Hamburg	Q-Methodology (McKeown and Thomas, 2013)	How is the 'mobility transition' in Hamburg envisioned among the actors working towards its realisation?	Hawxwell, Tom; Späth, Philipp (2025). Interrogating transition imaginaries: Mapping present futures of urban (auto)mobilities. In *Urban Transformations*, 7(1), 16. DOI: 10.1186/s42854-025-00085-7
4. The polysemous nature of the German Verkehrswende: Examining the role of floating signifiers in shaping mobility futures	Meanings associated with terminology related to mobility transitions in German public discourse	Discourse Network Analysis (Leifeld, 2017)	How is the 'mobility transition' framed in public discourse in Germany, and how has this changed between 2018 and 2023?	Ertelt, Sophie-Marie; Hawxwell, Tom (2025): The polysemous nature of the German Verkehrswende—Exploring the role of floating signifiers in shaping mobility futures. In *Environmental Innovation and Societal Transitions* 55, 100963. DOI: 10.1016/j.eist.2025.100963.

3. Overarching findings and avenues for future research

Each of the individual papers introduced in the previous section offer their own conceptual and empirical insights entering into a variety of academic debates. This diverse array of contributions reflects the realities of a cumulative interdisciplinary dissertation characterised by the emergence of interesting lines of inquiry. This section zooms out to reflect on the important findings that cut across the contributions. The section is organised in four parts. Firstly, reflecting the main arguments of this thesis, I argue it might be helpful to consider future-making as a type of (de)stabilisation and reproduction 'work', and that 'temporalities' can be understood as a resource at the disposal of actors to influence the directionality and speed of socio-technical change. Secondly, in light of an observed spatially-uneven departure from predict-and-provide, there might be value in tracing spatially-specific shifts in dominant future-making practices as a helpful indicator of destabilisation. Thirdly, considering researchers are themselves actors in transitions processes, I make some suggestions for future research on mobility futures. Finally, I reflect on limitations of the overarching research approach.

3.1 Future-making as (de)stabilisation and reproduction work

The overarching objective of this thesis was to investigate how automobility is challenged and reproduced through future-making. To explore this dimension of socio-technical reproduction and change, the thesis focused on different arenas of mobility future-making, where diverse ideas about what can, will, and should happen in the future are articulated, negotiated, and contested, often in underappreciated ways.

Looking more closely at these activities, the research has exposed some underappreciated ways through which automobility is *challenged*. A range of different types of actors engaged in this work, including civil society actors in Hamburg, who articulated, spread, and pushed to implement their visions for a post-car-centric future (**Contribution 2**). Additionally, politicians and planners tweaked their approaches to transportation development planning to convince broader publics and decision-makers to engage in a more ambitious strategy (**Contribution 2**). Even the abilities of political parties in opposition to articulate statements that run counter to the logics of automobility within parliamentary debates and formal transportation committees itself a challenge to automobility (**Contribution 3**). Moreover, **Contribution 4** demonstrates an emergent reflexive awareness of the risks of discursive capture: the mainstreaming of the *Verkehrswende* could easily manifest primarily as a drivetrain transition. Many actors engaged in the discourse will draw on storylines that work against this tendency and, in turn, shape what the transition will come to mean (**Contribution 4**). Even some academics were able to negotiate pressures to 'keep it real' and creatively work with a variety of practices and theories to imagine beyond automobility (**Contribution 1**).

The research has also identified some underappreciated ways through which automobility is *reproduced* in the face of mounting pressure for change. Most obviously, this occurs through the shifting strategies of incumbents responding to the rising pressures for deeper structural change in the urban transportation system in Hamburg (**Contribution 2**). These strategies were more or less successful in alleviating the pressures but rarely demonstrated any real commitment to

departing from car-centrism. In the rare instances where there was a hint of incumbent commitment to deeper changes, opposition took a very different form, with the mobilisation of (often a relatively small number of) individuals engaging in a range of future-making activities to mobilise opposition (**Contribution 2**). These activities can be understood as a form of regime resistance (Geels, 2014) through future-making. Automobility is also reproduced through the deployment of 'repugnostic storylines' that discredit and oppose the narratives tied to proposals for curbing automobility (for example, through speed limits and low emissions zones) in the German public discourse (**Contribution 4**). Moreover, automobility is reproduced in the ways that the logics of automobility infiltrate the visions of 'sustainable' alternatives (**Contribution 3**) (also see Bergman *et al.*, 2017; Haarstad *et al.*, 2022). It is also evident through an overwhelming focus on (particularly drivetrain) technologies when transitions researchers engage with the future (**Contribution 1**).

These examples can be understood as forms of 'transitions work' (Löhr *et al.*, 2022). Not all of the examples mentioned above are explicit manifestations of future-making practices. However, many were revealed through a closer examination of activities (e.g. practices, techniques) around future-making. Accounting for this work does not provide an explanation of why a transition did or did not happen, but this kind of work is always ongoing throughout a transition process. Therefore, I suggest that transitions research should pay more attention to such activities, particularly within the growing body of work that has begun to focus more explicitly on processes of destabilisation and decline (e.g. Turnheim and Geels, 2012; Geels, 2014; Rosenbloom and Rinscheid, 2020; van Oers *et al.*, 2021; Frank and Schanz, 2022; Koretsky *et al.*, 2023). For those who explicitly place the *governance* of destabilisation and decline at the centre of their investigations, such work may be of particular importance (Rosenbloom and Rinscheid, 2020; van Oers *et al.*, 2021; Frank and Schanz, 2022). However, accounting for such work may necessitate a move away from 'cockpit' perspectives on governance towards more emergent and relational perspectives (Stirling, 2018; Briassoulis, 2019)

3.1.1 Temporality as a resource in transitions

I suggest it might be helpful to see the future, or rather temporalities more generally, as a resource at the disposal of actors to influence transitions. This connects with arguments made elsewhere that transitions research needs to better account for how actors 'explore the past' and 'exploit the future' in order to reach their goals (Garud and Gehman, 2012). If we consider that there are significant asymmetries among different societal actors regarding access to resources to exercise agency, this view extends this pool of resources to the 'instruments of imagination' (Beckert, 2021) through which collective expectations are shaped. Because academia has access to its own instruments of imagination, these should be wielded wisely. This means recognising a tendency of 'scope incumbency'—that the array of possible and desirable futures in circulation is shaped by the prevailing power arrangements—as described in **Contribution 1**. For transitions research, this necessitates the integration of mechanisms in research design that actively work against these tendencies. The ability to shape visions, imaginaries, and expectations is, arguably, one source of incumbent power that academia has not insignificant influence over (Avelino, 2017).

It is for this reason that the growing interest in the hidden politics of future-making is promising. To investigate and interrogate imagined futures is to intervene in the shaping of the scope of possible pathways towards transformation at a point when they remain open to influence (Jasanoff and Kim, 2015; Stirling *et al.*, 2023). However, this requires a critical and reflexive

stance (Ampe *et al.*, 2024). It is not enough to assume a singular monothetic imaginary and then proceed to investigate it in a non-reflexive way. This approach risks reification and reproducing dominant imaginaries, thus increasing their performativity. Rather, it is helpful to bring the contestation between imaginaries to the fore (Longhurst and Chilvers, 2019; Mutter and Rohracher, 2022; Kuchler and Stigson, 2024). This also means, at times, amplifying less dominant imaginaries and questioning the underlying assumptions, interests, and sources of legitimacy of more dominant imaginaries.

Taking temporalities as a resource not only relates to making the future but also to (re)imagining the past (Hendriks, 2024). The stories told about the past also inform the narratives about possible futures. A good example of the implications of losing sight of the past can be seen in the common framing of cycling as a new 'innovation' in transitions research, most often linked to bike-sharing or e-bikes (Valentini *et al.*, 2023). By framing cycling as something new, the long and contested history of the bicycle in urban areas is overlooked, along with the flourishing cycling cultures that were commonplace in urban areas before the car (Oldenziel *et al.*, 2016). Furthermore, it overlooks potential legitimation strategies that might help justify the feasibility of the *return* of older mobility practices. What better way to argue that a different arrangement in a given context is possible than to demonstrate that it has already existed and flourished?

3.2   Cracks in predict-and-provide at the local scale

One important interface between destabilisation and future-making can be drawn from the observed changes to future-making practices related to long-term urban transportation planning in Hamburg. These changes can be understood as 'cracks' in what Oomen *et al.,* (2021) refer to as 'dramaturgical regimes' or "specific sets of arrangements, competencies, meanings and identities underpinning a way of imagining the future and of going about things" *(Oomen et al., 2021: 9).*

The earlier example from the German Minister suggests that predict-and-provide is still the dominant logic of transport planning in Germany at the national level. Yet, as mentioned in **Contribution 2**, the approach responding to a similar challenge (longer-term transportation planning) at the local level in Hamburg was fundamentally different. For the development of the city's most recent Transportation Development Plan (*Verkehrsentwicklungsplan*), practitioners do use quantitative models that predict future demand, but these predictions are also used to measure against explicitly normative objectives: to assess whether they are going to achieve their goals around safety, pollution, carbon emissions, etc. One overarching goal of the plan stands out: by 2030, 80% of journeys in Hamburg should be made by public transport, cycling, walking, or shared services. This necessitates a reduction of the (privately owned) car in the modal split from 32% in 2023 to 20% in 2030. Goal and scenario development were informed by a mobility advisory group (*Mobilitätsbeirat*) that included a broad range of political factions and interest groups. During the scenario development, it became clear that planners would likely have to use *all* the tools at their disposal to reach the city's climate goals, which led to the proposal of an additional scenario that combined all possible instruments (FHH, 2022a). The developed scenarios were tested with a range of other practices that engaged the public in creative ways to gain insights into prevailing *desirable* futures. One example includes an online game where citizens were invited to allocate a hypothetical budget, reflecting their priorities for changes in the urban environment. Through this experiment, planners were able to determine that the vast

majority of children (in addition to participants more generally) who engaged with the game prioritised measures that would convert space currently occupied exclusively by motorised vehicles (FHH, 2022b).

Having these 'facts' that many citizens *want* to live in a less car-centric city was important for justifying the politically challenging decisions that would have to be made to make this a reality. These different practices of future-making required fundamentally different skills and technologies compared with a purely predict-and-provide approach. This meant that planners had to draw on other organisations that had more experience with creative formats of participation. Importantly, the meanings associated with these practices had changed fundamentally. The practices were less oriented towards "what do we have to do to make sure people remain mobile?" and more oriented towards "how do we convince the people, politicians, and the other powers-that-be that more ambitious efforts to curb car centricity are a good idea?" We can see here that there is clearly a shift in the dramaturgies of transportation planning in the city of Hamburg. This has manifested in very different practices of making mobility futures and the meaning of the plan itself: it appears that, compared with transportation development plans of the past, what is actually written in the plan is less important today than the activities that led to its creation.

Such changes are not limited to Hamburg and are not new. Innovation around transport development planning, which, for example, encourages creative participation formats, has been happening across Germany, throughout Europe, and beyond for some time (Lindenau and Böhler-Baedeker, 2014; May, 2015; Michelini *et al.,* 2023; Paddeu *et al.,* 2024). However, these changes expose some structural conditions that are present at the local level but not at the national level (at least in Germany) that allow practitioners to engage in different forms of mobility future-making that permit varying degrees of divergence from predict-and-provide. Various context-specific factors (such as urban form, quality of alternative transportation infrastructures, local governance autonomy, etc.) may influence the degree to which transportation planning institutions are willing or able to depart from prevailing logics and models of transportation planning (Prieto-Curiel and Ospina, 2024). However, the findings of this dissertation reveal some agency prevailing at the local scale in terms of choosing and designing the practices that would be drawn upon to develop their plans. Previous political administrations in Hamburg simply opted not to engage in long-term transportation planning whatsoever, or limited the scope of the types of future-making practices practitioners were allowed to engage in. Also, practitioners in Hamburg observed that shifts away from predict-and-provide had occurred to a greater extent in other urban contexts, and in relation to different dimensions of transportation infrastructure planning (e.g. parking, intersections, road capacities, etc.) (see **Contribution 2**).

These nuanced differences are the product of local political jostling and are highly context-specific and contingent. However, they have important implications for the kinds of future-making that are engaged in as well as the performativity of those future-making practices. Again here, one must not lose sight of the structural conditions that limit the types of future-making that can occur. However, to allocate too much responsibility to broader structural factors for a local shift away from future-making logics governed by predict-and-provide (as one example) is to miss important openings for transformative change.

3.2.1 Tracing the cracks and the work towards their openings

These openings at the local scale could be expanded through radically different future-making practices: to design fundamentally different Techniques of Futuring (Hajer and Pelzer, 2018) or

'sites of hyperprojectivity' (Mische, 2014) for making mobility futures. Indeed, some practitioners in Hamburg identified clear limits to the transformative potential of the current approach to transportation planning. Instead, some practitioners suggested the need for completely different methods that could better help negotiate the trade-offs and even decentralise decision-making power over the difficult and politically inexpedient decisions that must be made to curb automobility. Consideration is warranted towards fundamentally rethinking how long-term urban transportation planning is conducted. This could include developing fundamentally different 'ecologies of participation' (Chilvers *et al.*, 2018), drawing on, for example, citizen assemblies to take some of the responsibility away from elected officials whose time horizons are often narrowed due to political cycles. What appears to be particular important is that approaches to future-making are designed in a way that appreciates and embraces the in inherent conflicts and resistance that are inevitable in transformative change (Chambers *et al.*, 2022). Also, within transitions research more broadly, Friedrich and Hendriks (2024) argue for the need to foster fundamental changes in the prevailing relationship the research community has with the future.

While I agree with the above suggestions, the findings of this research demonstrate that it can also be helpful to trace the subtle shifts in more conventional and institutionalised future-making practices. While local actors might be limited in their abilities to fundamentally overturn their approaches to future-making, there may be more scope to nudge and tweak existing practices, which can have noteworthy implications for the types of futures created. Regarding urban mobility future-making, research could investigate the spatial and temporal distribution of such shifts in more detail by examining and comparing them across multiple urban contexts. Other research has demonstrated that particularly at the urban scale, one observes anything but a uniform linear development across cities as a result of the car's entry into the configuration (Pflieger *et al.*, 2009; Oldenziel *et al.*, 2016). Why should the destabilisation of dramaturgical regimes of future-making be any different? Are departures from predict-and-provide more pronounced in particular urban areas than in others? Does a departure emerge earlier or later in specific urban contexts? Are there particular dimensions of transportation infrastructure planning that are more or less amenable to shifts away from predict and provide (apart from the obvious extent of car dependency)?

This finding connects with arguments made elsewhere that place, space, and scale matters more than is often assumed when accounting for the complexities of socio-technical change (Hansen and Coenen, 2015; Binz and Truffer, 2017; Fuenfschilling and Binz, 2018; Binz *et al.*, 2020). However, I suggest that more explicit attention could be paid to the spatial and scalar dimensions of the 'unlocking' of established lock-ins, as well as to the spatially specific processes of socio-technical destabilisation and reproduction. Also connecting to the work on the locally specific, and multi-scalar processes in the 'making' of visions (a reality) through their structuration (Späth and Rohracher, 2010, 2012), more attention could be paid to the 'unmaking' (Feola *et al.*, 2021) of dominant imaginaries. Paying attention to the future-making actors engage in might be a helpful analogue for mapping this dimension of destabilisation.

Future research could also pay closer attention to (innovation around) the specific practices that comprise the formal approaches taken to make mobility futures in different urban areas. Making mobility futures with the purpose of persuading rather than predicting requires fundamentally different future-making practices (with different competencies and tools) than those that inform predict-and-provide. There is somewhat of a 'legitimacy gap' that can emerge when the 'trust in numbers' (Porter, 1995) and an assumption of 'scientific rigour' and rationality (Oomen *et al.*,

2021) that underpins predict-and-provide are substituted by other discursive genres. How do actors fill this legitimacy gap to make less conventional approaches more performative? Research could engage more explicitly with a practice perspective to help bring the politics of future-making to the fore at a much higher resolution (Reckwitz, 2016; Wenzel *et al.*, 2020; Oomen *et al.*, 2021).

However, one should not lose sight of the structural conditions within which future-making takes place. While the scope of agency might be comparably more open during moments when actors shift their gaze to the future, the structures within which future-making is performed still limit possibilities in terms of which techniques are deployed and how. In Hamburg, significant changes in the structural conditions allowed for (and to some extent necessitated) practitioners to change their approaches to mobility future-making (see **Contribution 2**). Even during the development of the most recent Transportation Development Plan, there were structural pressures that intervened, resulting in the published plan leaving out some of the governance instruments deemed necessary for realising the plan's goals. This made it significantly less ambitious and limited its transformative potential. Therefore, it is important that such practices are understood in relation to the material, institutional, discursive, and cultural contexts within which they are embedded, rather than as a technology that can be passed around contexts in a 'plug-and-play' manner (Oomen *et al.*, 2021; Altstaedt, 2023).

3.3 Future investigations into mobility futures

3.3.1 Questioning drivetrain transition imaginaries

Beyond seeing temporality as a resource available to actors 'out there' in the field, temporality can also be viewed as a resource at the disposal of researchers who are also actors in processes of socio-technical change. Like any epistemic community, there can be obvious pressures to 'keep it real' and 'keep it simple', particularly for more policy-adjacent research. Yet this cannot lead to a reluctance to engage with complexity, as doing so can hinder more radical and progressive forms of transformation (Stirling *et al.,* 2023). Importantly, the findings of this thesis highlight the need to critically examine the assumptions underlying what can be understood as relatively low-hanging fruit of transitions in the transport sector in terms of required behavioural change: changes in the drive train of personal motorised vehicles. In **Contribution 1**, we demonstrated a tendency amongst the vast majority of academic contributions within transitions research that attempted to create or engage with a future state of affairs around mobility to limit the scope of possible mobility futures to those centred on the personal motorised vehicle. This tendency was largely related to an abundance of work that engaged with electrification and other technologies speculated to potentially become the drivetrain of tomorrow.

Understanding which drivetrain technologies will power the vehicles of tomorrow is undoubtedly an important area of research. However, it is also crucial for transitions researchers to be reflexive about the potential implications of drivetrain transition imaginaries dominating academic discourse. Compared with the critical examination of emerging technologies broadly perceived as potentially 'disruptive' (particularly autonomous vehicles and Mobility as a Service (MaaS)), there has been a surprising lack of future-making that questions and interrogates pathways that simply substitute the drivetrain. The technologies, perceived as potentially more 'disruptive', seem to (understandably) garner more critical attention due to their status as 'hopeful monstrosities' (Mokyr, 1991; Borup *et al.,* 2006). Yet it is important to recognise that even transitions presented

as more 'technical'—such as the substitution of one drivetrain for another—are always normative: they bring forward particular political and social orders at the expense of others (Longhurst and Chilvers, 2019). What also seems to be frequently overlooked is the monstrous nature of automobility in its current form (regardless of the drivetrain).

This issue becomes even more pressing if we consider the dynamics of *trasformismo* as described in section 1.1. The socio-technical regime is constantly changing and adapting to shifting circumstances and mounting pressures, which can create openings for transformation. Facilitating a transition that reproduces the prevailing power arrangements while nullifying the pressures which presented the openings for change could be understood as a missed opportunity and even as aiding the further entrenchment of unsustainability. If the prevailing moment—characterised by a destabilised automobility regime (Wells, 2023)—manifests in change primarily limited to improvements to the drivetrain with mobility systems practically reproduced in their current form, such 'improvements' might better be understood as missed opportunities.

This is particularly evident if we consider the problems associated with transport at the urban scale. An electric vehicle is just as likely to kill a pedestrian if they are hit at speed. Electric vehicles also suffer from 'autobesity' (Fuller, 2023), an increasing trend towards ever heavier cars that has been underway since the 1990s (Carslaw, 2006). The fine particulate matter produced through the brakes and tyres of EVs still leaks into our bodies and into local ecosystems (EEA, 2018). The friction of the electric vehicle's tyres on the road still produces noise pollution, equal to that of a conventional car at speeds beyond 50 km/h (Verheijen and Jabben, 2010). The cocooned capsules of the electric vehicle still have to be penetrated by the sirens of emergency services and the horns of neighbouring vehicles, disturbing those not protected by their own cocoons. The roads that electric cars drive on still segregate urban space. Furthermore, the costs of the improvements EVs can deliver need to be understood in relation to the exploitation and extraction occurring elsewhere (Deberdt and Le Billon, 2024).

3.3.2 Being sensitive to new faces of automobility

Beyond the need for more critical interrogations into drive-train transitions, if the prevailing hype is anything to go by, a simple drive-train transition is unlikely. Therefore, the technologies perceived as more potentially disruptive also require particular critical attention. As alluded to in the introduction, connected and autonomous vehicles (CAV) have emerged as a dominant high-tech imaginary at the interface of automation, electrification, and digitisation (Dangschat and Stickler, 2023). This imaginary is somewhat 'empty' and susceptible to highly utopian and dystopian interpretations (see **Contribution 3**). The vision described in the introduction of clean, efficient, seamless, and comfortable travel is a very rosy narrative compared with the potential and, arguably, more likely outcomes. On the more dystopian side of the CAV imaginary, automation has the potential to exacerbate urban sprawl and create further mobility injustices (Dianin 2021), encourage longer and more frequent car commutes (Milakis *et al.*, 2017), and further shifts away from conventional public transport and active transportation (Milakis *et al.*, 2017). These hugely divergent hopes and fears associated with the imaginary of the CAV suggest its potential as a new face of automobility, justifying critical scrutiny around these developments. The same can be said for MaaS and other variations of 'smart' mobility (Pangbourne *et al.*, 2020; Nikitas *et al.*, 2024).

Hamburg aspires to be a leader in the developments of smart mobility, with agreements made between the city and national government to have up to 10,000 autonomous shuttles in the city

by 2030 (see **Contributions 2** and **3**). Despite this imagined future edging closer to reality (with the planned rollout of 20 autonomous shuttles in 2025), one might expect heated debates and strong stances to be taken regarding the potentials and risks of these technologies (as is the case for interventions such as parking management, speed limits, and space conversion). Nevertheless, the investigation into how the future of mobility is imagined among practitioners outlined in **Contribution 3** shows that practitioners are much more ambivalent towards these technologies in comparison with more conventional, tried-and-tested (albeit often contentious) interventions. This is likely due to the deep uncertainties surrounding these technologies, leading people to be less inclined to take a stance. This is an interesting finding in itself because it demonstrates the necessity of uncertainty and the associated ambivalence for such potentially disruptive technologies (for better or for worse) to slip through the governance arrangements that might have otherwise rejected them. We are then left with the question of why tried-and-tested interventions can be so much more polarising than those shrouded in uncertainty. Intuitively, one might expect the opposite.

Negotiating promising signifiers

How might academics negotiate the space where it is unclear whether a promising signifier such as CAV, MaaS (as well as 'smart', 'transition', 'circularity', 'sustainability', etc.) may emerge as a new face of automobility (or unsustainability)? Academics frequently engage in important work to disambiguate such promising signifiers to articulate differences. Once these terms enter broader public discourses, they take on a life of their own and begin to be shaped by various forces (see **Contribution 3**). To prevent such promising signifiers from being captured and becoming another mechanism of power reproduction, conventional critical academic approaches to deconstruction are important but not sufficient. Bina *et al.* (2020) demonstrates the need for utopian thinking in urban transformation, which can be undermined if future-oriented social science is limited to deconstruction (also see Gümüsay and Reinecke, 2022).

Rather than rejecting or embracing terms wholesale, research could pay closer (critical) attention to the institutional and material changes that are actually occurring (or envisioned to occur) under the banner of such promising signifiers. Consideration could be given to how these developments might be nudged in a direction that improves sustainability and/or justice. For example, a closer examination of the developments happening under the banner of smart mobility in the Hamburg case also demonstrates the agency among local actors to re-imagine and re-brand 'smart'. While a more progressive government inherited a particularly profit-oriented, car-centric smart mobility agenda in 2020, there has been a broadening of its framing in recent years, which has brought cycling and public transportation into the array of technologies and artefacts considered when imagining smart mobility futures (see **Contribution 2**). Although the current framings are certainly not 'perfect' (from a sustainability or justice perspective), these changes suggest that 'smart' mobility futures might not necessarily be destined for worse (or better) outcomes. Rather, the extent to which its promethean, profit-oriented potential is realised is open to negotiation and contestation. Other contributions have demonstrated that there is scope for re-framing even incumbent-friendlier imaginaries such as 'net-zero' (Sharp *et al.*, 2024).

Importantly, the current visions around future mobilities suggest that automobility needs to be understood beyond the personal motorised vehicle. It appears that the logics, assumptions, and principles underpinning automobility (speed, status signalling, privacy, profit imperatives, outsourcing of environmental and social costs, structural injustices, etc.) can find their way into

the imagined futures of the solutions intended to solve the very problems that automobility creates (Haarstad *et al.*, 2022). However, this too should not be regarded as a foregone conclusion. Future research could, therefore, look more explicitly toward the arenas in which these questions regarding the future of mobility are being negotiated.

When investigating such arenas, keeping the deeper cultural structures underpinning automobility in mind can be helpful. This involves tracking the shifts in meaning associated with the car (Wells and Xenias, 2015). There are also powerful underlying narratives or metaphors that govern how we think about movement and structure present-day mobility future-making practices (te Brömmelstroet *et al.*, 2022a). One example is the associations between traffic and water: *gravity* models inform traffic *flows*, *bottle-necks*, *volumes*, etc. It can also be helpful to communicate effective interventions if they lead to traffic *evaporation* (Nello-Deakin, 2022). These myths are all bound up in the assumption that traffic is somehow like water (an unconscious substance) and is not the product of emergent human behaviour. The water metaphor still seems to persist despite most people reporting that they feel far from being in 'flow' when they are on the move within the current transport paradigm (te Brömmelstroet *et al.*, 2022b). Other examples include prevailing unconscious biases that allow us to blissfully overlook the massive public health implications of car-based automobility, a phenomenon that others have dubbed 'motonormativity' (Walker *et al.*, 2022). Additionally, automobility is intertwined with the ways gender is performed and articulated (Daggett, 2018). These are just some examples of how deeply the car and automobility have penetrated culture and subjective experiences of the world (Bonham, 2006; Manderscheid, 2014).

3.4   Limitations

Some limitations of the broader approach are worth noting. These relate to 1) limits to generalisation, 2) limited access to high-resolution insights into future-making practices, and 3) problems with centring the research on automobility.

There are obvious limitations to the generalisation of the findings, as much of the empirical work focuses on the city of Hamburg. As argued in section 2.2, there are particularities related to the Hamburg case that make it unique, even by European standards. Its status as a city-state gives it significant legislative autonomy compared to other urban areas. More importantly, structural conditions such as urban form and a well-established and enduring public transportation system perhaps make the prospects of imagining post-automobility a more feasible endeavour in Hamburg compared with many other urban contexts (Prieto-Curiel and Ospina, 2024). Nevertheless, the intention of this thesis was not to deliver generalisable findings. Rather, the purpose was to encourage research that opens up the black box of the regime, explores its boundaries, and considers the underappreciated work of actors in challenging and reproducing it. This might look very different in other urban contexts.

Secondly, the approach taken does not necessarily do justice to the types of investigations that might be expected to really appreciate the political dimensions of future-making. Initially, the ambition was to focus more closely on *practices* of future-making and to really embrace a practice ontology (Reckwitz, 2016; Wenzel *et al.*, 2020; Oomen *et al.*, 2021). Such an approach necessitates a much more embedded research design, also embracing more ethnographic research methods. A number of limitations related to field access made this approach an impossibility. These limitations were compensated for with interviews with those involved and an in-depth document analysis of the outcomes of such practices. However, the kind of access

required to truly embrace the principles of practice theory to analyse future-making practices is not easy to obtain. This may be a limitation that others could encounter.

Finally, the approach is susceptible to criticism that by centring on automobility, real attempts to imagine otherwise are obscured because they completely transcend mobility-centred (urban) development logics. Terms like 'transport' or 'mobility' were key features in the development of search strings for the literature reviews and for determining interview partners, etc. It would be a legitimate criticism to suggest that this might obscure important future-making activities that are much better suited to challenging automobility. It could also be suggested that the approach might serve to reify a 'regime' of automobility, increasing its power by insisting on its existence. Indeed, Bertolini (2023: 2345) argues that the imaginaries guiding urban development need to transcend not only automobility but *mobility* more generally: we should be focusing "on cultivating a broad set of highly diverse urban qualities […] to foster an urban mobility paradigm beyond urban mobility".

For research to subscribe to a post-mobility urban development paradigm is likely a productive step forward. However, the research demonstrates that it would likely not be enough. There is also a need to recognise the powerful mechanisms of automobility reproduction and understand (and engage in) the work that chips away at and destabilises these mechanisms. Furthermore, by focusing on the edges of automobility, one inevitably encounters examples of post-mobility paradigms. This is because the source of inspiration for post-mobility initiatives is often the brutality of automobility itself. Through the empirical work in Hamburg, the approach caught glimpses of, but could not fully grasp, the emergence of a broader vision that centres on such diverse urban qualities. This comprises actors working to make the 'green city', 'sponge city', and 'bike city'. It is not clear to what extent such visions overlap with (or potentially contradict) each other in terms of actor constellations and strategies. However, what they all have in common is a vested interest in the decline in the dominance of the car in urban areas. These activities were revealed because they are appear to be applying pressure to the regime. An equally fruitful investigation could be to map the 'work' through which these groups re-imagine, re-code, and re-configure the city around their visions (Hoffman *et al.*, 2021). Yet, starting with destabilisation was a helpful way to identify such 'niches' that warrant deeper investigation and perhaps 'strategic management'. This could be a useful way to justify a focus on the emergence of specific social or technological innovations as the 'flip side' of destabilisation. Importantly, **Contribution 1** demonstrates how important the recognition of the 'existence' of automobility actually is. The academic contributions that even mentioned the term "automobility" were much more likely to produce futures that challenged its underlying logics.

4.   Conclusions

This thesis builds on arguments within transitions research that suggest a need to shift the focus away from the processes behind the emergence of innovation and pay more attention to existing socio-technical systems and the processes through which they become destabilised and decline. A logical extension of this focus on existing systems is to pay more attention to why destabilisation and decline are not occurring despite efforts to bring them about, thereby exposing underlying and underappreciated mechanisms of socio-technical reproduction. Building on emerging discussions around the politics of the future, the thesis argued that engagement with the future and temporalities more broadly is an important yet underappreciated dimension of the politics of transformation. While acknowledging the structural conditions within which futures are made, there is often more agency for actors to shift direction, which is contingent on the types of future-making practices they engage with and how these practices are performed (Reckwitz, 2016; Oomen *et al.*, 2021). Extending this thinking to transitions research and focusing on the empirical field of mobility, the thesis investigated how automobility is challenged and reproduced through future-making. To explore this question, four contributions investigated different arenas of mobility future-making, where diverse ideas about what can, will, and should happen in the future are articulated, negotiated, and contested.

Each contribution delivered its own set of empirical, conceptual, and methodological insights. The discussion section of this framework paper introduced a range of cross-cutting themes and developed avenues for future research. In particular, I argued that future research could pay more attention to the moments when actors set their sights towards the future and understand these moments as opportunities to question and confront the inherited realities of the past or perpetuate them into the future. More broadly, it may be helpful to consider 'temporalities' as a resource at the disposal of actors to influence the directionality and speed of socio-technical change.

I also argued that there may be value in mapping destabilisation journeys by focusing on changes in the underlying dramaturgical regimes that constitute future-making. In relation to automobility, future research could pay more attention to the cracks in dramaturgical regimes at the urban scale. Other research has shown that shifting scales exposes other (manifestations of) stabilising forces while potentially revealing underappreciated instabilities (Jayaweera *et al.*, 2023). Automobility is not only realised (both made aware of and brought into existence) through the statistics that articulate local air pollution, noise pollution, collisions, and space consumption. It is also realised through the mouthful of fine particulate matter, the sleepless night, the collision or near miss at an intersection, and the inability to walk two-abreast down a car-filled street. This brutal materiality seems easier to overlook when engaging in future-making practices performed at higher governance levels compared to those performed at the local scale. Appreciating the urban dimensions of automobility and socio-technical reproduction—and destabilisation more generally—does not mean we should assume that mobility transitions can happen "inside" cities (Sheller, 2018). We also need to remain cautious of the "local trap": overlooking the broader forces and dynamics that operate beyond the local level (Purcell, 2006) and overstating the agency of local actors alone to leverage the necessary change that a broader transformation requires (Bulkeley and Betsill, 2013). Rather, it is important to be able to shift analytical foci between scales and account for what nuance is lost and gained when these moves are made.

Importantly, I argued that researchers should also see themselves as actors in transitions processes and be wary of reproducing dominant ideas about the future, suggesting some

potentially productive ways forward. This requires a more critical engagement with promising solutions to address problems related to automobility. There is often a tendency to reproduce the underlying logics and assumptions of automobility, thereby facilitating its reproduction in the face of growing pressures that could manifest in its transformation. There is no easy way to negotiate this situation, where it may not be so obvious whether a promising mobility solution will ultimately manifest as a new face of automobility or not. However, negotiating this space entails a particular mandate for those working under the banner of 'sustainability transitions' to improve our futures literacy (Mangnus *et al.*, 2021; Friedrich and Hendriks, 2024) and to recognise that academic resistance to normative partiality can often be futile (Ampe *et al.*, 2024).

This also means questioning the prevailing linear understanding of time, such as the notion that the past is the only temporality open to factual inquiry but empty of possibility, while future possibilities are boundless yet inaccessible to factual inquiry. Future facts are constantly in the making, and revealing hidden pasts exposes new possibilities for the future. More concretely, this might involve research that critically investigates developments occurring under the banners of 'sustainable' and 'smart' mobility while also remaining critical of automobility in its current form. In doing so, it is crucial that we dare to challenge prevailing myths surrounding future mobilities (Peeters *et al.*, 2016; Fletcher *et al.*, 2019), including the inflated promises of technologies often tied to hype cycles (Borup *et al.*, 2006; van Lente, 2012; van Oers *et al.*, 2020), rather than inadvertently reproducing them. It also means questioning the pervasive influence of capitalist logics that reinforce assumptions linking economic growth with how people move around (Schwanen *et al.*, 2011; Bergman *et al.*, 2017; Nikolaeva *et al.*, 2019; Schwanen, 2021; Cox, 2023), the often assumed profit imperatives of mobility experiments (Henriksson and Wallsten, 2020), and the socio-economic compulsions to travel (Manderscheid and Cass, 2022). Such a task is beyond the abilities of any single researcher. Rather, these findings stress the importance of a *coordinated* approach to expose, deconstruct, and even *destitute* automobility (Braun and Randell, 2023) while exploring, articulating, and stabilising real alternatives.

Riffing on Fredric Jameson's famous quote about an unimaginable end of capitalism, Jones and McCreary (2022: 19) argue that "the car is so entrenched in our social imaginary that we cannot see beyond it. It remains easier to imagine the end of the world than the end of the expressway". If we take the regime (e.g. of automobility) as a black box, as is often the case (see section 1.1), then this statement largely resonates. The vast majority of future-making activities encountered through this research did not challenge automobility in any serious way. Yet, there were many notable exceptions to the rule. By searching for the edges of the regime and taking a closer look at the work of actors challenging and reproducing automobility, we can start to question who the "we" is that cannot see beyond the expressway. The research demonstrates that there are indeed actors who can and do imagine otherwise. Academics enjoy a relatively privileged position in terms of access to theories that allow us to apply different lenses to understand the world and move back and forth through time. In light of a transformations agenda, we have a responsibility to imagine otherwise.

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7. Individual publications

7.1 Transformative or incumbent futures? How the future of mobility is imagined in sustainability transitions research

Transformative or incumbent futures? How the future of mobility is imagined in sustainability transitions research

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ARTICLE INFO	ABSTRACT
	How actors relate to the future has long been considered important in research on the governance of transformations towards sustainability. Recent contributions have explored the politics at play in the 'making' of futures and the forming of collective expectations. Building on the concept of socio-material incumbency and integrating academic discussions which appreciate the politics of future-making, we consider the forming of collective expectations as a process through which prevailing socio-material arrangements are challenged and reproduced. We introduce the concept of 'scope incumbency', through which the particular ideas about the future collectively deemed plausible are shaped by prevailing power arrangements. Consequently, we suggest it plays an important and underappreciated role in the reproduction of locked-in systems. We illustrate this perspective by exploring how mobility futures are imagined in sustainability transition research. We investigate academic contributions which explicitly articulate possible, plausible and/or desirable alternative mobility arrangements and consider the extent to which and how contributions challenge and reproduce hegemonic socio-technical orders. We find that a substantial portion of the contributions collectively limits the scope of the plausible around automobile-centric futures in several ways.

1. Introduction

The future, or rather the ways through which actors make sense of the future, has become an important area of research interest (Beckert & Suckert, 2021). Engagement with the future is particularly prominent in sustainability transitions research (STR). Like other research communities interested in understanding the dynamics underpinning transformative change, STR is constantly grappling with questions around probable, plausible, possible and desirable futures. Following Wenzel et al. (2020, p. 1443), future-making is understood here as "the specific ways in which actors produce and enact the future". Different future-making activities produce different futures or conceptualisations of possible future worlds. This perspective recognises that there are "no future facts" and nothing that can be truly known about the future (Brumbaugh, 1966, p. 649). In the face of this inherent uncertainty, actors deploy a range of future-making practices which help fulfil diverse social functions (Aykut et al., 2019) and make collective action possible (Beckert, 2016). Yet there are always questions about for whom and by whom futures are made (Aykut et al., 2019; Stirling, 2011). Thus, a growing research interest in the future has coincided with emerging questions about the politics at play in future-making and

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the forming of collective ideas about the later-than-now (Altstaedt, 2023; Beckert, 2016; Knappe et al., 2019; Lösch et al., 2019; Oomen et al., 2021).

At the same time, STR explicitly aims to understand the complex and plural forces that shape and reproduce obdurate socio-technical systems and propose interventions to realise fundamentally different futures (Loorbach et al., 2017; Turnheim et al., 2020). Regarding these plural forces, there are dimensions of complexity which remain elusive. Kok et al. (2021, p. 1) articulate this with a call to better understand the mechanisms underpinning "the stability of locked-in constellations, and to conceptualize the power at play in sustaining and changing these".

This research aims to bridge these two discussions: to explore the role of future-making in stabilising and destabilising obdurate socio-technical systems. We are responding to calls to reflect on the extent to which future-making practices are fit for the purposes they are designed to fulfil (Mangnus et al., 2021). This exploration goes beyond investigating the fit between specific micro-level future-making practices and the purposes they aim to fulfil. We rather investigate the fit between types of futures which are imagined collectively within a given community and the goals of that community more broadly.

To explore this perspective, we focus on the case of mobility and examine STR as one forum where mobility futures are *made*. We analysed scholarly articles in STR that articulate an explicit narrative, vision, prediction, etc. about the future of mobility, interpreting these as manifestations of future-making practices and reflecting on the possible implications for the types of mobility futures imagined collectively. Drawing on the concept of a regime of automobility (RoA) (Böhm, 2006), we investigate the extent to which and how automobility futures are challenged and reproduced through future-making practices utilised within the community. We find that a significant portion of the imagined futures would still be characterised as a system dominated by the personal-motorised vehicle (PV) and that deeper characteristics of a RoA, such as the preference for speed, efficiency and privacy, and the cultural meanings associated with the car, are rarely imagined otherwise.

To explain this tendency to (often unintentionally) extend the dominant power arrangements of the present into imagined futures, we draw on the notion of deep incumbency as a "self-reinforcing trajectory in obdurate configurations of actors, practices, interests, infrastructures, institutions and cultures, that dominate in some specific political setting" (Cox & Johnstone, 2016, p. 16). We contend that this self-reinforcing trajectory is also present in the forming of ideas about the future through future-making practices. We thus argue that research needs to take into account the ways through which the future is conceived of as an underappreciated source of socio-technical stability as a starting point for establishing approaches which can counteract these tendencies.

The paper is structured as follows. First, we trace the emergence of STR with a focus on the relationships with the future that have been developed in its different strands of research and integrate ongoing discussions about the politics involved in the making of futures. Second, we draw on the notion of deep incumbency and outline a particular form of incumbency termed here 'scope incumbency' through which the dominant ideas about what is collectively considered possible, plausible and desirable are shaped by power arrangements in the present. Third, considering this view and building on the objectives of the STR research community, we develop four archetypical functions of future-making for transformative change which could help work against scope incumbency. After that, we introduce the case study and methodology to investigate possible mechanisms of scope incumbency through the making of mobility futures in STR. Building on the findings, we outline seven types of future-making elicited from the data corpus and consider them in relation to the functions of future-making for transformative change. We illustrate these types by referring to specific examples from the data corpus and reflect on the extent to which and how the analysed future-making practices challenge and reproduce a RoA. In the final section, we reflect on the findings and discuss the possible implications for future research in STR.

The main contributions of the paper are twofold. Firstly, it serves as an invitation to investigate the underappreciated ways through which incumbency is reproduced through future-making in a range of possible arenas. Secondly, it investigates one such arena as a reflexive practice considering the extent to which the future-making deployed in the research community is aligned with the goals of that community.
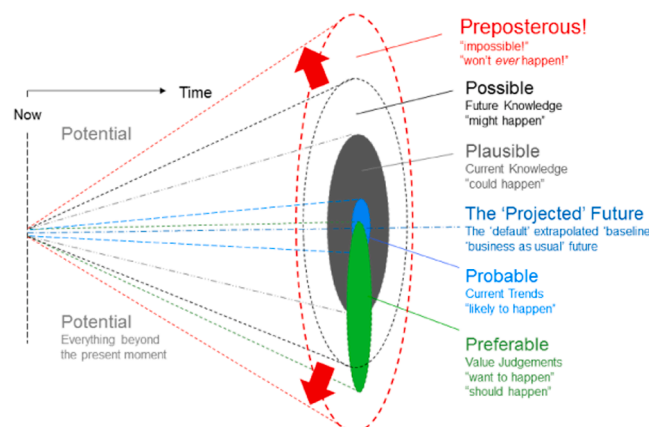

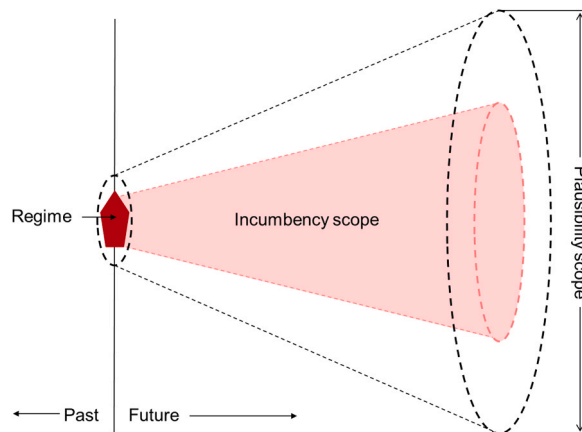**Fig. 1.** 'Futures Cone' adapted from Voros (2003, 2017).

Fig. 2. Conceptualising scope incumbency based on an adapted futures cone (Voros, 2003).

2. Background

2.1. Problematising the future in STR

Two main goals can be understood to guide STR: *understanding transitions* and *supporting transitions*; both with the broader overarching objective to "help move society in the direction of sustainability" (Köhler et al., 2019, p. 2). Transitions research, therefore, tends to be located on a spectrum ranging from underlying *analytical* motivations which aim primarily to understand transitions and underlying *normative* motivations which are more interested in bringing about transformative change. Each approach tends to treat the future in fundamentally different ways.

Research driven by analytical motivations looks to the past or present to better understand how and why transitions (do not) play out. For much of the work, the future does not play an explicit role. For example, retrospective contributions have improved the understanding of the stability of certain regimes in terms of diverse lock-ins and path dependencies (Klitkou et al., 2015; Simoens et al., 2022; van der Vooren et al., 2012). These perspectives focus on decisions made and phenomena emerging from the past, which need to be overcome before realising desirable futures (Grin et al., 2010; Loorbach et al., 2017). Retrospective research focusing on past transitions has also been instrumental in improving our understanding of broader transition dynamics (Martínez Arranz, 2017; Zolfagharian et al., 2019). Theoretical development building on the knowledge accrued about past transitions has allowed the key concepts of the Multi-level Perspective (MLP) (e.g. regime, niche, landscape) (Geels, 2002; Rip & Kemp, 1998; Smith et al., 2010) to be operationalised for analysing unfolding dynamics in the present and potentially hypothesising about future developments. This has led to a significant body of research which aims to better understand 'transitions in the making' (e.g. Farla et al., 2012).

Research in STR has also explicitly recognised and explored the *performativity* of futures: that futures do not only describe or represent something but also have the power to bring about a particular action or change in the world. The significance of future-making in transition processes is widely accepted (Hebinck et al., 2018; Lösch et al., 2019; Späth & Rohracher, 2010). Studies have demonstrated the importance of collective expectations (Geels, 2005; van Lente & Rip, 1998), the emergence of promising technologies (van Lente, 1993), visions (e.g. Smith et al., 2005) and other articulations of desirable futures in attracting the interest of (potential) allies, defining roles, showing direction, advising or establishing mutually-binding obligations (Borup et al., 2006; Hajer & Pelzer, 2018; Lösch et al., 2019; van Lente, 1993).

The understanding of the performativity of future-making led to the emergence of more prescriptive approaches that utilise future-making practices (e.g. through the development of shared visions) to support the governance of transitions. One prominent example of this is Transition Management, where actors are facilitated in the creation of a collective guiding vision of a desirable future as an important step in transition processes (Loorbach, 2010). Various creative approaches to better understand and improve deliberative vision development have become prominent activities in STR (John et al., 2015; Quist et al., 2011; van der Voorn et al., 2017). These approaches are explicitly future-oriented, recognising the performativity of future-making and assuming a relatively open future if actors or stakeholders can be mobilised around such a collective vision.

Despite an understanding of the importance of ideas about the future in transitions research, to date, there has been limited critical reflection on the types of future-making deployed by researchers and the implications for the underlying objectives of the research community. This view has been articulated elsewhere with calls for researchers to consider constructions of the future, such as visions, scenarios, and predictions as "*explanandum* (that what should be explained)" to compensate for a tendency to see constructions of the future as "*explanans* (that what explains)" within STR (Hajer & Pelzer, 2018, p. 223). This limited reflexivity is particularly problematic considering the complex relationship STR has with the future: implicitly or explicitly, the theories and approaches at the core of STR are also involved in negotiations of what is deemed collectively possible, plausible and desirable. Considering the ambition of both understanding and supporting sustainability transitions, future-making in STR should question "taken-for-granted assumptions that often shut down potentially promising imaginations" (Beck et al., 2021, p. 143) while making visible "the ways in which imaginaries

reconstitute underlying constitutional relationships in the triad of state–society–environment" (Beck et al., 2021, p. 147).

To help bring a more reflexive and critical view on future-making in STR, we build on the emerging body of work which interrogates the ways through which ideas about the future are brought to influence action in the present. These contributions come from a range of disciplines including (but not limited to) science and technology studies (STS), technology assessment, environmental governance, economic sociology and human geography. Scholars differ slightly in emphasis when developing different perspectives on future-making. Examples include 'approaches to anticipation' (Muiderman, Gupta, et al., 2020; Muiderman, Zurek, et al. 2022), 'anticipatory practices' (Anderson, 2010), 'future-making practices' (Reckwitz, 2016; Wenzel et al., 2020), 'instruments of imagination' (Beckert, 2021), or 'techniques of futuring' (Hajer & Pelzer, 2018; Oomen et al., 2021).

What these perspectives have in common is an emphasis on the ways through which futures are performed, practised and enacted. Therefore, there is an appreciation that future-making—like other forms of knowledge production—is political (Knappe et al., 2019). The domination of particular forms of future-making can close-down the "horizon of the possible for social and political creation" (Schulz, 2015, p. 132), obscuring particular views of the future whilst bringing others to the fore (Aykut et al., 2019). Beckert (2021), for example, argued that firms utilise 'instruments of imagination' not only to guide activities within the organisation but also to convince other actors of the legitimacy of their imaginaries. Through this legitimation, imaginaries can become collective expectations thus supporting the firm in achieving its objectives. Less overt examples of power being exercised through future-making can be seen in the crowding-out of perspectives as a product of mismatches between the future-making tools and methodologies applied on the ground and the nature of the problems being addressed through those tools and methodologies (Muiderman et al. 2022). These examples demonstrate that the sites where collective expectations, ideas and visions of the future are formed should be understood as sites of contestation where intentionally or unintentionally particular ideas about the future become dominant whilst others remain at the periphery. In the following section, we link this argument to another central focus of transitions research: the search for underappreciated sources of system lock-in and obduracy inhibiting transformative change.

2.2. The forming of collective expectations in challenging and reproducing governance arrangements and the notion of scope incumbency

Whether considering transitions in the past, present or future, at the heart of transitions research are questions of (in)stability and change (Geels & Kemp, 2007; Rip & Kemp, 1998). The dynamics underpinning the stability of regimes are highly complex and interdependent and can be conceptualised from diverse epistemological and ontological perspectives (Stirling, 2019). Stirling (2019) proposes a relational and emergent understanding of the power underpinning regimes which is referred to as 'socio-material incumbency'. Early work associated with incumbency would focus on incumbent actors: actors who are deeply entrenched in positions of power in a given regime. Work has been done in recent years to 'pluralise' incumbency, to help move away from notions of good vs bad actors in transitions, and to acknowledge the systemic nature of power relations and agency in transitions processes (Späth et al., 2016; Turnheim & Sovacool, 2020). Beyond primarily focusing on *incumbents* as actors, *incumbency* considers the diverse overlapping socio-material relations that reproduce the prevailing arrangements (Stirling, 2019). An incumbency perspective highlights the *dynamic* nature of a dynamically stable regime (Grin et al., 2011), recognising the permanent reproduction of arrangements that constitute system stability. This perspective, in turn, shifts focus towards the various fields in which this occurs. These fields can be elusive as they often constitute activities which are taken for granted due to their embeddedness in everyday life. Considering inertia through a lens of incumbency can help shed light on the taken-for-granted and often unconsciously reproduced sources of stability, such as the relationships formed with the future.

To contribute to accounting for the politics of future-making in transitions research and consider its role in challenging and reproducing incumbency, we propose a heuristic (stylised in Fig. 2) building on the 'futures cone' (Fig. 1), which was developed initially by Hancock and Bezold (1994) building on a taxonomy of futures by Henchey (1978) and further developed by Voros (2003, 2017). Amara's (1981) classic distinction of possible (what could happen?), probable (what will likely happen?) and preferable (what should happen?) futures can be stylised in a futures cone as a heuristic device to interact with futures as an object of enquiry (Voros, 2017). Other taxonomies can and have been deployed in the same way (see e.g. Voros, 2017).

At the centre of the futures cone is typically some form of extrapolation of the present arrangements, business-as-usual, and/or projected future. Taking power in future-making seriously, we propose an alternative view through the notion of scope incumbency. Scope incumbency recognises the ideological contestation that occurs when defining what is collectively considered possible, probable and preferable. Here, we refer to the Gramscian notion of 'hegemony' and hegemonic futures – seeing dominance exercised through the use of ideological, cultural, and intellectual means – in our case through the forming of ideas about the future (also see Haas, 2020). It also recognises the existence of counter-hegemonic futures pushed by subordinate or oppositional groups to challenge and contest the dominant hegemonic order. This view takes into account that particular expectations and ideas about the future become hegemonic whilst others remain beyond the scope of the collectively plausible. It further recognises how this distinction is constantly under contestation with future-making playing an important role in this regard.

This view also considers asymmetries amongst different societal actors regarding access to the 'instruments of imagination' (Beckert, 2021) to shape collective expectations. Powerful actors are likely to enjoy privileged access to such instruments, or their perspectives are more likely to be integrated by other actors utilising such instruments. Incumbents 'tend to be powerful, materially resourceful, politically influential, societally authoritative, strategically conservative and risk-averse' (Sovacool et al., 2020, p. 3). As another tool at their disposal, future-making can be consciously and strategically performed "by those representing specific positions on social issues, substantial values, and particular interests in order to produce future visions corresponding to their interests and to employ these to assert their particular positions in debates" (Grunwald, 2019, p. 26).

Beyond merely maintaining the status quo, actors can also utilise future-making to imagine and realise radically different futures

from the current arrangements. In the case of the making of mobility futures, Hajer and Versteeg (2019) outline the example of 'Futurama', an exhibition sponsored by General Motors (GM) at the New York World's Fair of 1939 as setting the stage for the transition to the car-centric city that would follow in the decades after. This suggests the perspective highlighted by considering scope incumbency can serve as an indication of what a business-as-usual scenario might look like, even when it does not reflect extrapolated present arrangements.

The shaping of scope incumbency does not necessarily have to be as overt and strategic as the GM example. Instead, future-making can also be deployed for diverse ad hoc planning purposes (Muiderman et al., 2020), such as a municipal department figuring out how many lanes a street to be completed years after should have. There are cognitive limits amongst the actors performing such tasks. Collective definitions of plausible and possible tend to mirror the prevailing conceptions of technological utility (Borup et al., 2006). In this regard, much of the reproduction of scope incumbency is not necessarily merely driven by actors on behalf of explicit vested interests. It is rather likely to occur through banal planning processes conducted by actors whose ideas about the future are influenced by prevailing norms, values and practices (Jasanoff & Kim, 2009). Thus, it is the *scope*, or rather the process of *scoping,* that constitutes the incumbency, instead of it being merely an extension of the goals, preferences, aspirations and expectations of incumbent actors.

3. Conceptualising functions of future-making for transformative change in STR

The tendencies described above present a compelling argument for the importance of a thorough examination of the origins and processes through which notions of the future are formed. This is particularly the case for actors interested in transformative change. Although STR is not the only important arena where different ideas about the future are contested, discussed and legitimated, we contend that STR researchers fulfil a politically relevant role in producing and/or selecting and articulating a set of futures that are deemed relevant. We suggest, therefore, that STR plays an important role in the challenging and reproducing of scope incumbency in the forming of ideas about the future. In light of this, it is suggested that being collectively aware of these dynamics and establishing measures to counteract them should be an important project in research that aims to understand and bring about transformative change.

Therefore, we propose a typology of functions of future-making for transformative change to reflect on the extent to which and how hegemonic ideas about the future might be challenged. We draw inspiration from existing typologies which are designed to investigate approaches to future-making and encourage the consideration of the diversity of reasons for their application, as well as their differences as regards underpinning conceptualisations of the future (Mangnus et al., 2021; Muiderman et al., 2020). These distinctions offer a helpful means of inquiry into future-making practices. Yet these defined approaches to anticipation can be utilised by a multitude of actors for a multitude of reasons to reach a multitude of ends. They can be utilised to both challenge incumbent arrangements and reproduce them. We propose an additional layer to this perspective which acknowledges scope incumbency and enables those making futures to reflect on the extent to which and how hegemonic ideas about the future are being challenged and reproduced.

According to this view, approaches to future-making can be differentiated according to two main variables. The first point of differentiation relates to their broader underlying aims as regards challenging scope incumbency. In other words, in what way is it supposed to be performative in the present in terms of challenging hegemonic orders? We thus differentiate between future-making that challenges the incumbent arrangements through destabilising hegemonic futures and future-making that imagines alternatives to the incumbent arrangements through articulating and stabilising counter-hegemonic alternatives. A second point of differentiation can be made based on the different underlying motivations that drive transformation-oriented research. Mangnus et al. (2021) observe that one can differentiate between approaches to future-making which, on one hand, focus on the enquiry into *what the future may hold* (e.g. predicting, defining probabilities, determining plausible scenarios, etc.). On the other hand, others take the *performativity of futures* in terms of influencing action in the present as a starting point to either cocreate and experiment with futures (e.g. to mobilise actors around a common vision) or through the reflexive deconstruction of visions and imaginaries of the future, aiming to "demystify, denaturalize, and historicize imagined futures, showing how ideas about plausibility, desirability, and probability are not self-evident or natural" (Mangnus et al., 2021, p. 5). A similar distinction, useful for considering the transformative or reproductive potential of future-making, can be made in that the former two tend to bring *probability*—the likelihood of something occurring—to the fore, whilst the latter tends to bring *normativity*—the desirability of particular futures coming to be—to the fore. Normativity can relate both to utopian ideas to strive towards and dystopian ideas which should be avoided. This distinction reflects the underlying *analytical* and *normative* motivations of the research community as articulated earlier. It acknowledges that there is research more interested in what *can* happen and research that is more interested in what *should* happen and that for understanding and supporting transformative change, both are necessary.

Type 1 approaches will aim to demonstrate risks and potential problems associated with hegemonic futures should they manifest. A typical example is the extrapolation of the problems associated with the prevailing arrangements or making transparent the implications of hypothetical extrapolations of lofty promises around panacea solutions proposed to extend hegemonic arrangements into the future. This might include warning against overly optimistic expectations and potential negative repercussions of particular technologies and collecting strong and different forms of evidence to demonstrate this. *Type 2* approaches will interrogate and expose hegemonic futures by using future-making to critically engage with hegemonic futures (visions, scenarios, predictions, etc.) to expose assumptions embedded in ideas about the future and reveal hidden power arrangements that underpin them. These approaches bring normativity to the fore in the sense that there is an assumed *un*desirability or problematic dimension to the prevailing arrangements and hegemonic ideas about the future, thus warranting their interrogation. *Type 3* approaches will seek to stabilise alternatives by demonstrating the plausibility of counter-hegemonic futures these might include demonstrating or investigating, often through
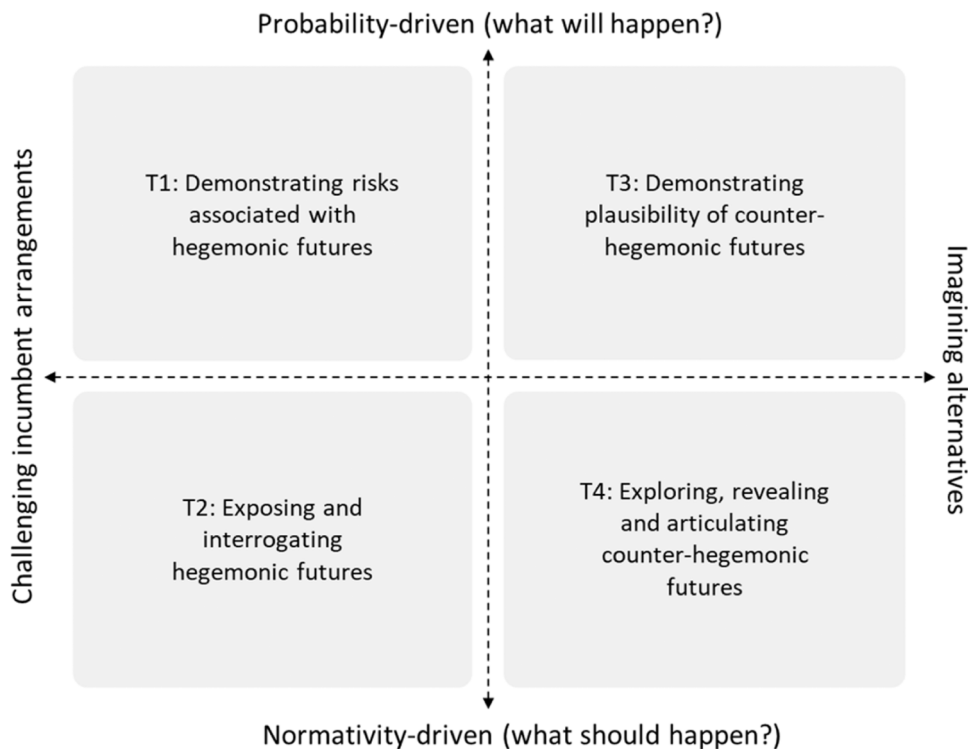
Probability-driven (what will happen?)

T1: Demonstrating risks associated with hegemonic futures	**T3: Demonstrating plausibility of counter-hegemonic futures**
T2: Exposing and interrogating hegemonic futures	**T4: Exploring, revealing and articulating counter-hegemonic futures**

Challenging incumbent arrangements ← → *Imagining alternatives*

Normativity-driven (what should happen?)

Fig. 3. Four functions of future-making for transformative change.

quantitative methods, the plausibility or desirability of emerging alternatives which are deemed a true break from the incumbent arrangements. *Type 4* approaches will seek to open-up the scope of plausibility by exploring, revealing and articulating counter-hegemonic futures. This could range from the elicitation and articulation of niche imaginaries amongst marginal actors to the (co-) creation of policy mixes to leverage desirable change, and beyond. The four functions are stylised in Fig. 3.

These functions are archetypical and it can be expected that different approaches can serve multiple functions at the same time and with varying degrees of effectiveness. We also recognise the relationality between hegemonic and counter-hegemonic views in particular contexts: the destabilisation of hegemonic futures and future-making can be supported by exposing counter-hegemonic futures and future-making and vice versa. Furthermore, there is no claim here that a purely plausibility-driven future-making practice is possible: normativity is woven into any future-making practice. At the same time, there is no strictly normative future-making practice: those tasked with imagining differently are always bounded by plausibility scopes imposed by prevailing arrangements. Nor can there be an objective understanding of what is considered plausible and desirable. Rather this view of future-making aims to better appreciate the ongoing contestation around these types of issues. We further do not contend that in all cases the dominant ideas about the future should be deemed undesirable and thus challenged. However, taking scope incumbency seriously means that often the dominant ideas about the future might not necessarily be in the best interest of broader publics and future generations. It is thus likely that in many contexts, transformative change will require practices through which these functions are performed. In the following section, we introduce the research design and a case study where we explore the extent to which and how future-making in STR performs these functions when imagining futures focusing on the case of mobility.

4. Case study: exploring the making of mobility futures in STR

To explore the contributions of STR to future-making and reflect on some of the issues discussed above, we focus on the empirical field of mobility. We chose explicitly to focus on future-making through research rather than in forums where future-making brings about more direct instrumental repercussions and is thus subject to more obvious examples of political influence (e.g. through investigating national foresight activities or formal policy-making). Through focusing on academic future-making—as a space sup-posedly freer of direct political influence—we hope to expose some of the less obvious underlying political dynamics that underpin future-making. Finally, we also do not claim that there is consensus in the transitions community about the directionality, speed and means of transformative change. It is rather to investigate the extent to which a transformation-oriented research community is collectively able to expand the scope of plausibility and question the prevailing power arrangements embedded in hegemonic ideas about the future.

To get a grasp on incumbency in our case and consider which mobility futures can be deemed hegemonic, we can look to the significant work done in conceptualising a regime of automobility (RoA). Böhm (2006, p. 3) defines a RoA as "a set of political

institutions and practices that seek to organize, accelerate and shape the spatial movements and impacts of automobiles, whilst simultaneously regulating their many consequences." Socio-technical regimes comprise complex assemblages which can be considered according to a range of dimensions (e.g. industry, markets and user preferences, culture, technology and policy) (Geels, 2012). Exploring a RoA requires going beyond the tangible and measurable system elements to investigate the "deep structure" behind such elements (Geels, 2012, p. 473). At the heart of the RoA is the artefact of the 'car' or personal motorised vehicle (PV), but the regime extends deeply into diverse areas of human and non-human life:

"It is also a (…) discursive formation, embodying ideals of freedom, privacy, movement, progress and autonomy, motifs through which automobility is represented in (…) discourses (…), and through which its principal technical artefacts – roads, cars etc. - are legitimized. Finally, it entails a phenomenology, a set of ways of experiencing the world (…)" (Manderscheid, 2014, p. 5 citing Böhm, 2006).

This view of the mobility system allows for the consideration of the significant work conducted to understand the multitude of ways through which this RoA is constantly being reproduced (e.g. Manderscheid & Cass, 2022). This breadth of knowledge helps identify the embedded assumptions that are often taken for granted when thinking about mobility futures. Previous work has also demonstrated the unsustainability and persistence of this regime in the face of massive social, environmental and economic consequences (Böhm, 2006; Paterson, 2007). The obduracy of a RoA in the face of these consequences suggests it to be an example of a case to study incumbency par excellence.

Mobilities studies can also function as a comprehensive frame of reference, aiding in reflection on the various mobility futures broadly deemed possible amongst wider publics. Manderscheid (2020) differentiates between 1) a *drive-train transition*, focusing on the decarbonisation of the mobility system through the substitution of propulsion technologies; 2) a *modal transition*, focusing on shifts between different modes of transportation; and 3) a *mobility transition* avoiding trips altogether and integrating arguments of sufficiency. Similar differentiations have been made elsewhere (Kivimaa & Virkamäki, 2014; Nykvist & Whitmarsh, 2008; Ruhrort, 2022). Despite some 'cracks' in the regime of automobility (Geels, 2012), it can thus be hypothesised that hegemonic mobility futures and future-making will be those that perpetuate this regime. The logical extrapolation of this could be business-as-usual (BAU): an ongoing internal combustion engine car-dominated system. However, as a transformation-oriented research community, BAU scenarios will likely at most be used as a counter-point to exemplify normative alternatives. Therefore, in light of this prevailing change-imperative, a logical extension of a RoA would be system optimisation and a drive-train transition (Geels, 2012). Such a transition would undoubtedly bring about significant socio-technical change on the production side, but the changes regarding behaviour, values and perceptions on the user side would remain relatively limited (Kemp & van Lente, 2011). However, we take the question of what futures should be deemed hegemonic as an empirical one, allowing for consideration of non-material dimensions of a RoA (such as the "ideals of freedom, privacy, movement, progress and autonomy" as articulated above) to emerge in other sociotechnical arrangements.

5. Methods

We seek to investigate the questions of the extent to which and how a regime of automobility is challenged and reproduced through future-making in STR. Our approach is not a literature review per se in that it does not synthesise evidence or summarise an empirical field. Rather it treats peer-reviewed articles as manifestations of future-making. We designed a search strategy to develop a data corpus that offers a broad overview of the explicit attempts at making futures in STR. To target papers within the STR community, we built on the search string developed by Markard et al. (2012) and updated by Ertelt et al. (2023). To integrate the future-making perspective, we added as search terms the names of diverse foresight tools and methods referred to in a range of articles exploring future-making activities (Dolez et al., 2019; Muiderman et al., 2020; Oomen et al., 2021). We also added keywords to reflect the focus on mobility. The search was run through SCOPUS—a database which captures the key STR journals (Zolfagharian et al., 2019)—and results were limited to peer-reviewed articles (N = 337). We applied a qualitative review approach to included articles (N = 94) following Saldaña (2016) and Zolfagharian et al. (2019). In the first step, we scanned the abstracts in the data corpus applying inclusion/exclusion criteria. In the second step, we developed categories inductively responding to the research question and retuning to the data set in iterations. Details of the search strategy and corpus development can be found in the annexe. The approach integrated mechanisms which help address single-coder bias by establishing moments of integration and reflection amongst coders before returning to previously coded contributions. We do not claim to have captured all examples of making mobility futures in STR. Nor do we claim that the contributions to mobility future-making in STR are particularly representative of mobility future-making in transformative research globally. There are clear limitations regarding the focus purely on (English-language) journal articles. However, any biases that can be seen in our approach are a reflection of those prevalent in the research community more broadly. We have nevertheless developed a data corpus which captures a somewhat representative sample of the broad range of approaches to future-making utilised in this particular research community.

6. Findings

6.1. Seven types of future-making for transformative change

To account for the plurality of the approaches to future-making observed in the data corpus, contributions were clustered based on similarities according to their apparent role in light of the functions of future-making for transformative change articulated in Section 3. In the first part of the following section, we introduce the types elicited from the data set one by one, illustrating where suitable with some examples from the data corpus. We chose to explicitly mention contributions through which automobility futures are questioned

and delegitimated and mobility futures beyond a RoA are articulated and legitimated. The second part synthesises the observed ways through which future-making led to the projection of a RoA as the only plausible mobility future, responding to the question of how a RoA is reproduced in the observed contributions. The seven types are stylised in relation to the four functions of future making for transformative change in Fig. 4.

6.1.1. T1 investigating and supporting the emergence of a niche innovation

This approach takes a particular emerging social or technical innovation at its centre and will inquire into possible trajectories through a range of both qualitative and quantitative methods. This might be through the exploration of possible or likely emergence trajectories, evaluation and alignment of actor expectations, the development of policy mixes, etc. Although at times these contributions recognise multiple future socio-technical arrangements, imagined futures are limited to those centred on the focal innovation. Typically, there is an implicit or explicit assumption that supporting this particular niche would be a positive intervention which often is used to justify the research.

6.1.2. T2 sketching a scope of plausibility

T2 recognises the plurality of possible futures and sketches a range of futures, which can be deemed plausible. Many will sketch scopes of plausibility for future socio-technical arrangements around a particular technology. There are thus often overlaps with T1. These approaches can call into question the sustainability of future trajectories if they move beyond assuming potential opportunities to also consider possible threats and explore the plausible developments on both sides, such as those related to autonomous vehicles (AV) (González-González et al., 2020; Marletto, 2019). Others will aim to sketch scopes of plausibility of the future mobility system more generally. A limited number of examples demonstrated the ability to envision change and acknowledge the existence of multiple perspectives according to deeper regime dimensions, including institutional and cultural aspects. These examples specifically highlight certain dimensions of the prevailing system, extending beyond the technological to examine their interplay with other dimensions of the system. Truffer et al. (2017), as an example, investigate the potential future dynamics of institutional dimensions by contrasting multiple scenarios: one where the existing institutional dimensions persist and another where these underlying institutional aspects have shifted away from a RoA (also see Schippl et al., 2022).

6.1.3. T3 co-creating a different future

This approach typically brings various actors together to facilitate the collective envisioning of a desirable alternative future. These endeavours commonly employ qualitative approaches such as the backcasting methodology, which involves working backwards from the envisioned future to the present. By adopting this approach, a transformative future is imagined which should fundamentally depart from current arrangements. Auvinen and Tuominen (2014) as one example, report on a process whereby a different socio-technical arrangement is articulated. Through integrating a long-term scope and ensuring broad stakeholder engagement a mobility system with different norms placed at its centre (human safety and wellbeing) can be imagined. Another example is Müller and Reutter
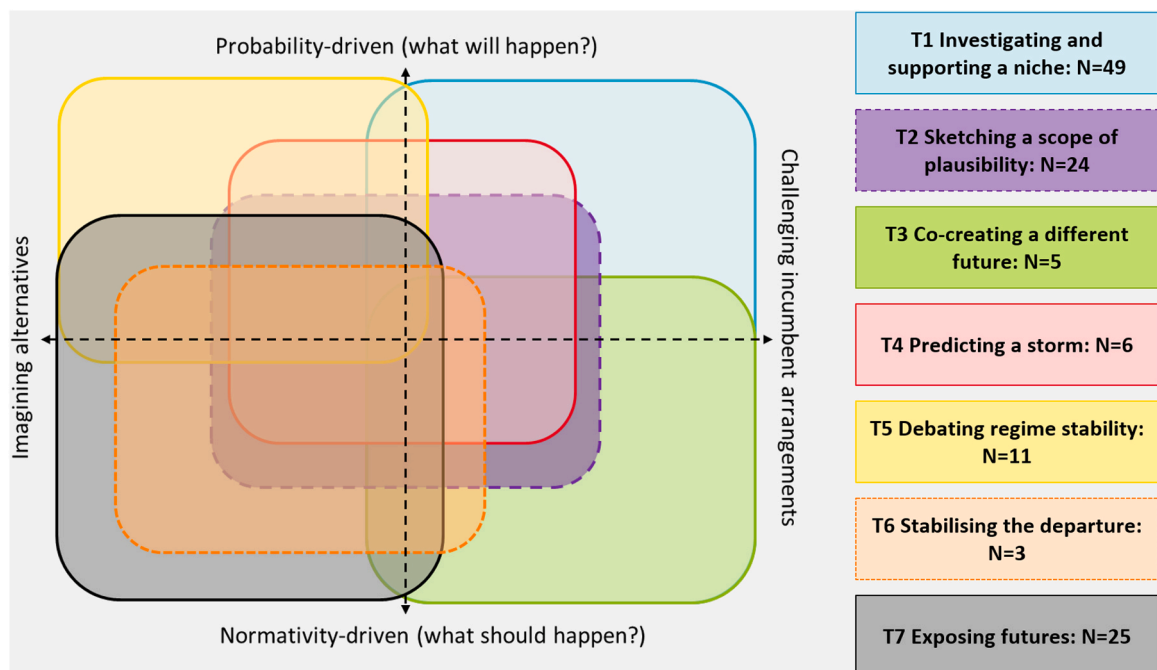

Fig. 4. Mapping types according to functions of future-making for transformative change.

(2017) who report on a regional vision development process in Germany. This approach is tied to shorter-term strategic planning in the region and is accompanied by the development of a sustainability strategy for that region. Through establishing a consensus on the need for transformation amongst key stakeholders, they can establish a concrete, agreed-upon goal which would mean the PV would play a minor role (at least in terms of modal split) in the mobility system in the relatively near future (2030).

6.1.4. T4 predicting a storm

T4 investigates emerging trends to warn of potentially emerging undesirable futures. These approaches take the niche as is done in T1 and extrapolate possible futures but from a more critical stance. For example, Augenstein (2015) highlights the potential problems regarding the sustainability of the drivetrain transition quelling hopes of techno-fixes. Other contributions identify possible under-appreciated consequences or risks associated with future rollouts of drivetrain technologies (e.g. van Wee et al., 2012). Contributions can also interrogate new emerging innovations which are supposed to present an alternative to the car-dominated transportation system. Pangbourne et al. (2020), for example, provide a critical exploration of Mobility as a Service (MaaS) presenting an analysis of the rhetoric surrounding the concept.

6.1.5. T5 debating regime stability

T5 investigates the degree of stability, the sources of stability and signs of cracks in the incumbent arrangements. Approaches are often used to articulate the likelihood of ongoing path dependency in response to optimistic claims that change is just beyond the horizon, such as through warning against techno-optimism (Cohen, 2012), or demonstrating that external system shocks are not automatically going to destabilise a RoA as some have hoped (Wang & Wells, 2020). They can also demonstrate the obduracy of a RoA and warn against emerging hopes of a natural departure from a RoA (Marletto, 2010). Such approaches will often draw on systemic factors reproducing the regime through a range of approaches (Moradi & Vagnoni, 2018; Morton et al., 2017; Rees et al., 2017). These contributions will typically highlight that interventions need to be made to destabilise the regime beyond merely supporting alternatives.

6.1.6. T6 stabilising the departure

T6 explores and stabilises potential pathways of departure away from prevailing arrangements. Their main point of differentiation from others is that they seem to take the desired discontinuation of particularly sociotechnical arrangement at the centre of the approach and aim to stabilise pathways around this. Examples include, Kivimaa and Virkamäki (2014) use the concepts of the walking city, cycling city and auto city, proposing a policy mix to facilitate a modal shift away from the auto towards the walking or cycling cities: considering the push and pull factors from the relative perspectives and assessing and reconfiguring the prevailing policy mix. Some will utilise existing typologies which cover a broad scope of possible interventions to justify considering futures beyond RoA. Examples include push/pull, carrot/stick dichotomies, or more frequently, the ASI (avoid, shift, improve) framework is applied. Müller and Reutter (2021) go one step further with the ASI and focus explicitly on 'avoid' and 'shift' to compensate for the bias of research focusing on 'improve'.

6.1.7. T7 exposing futures

T7 interrogates futures to expose underlying assumptions and political implications. These contributions serve an important function in questioning and delegitimising a RoA through deconstructing the assumptions often bound up in a RoA and reproduced through future imaginaries. This can be through critical analysis of futures made such as the example from Bergman et al. (2017) which investigates how people, behaviour and mobility are imagined in a range of visioning documents about the future around car-clubs and electric mobility. They demonstrate the perpetuation of a RoA in the envisioning of allegedly transformative innovations. These contributions can also interrogate future-making practices themselves. Richter & Haas (2020) examine the political dynamics of defining the future of German transport, focusing on the National Platform for Electric Mobility (NPE), a high-level political forum that aimed to accelerate the run-up of the electric mobility market in Germany. They demonstrate how the activity is captured by incumbent interests limiting the scope of plausibility to the interests of private firms.

6.2. How is a RoA reproduced through future-making in STR?

Transitions researchers utilise a multitude of approaches to make mobility futures. Whether an approach will challenge or reproduce a RoA appears to be less dependant on which method is chosen than it is on the broader framing of the project and the intentions behind it. Through the analysis, three general pitfalls could be identified: 1) Incumbency-friendly methodological design principles; 2) Narrow problem definitions; and 3) Dominance of automobility-compatible technology-oriented approaches.

6.2.1. Incumbency-friendly methodological design principles

Which actor perspectives are integrated into the approach is particularly relevant in determining the extent to which transformative futures can be elicited. Firstly, by solely incorporating the viewpoints of incumbent actors—particularly those who have a strong vested interest in maintaining their position in a future sociotechnical arrangement—the likelihood of imagining futures beyond a RoA is minimal. This is not to say that incumbent actors are unable to imagine radically different futures. Even if a fundamentally different socio-technical arrangement is articulated, the criteria used to form or judge the plausibility or desirability of future scenarios are often bound up in those which underpin a RoA (such as speed, privacy, automation, cocooning, seamlessness etc.). Those designing approaches should also be wary of tokenism. Apparently aware of the need to integrate a breadth of perspectives into the methodology,

approaches will typically integrate a small number of NGOs or similar critical voices for 'balance' against the powerful regime actors. These voices are likely to remain in the periphery if methodological considerations are not made. In the same sense, relying solely on the expectations of lay people, such as citizens, is unlikely to yield radically different futures unless integrated into a comprehensive methodology that aims to expand the realm of plausibility and challenge prevailing arrangements.

6.2.2. Narrow problem definitions

Another important factor is the formulation of problem definitions. The scope of the problem being addressed directly influences the breadth of possible futures. Despite a good understanding of the diversity of social and environmental problems associated with the transportation system, problems still tend to be narrowly defined around tailpipe emissions. The resulting future will thus likely have a bias towards drive-train technologies. Similarly, if the problem is framed around something so overtly incumbent-friendly such as the uncertainty surrounding the future market for firm products, the envisioned futures will unsurprisingly align with the continued dominance of that firm. However, a different outcome can be achieved by those who frame the problems they address in a manner that encompasses the broad spectrum of social and environmental issues associated with the current car-dominated transportation system. By adopting such an approach, they are more likely to arrive at futures that transcend automobility and offer transformative alternatives.

6.2.3. Dominance of automobility-compatible technology-oriented approaches

An important distinction can be made between approaches which explore mobility futures more broadly and those where futures are built around specific technologies. Around two-thirds of the contributions place a particular technology at the centre of their explored futures. Technology-oriented approaches might range from those which aim to explore plausible socio-technical relationships with a particular technology, to identifying barriers or highlighting potential problems and risks associated with its emergence. Technological-oriented approaches thus cover the full spectrum of types of future-making for transformative change. The technologies differ in terms of their compatibility with a RoA: some would be more easily integrated than others. At the same time, the stance of the contributions as regards the assumed desirability of the emergence of the technology also differs greatly. Some assume its emergence would be an unquestioned positive development whilst others see its emergence as a potential threat. Others take a more impartial stance, assuming the possibility of both utopian and dystopian future relationships with the technology. For investigations into technologies which are considered potentially more 'disruptive' (such as AVs and MaaS), it is often deemed necessary to take an impartial stance and also consider possible negative outcomes. For investigations into drivetrain technologies (which are by far the most common technological-oriented contribution in the data corpus), consideration of possible negative future socio-technical arrangements appears to be frequently deemed unnecessary (see annexe).

7. Discussion and conclusions

Whilst the future might be inherently nebulous, the way we engage with it matters: Researchers engaged with future-making can consciously or unconsciously challenge and/or reproduce prevailing regimes. We have reflected on how different approaches found in STR engage with mobility futures and how they challenge and reproduce scope incumbency with significant implications for automobility in the present and the future. Scope incumbency as a notion can, on one hand, be utilised for critical inquiry into future-making as researchers can orientate scenarios, pathways, and visions according to their relation to the hegemonic ideas about the future. On the other hand, we assume it can help provide insights into *likely* futures by embedding an appreciation of the influence that powerful regime actors have over defining what is collectively considered desirable and plausible. It thus recognises a tendency to bend what is collectively considered 'probable' into the direction of 'favourable for incumbents', without this implying a cognitive process or necessarily intentionality. We thus see the forming of collective expectations as another mechanism through which incumbent arrangements can be reproduced (and therefore also challenged). However, considering scope incumbency should contribute to projects which aim to 'pluralise incumbencies' (Turnheim & Sovacool, 2020). While incumbents can come and go, underlying systems of power are far more obdurate: the maintenance of a RoA extends far beyond the incumbent actors who have a vested interest in its reproduction into the future.

Although we observed examples where transitions researchers challenge a RoA and articulate alternatives, there is a strong tendency towards techno-optimism and a lack of critical reflection of the potential implications of technologically-driven transitions. Looking at the types of mobility futures articulated in STR demonstrates a dominance of imaginations around substitution pathways, or drive-train transitions, whose sustainability credentials are highly questionable (Brömmelstroet et al., 2022; Huber & Schwedes, 2021; Manderscheid, 2020). This confirms similar findings articulated elsewhere (Wells & Nieuwenhuis, 2012). Such a bias is not likely the result of a collective conscious decision to choose this pathway as the most plausible. Rather, it is likely the product of diverse decentralised future-making activities deployed for various purposes, with a baseline assumption that the future mobility system will be built around some form of the personal motorised vehicle. The 'creeping normality' (Diamond, 2011) of the car in everyday life during the 20th century despite its immense negative social and environmental implications thus seems to extend into the practices through which the future of mobility is imagined. Figuring out which drivetrain technologies will drive the vehicles of tomorrow is no doubt an important field of investigation. However, there are likely practical implications of drivetrain transition imaginaries dominating academic discourse. Based on the approaching of peak oil, as well as a diversity of additional enabling conditions, it has been clear for over a decade that electric mobility has reached a 'critical threshold' (Dijk et al., 2013). Furthermore, optimism around substitution technologies (such as biofuels) has been proven unfounded in the past and can even amplify sustainability problems (Goetz et al., 2018; Jeswani et al., 2020; Oliveira et al., 2017). Despite this, compared with critical investigations into emerging and

potentially disruptive technologies (e.g. AVs and MaaS), there have been surprisingly limited examples of future-making that call substitution pathways into question. These biases will inevitably legitimise transitions embodying these dimensions at the expense of others and thus encourage the realisation of substitution pathways over deeper systemic change.

In the realm of envisioning transformative change within a given regime, certain dimensions such as technology, policy, and user preferences are more amenable to our imagination compared to others such as everyday practices, discourse, norms, and culture. These latter aspects, often attributed to the landscape level or the underlying foundations of the regime, exhibit greater resistance to change and tend to evolve slowly, especially in the absence of significant external disruptions. However, it is important to recognise that these seemingly immutable aspects are not immune to change; they have transformed in the past and continue to do so. Failing to acknowledge this dynamic nature inadvertently reinforces and perpetuates the prevailing conceptions that limit the potential for transformative change. The research thus suggests, like other contributions, that academic discourses play an important role in locking-in unsustainable mobility regimes (Schwanen et al., 2011).

7.1. Limitations and future research

Our contribution is a first attempt at a reflexive exploration of the relationship transitions researchers form with the future and the possible implications of this considering the broader objectives of the research community. While we investigated the example of mobility futures, we see the potential for building on our contribution with future research beyond this. Firstly, we were able to make this reflection based on the significant work invested in defining a 'regime of automobility' and understanding its complex mechanisms of reproduction. This allowed the notion of 'incumbency' to take a form that could be used for enquiry for our approach. We would suggest, however, that incumbency and its mechanisms of reproduction could look very different if different object of investigation were to be considered. Future research could, therefore, explore how the future is mobilised to challenge and reproduce incumbency in other empirical fields. We would also suggest drawing on the critical bodies of literature that focus on these respective fields to understand the nuanced faces of incumbency that might be relevant for their investigation. Secondly, doing true justice to the notion of *deep* incumbency (Stirling, 2019), would require consideration of underlying forces such as capitalism, modernity, coloniality or patriarchy (Stirling et al., 2023). These dimensions of incumbency lie deeper than the scope of observation we have applied in our approach but are important for understanding the reproduction of hegemonic orders. Finally, our approach explicitly looked to future-making in an academic context in an attempt to better understand the unconscious biases that might be at play, even in spaces often assumed free of political influence. However, research building on our approach could compare the future-making outcomes of forums that are more overtly influenced by powerful actors and future-making in academic contexts. This could help to establish a clearer grasp of the overtly hegemonic futures that are being perpetuated in a particular empirical field, such as future-making practices deployed strategically for commercial reasons. These could be presented as a counterpoint to the future-making that strives to engage in inclusive future-making and work against scope incumbency, which as we have argued is an important task of future-making in transformation-oriented research.

7.2. Implications for STR

If we take the role of transitions scholars seriously in defining legitimate, credible, plausible and desirable articulations of the future, more reflexivity around the implications of future-making is warranted. This makes a strong case for those working on STR to improve their 'futures literacy': this means being reflexive about the plurality of ways to engage with the future; about the potential implications of different approaches for future-oriented action; and about the power structures that underpin engagements (Mangnus et al., 2021). Therefore, approaches to future-making must be *fit-for-purpose* (Mangnus et al., 2021)—ensuring a fit between the problem at hand and the future-making deployed to address it. This necessitates the utilisation of a broad array of future-making approaches with diverse ontological and epistemological positions (Mangnus et al., 2021; Muiderman et al., 2020).

Beyond broader calls for more reflexivity in STR, some insights can be drawn from the research. A single contribution cannot fulfil all the functions of future-making to effectively open-up the plausible, destabilise the undesirable and close-down around the desirable (however these might be defined). Furthermore, it is not clear how much of one type or the other is required to effectively support desirable transformations. However, our findings suggest that researchers developing mobility futures could benefit from understanding their role in these processes to potentially integrate mechanisms into their methodologies that work against the reproduction of scope incumbency.

Researchers are continuously navigating the territory between insignificance and conformity: running the risk of their research losing relevance in the pursuit of expanding ideas about the possible on one hand, or reproducing highly plausible yet non-transformative futures on the other. Similarly, there are often tensions between the making of *plausible* and *desirable* futures. The former is typically framed in a way that suggests the researcher has no interest in articulating what the future *should* bring but rather aims to articulate plausibility, based solely on the likelihood of a particular future arrangement coming to be. Although approaches were identified that mix plausible and desirable futures, the majority of the contributions appeared to assign themselves (at least unconsciously) to one camp or another. It seems that some researchers shy away from articulating preferable futures, opting instead for making only likely futures. Such futures are treated as more plausible than their normative counterparts, reproducing, in turn, their plausibility. Yet considering the important function that imagining radical alternative futures has in transition processes, it is not an option to simply retreat to safe academic spaces where highly plausible futures are interacted with to deliver impartial prognoses of what is likely to come: through remaining in the realm of the highly plausible, tensions with the radical prevail.

At the same time, probable futures are important as they serve as a warning and can catalyse action in the present. For researchers

who prefer to avoid explicitly normative terrain, the community could benefit from more contributions which further expose emerging "cracks" in a regime of automobility (Geels, 2012; Haas, 2020; Ruhrort, 2022). This could be through the creative articulation of what will likely happen under an ongoing regime of automobility and the questioning of the lofty promises associated with particular technologies: particularly those which can be easily incorporated into incumbent arrangements. However, researchers should acknowledge the performativity of futures and that normativity is always bound up in assumptions which inform all future-making practices. It is not sufficient to merely reflect on these embedded normative assumptions of specific future-making approaches if collectively most approaches embed the same assumptions. In this regard, researchers should be aware of, and dare to challenge, 'myths' about future mobilities (Fletcher et al., 2019; Peeters et al., 2016); exaggerated promises of technologies bound up in 'hype cycles' (Borup et al., 2006; van Lente, 2012; van Oers et al., 2020) as well as the dominance of neoliberal discourses which embed assumptions around economic growth and its association with individual car use (Bergman et al., 2017).

Given the legitimating power academia has, researchers should be wary of how this power is wielded. The STR community, in its pursuit of addressing grand societal challenges, recognises these challenges cannot be "addressed by incremental improvements and technological fixes, but require *radical shifts* to new kinds of socio-technical systems" (Köhler et al., 2019, p. 3 emphasis added). This will often require liberation from dominant imaginaries and institutions to propose *radically* different futures beyond the prevailing arrangements (see e.g. Beck et al., 2021; Loorbach, 2022). If researchers (consciously or unconsciously) limit futures they deem plausible to those aligned with prevailing logics and socio-material arrangements, they inevitably risk reproducing, rather than challenging, the status quo. This would crucially undermine the proclaimed objective of instigating such 'radical shifts'.

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CRediT authorship contribution statement

Tom Hawxwell: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Visualization, Writing – original draft, Writing – review & editing. **Abe Hendriks:** Conceptualization, Data curation, Formal analysis, Validation, Writing – review & editing, Methodology. **Philipp Späth:** Conceptualization, Formal analysis, Supervision, Validation, Writing – review & editing.

Declaration of Competing Interest

None.

Annexe

Data corpus development

N = 337 (search string applied to scopus on 12.12.2022)
N = 276 (after inclusion/exclusion criteria applied to abstracts)
N = 94 (after inclusion/exclusion criteria applied to full-text)

Search string

Dimension	Operationalisation
Sustainability	TITLE-ABS-KEY (sustainab* OR environmental* OR bio* OR renewable OR socio-technical)
Transition	TITLE-ABS-KEY (transition OR transform* OR "system innovation" OR "radical innovation" OR shift OR change)
Foresight tools	TITLE-ABS-KEY - Building on lists of foresight tools from Muiderman et al. (2020),Oomen et al. (2021) and Dolez et al. (2019)
Mobility	TITLE-ABS-KEY (Transport OR mobility)
Sustainability transitions literature	Following Markard et al. (2012) and updated by Ertelt et al. (2023)
Peer-reviewed journal contributions	Selection in SCOPUS

Abstract screening: Inclusion/exclusion criteria (all inclusion criteria must be met).

Criteria	Include	Exclude
Future orientation	Clear future orientation: trying to make statements about plausible, possible, desirable, etc. futures; make some sort of prediction/ develops future scenarios/ visions etc.	Past or present orientation: Purely analyses past trends or only assesses present situations.

(*continued*)

Criteria	Include	Exclude
Long term futures	Future-making practices which interact with longer-term futures → years, decades, centuries	Future-making practices which are aimed to interact with short-term futures (hours, days, weeks, months) in the future
The presence of an articulation of a future state of affairs (vision, scenario, etc.)	Some manifestation of an activity brings a "future" to the present to make it actionable. This could be the article itself, or the article might be reporting on the development of some other activity that brings a future or futures to the present.	No example of such a manifestation
Empirical examples	Empirical papers that develop statements about futures in a particular case or a limited selection of cases.	Conceptual papers which develop theory
Reviews		Reviews of multiple cases
Papers	Journal articles	conference proceedings; book contributions etc.

The relationship between technological compatibility with automobility and the assumed desirability of the technology.[1]

		Technology's likely compatibility with automobility		
		Compatible with automobility (e.g. drive-train)	Borderline (e.g. autonomous vehicles, MaaS, …)	Alternative to automobility (e.g. cycling, public transport, …)
Stance concerning the technology	Promoting	18	6	11
	Impartial	8	9	2
	Problematising	5	1	0
	Total	31	16	13

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[1] Some articles focus on (A) substitution technologies (e.g. electric vehicles and alternative fuels etc.) while others focus on (C) technologies beyond the PV that might be seen to challenge automobility (e.g. public transport, soft modes etc.). Another group, (B) includes technologies which could either challenge or reproduce a RoA depending on how they are deployed (e.g. autonomous vehicles, Mobility-as-a-Service, etc.). They can be further differentiated according to the contribution's stance concerning the technology. A (1) *promoting* stance assumes the desirability of the technology and explores factors around its emergence. *Promoting* approaches appear neither to consider a range of plausible future relationships with the technology nor human agency to influence it. Rather, the desirability of the technology is assumed and the purpose of the contribution is to support its uptake, such as through developing policy recommendations or identifying barriers to be overcome. (2) *Impartial* contributions recognise a plurality of possible future relationships with the technology (some desirable, others not). A central purpose of these contributions is typically to ensure that the future relationship of the technology is a desirable one. Contributions with a (3) *problematising* stance explicitly aim to call the technology into question and warn about possible development, demonstrating the problems which could occur in the future in the context of its unchecked expansion.

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7.2 Mapping destabilisation journeys in urban mobility systems: The case of Hamburg

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8. Mapping destabilization journeys in urban mobility systems
The case of Hamburg

Tom Hawxwell

Introduction

Positioned at the juncture between the persistent forces for transformative change and the obduracy of established systems, urban areas are increasingly understood as promising yet highly contested spaces for transformation towards sustainability (Bulkeley et al., 2014; Rutherford and Coutard, 2014). The growing tensions between the lock-ins inherited from the past and the ambitions for a different future are particularly present when considering urban mobility systems. At the centre of these tensions is the car. During the 20th century, riding on the back of promises of freedom and progress, planners set about transforming urban environments into car-centric cities: cities designed and built around the personal motorized vehicle as the dominant, and in some cases the only legitimate, mode of transportation (Sheller and Urry, 2000). In recent decades, these promises seem to have faded, while the ubiquity of the car in urban life appears to have stabilized as part of the 'system' (Urry, 2004) or 'regime' (Böhm et al., 2006) of automobility, along with its many consequences. In Europe, there is an estimated €409 billion in externalized costs of car and motorcycle usage annually, mainly due to their disproportionate contribution to 'accidents', but also to local air pollution, climate change, noise pollution, and habitat damage (Heinrich-Böll-Stiftung, 2021). However, car hegemony also has far-reaching consequences that extend beyond those that are easily quantified, such as the segregation and the fragmentation of social practices that once occurred in shared public spaces (Sheller and Urry, 2000).

Despite a growing understanding of these issues, car hegemony prevails in most urban areas globally. This paradox has inspired a vast body of literature to understand how and why the car maintains its privileged status despite its built-in antagonisms (Sheller and Urry, 2000; Urry, 2004; Böhm et al., 2006). Yet due to changes in recent decades, it appears that the privileged position of the car is under pressure. Researchers highlight the emergence of 'cracks' in the regime (Geels, 2012; Ruhrort, 2020) and challenges to the car's culturally hegemonic status (Haas, 2020; Ruhrort, 2022). This pressure is particularly present in urban areas, with the emergence of concepts for more sustainable, liveable, and healthier cities (Nieuwenhuijsen, 2021). These alternative urban mobility futures seem to be more and more incompatible with the prevailing automobility imaginary (Braun and Randell, 2023), creating conflicts between the locked-in material, institutional, and cultural arrangements of the past and the aspirations for more just and sustainable urban futures.

In light of these changes, to what extent can it be said that the locked-in arrangements around car-based automobility are becoming destabilized? This question is aligned with an emerging strand of research that responds to a prevailing overemphasis on novelty and innovation in transformation-oriented research (Shove and Walker, 2010; Turnheim and Geels, 2012). However, a growing body of research is engaging with questions around how technologies, social practices, the use of particular substances, etc. decline or are discontinued or how the socio-technical systems that hold them in place become destabilized (Shove et al., 2012; Turnheim and Geels, 2012; van Oers et al., 2021; Koretsky et al., 2023). Contributing to these emerging debates, I argue for a need to place an emphasis on the importance of multi-scalar investigations of processes of destabilization and make a case for investigations into these processes on the local level. As Fuenfschilling and Binz (2018) argue, investigations into socio-technical change are influenced by an implicit methodological nationalism: a tendency to take the nation-state as the unit of analysis to investigate socio-technical change. I contend that, like investigations into innovation journeys, there is value in a multi-scalar understanding of destabilization processes. There is a contradiction in calling for a multi-scalar investigation into destabilization processes and proceeding to explore exclusively the local scale. However, whilst still appreciating that automobility regimes extend beyond the local scale, I argue that the local level can be a helpful starting point and/or additional perspective to shed light on the emerging tensions between locked-in arrangements and ambitions for desired socio-technical change and consider potential avenues for unlocking car-based automobility. The spatial diversity

in aspects such as pressures to transform, population density, access to alternative transport modes, levels of car dependency, engaged civil society, etc. is highly place-specific. While conflicts and their underlying drivers extend beyond the local, they are experienced locally and these experiences can be an important source of political mobilization. Therefore, as is the case for other foci on socio-technical change, place, space, and scale matter when considering destabilization (Hansen and Coenen, 2015).

This chapter aims to explore the utility of investigations into processes of destabilization of urban car-based automobility in one particular urban context: the city of Hamburg, Germany. Through historical reconstruction, I map central changes in the local arrangements that have governed urban mobility in the city since an identified historical turning point in the late 1970s. Building on concepts from Turnheim (2023), I identify mounting *pressure fronts* (as quasi-manifestations of conflicts) within the prevailing arrangements and corresponding *incumbent responses* to the mounting pressures. Methodologically, the research attempts to operationalize these concepts to assess their usefulness for investigating the broad contours of socio-technical destabilization processes. Drawing on changes to the incumbent responses, I identify five phases which help map the changing strategies of incumbents to *accommodate*, *ignore*, *mobilize*, *divert*, and *transform* the mounting pressure fronts. Empirically, the research exposes underappreciated historical developments in the governance arrangements around urban mobility in Hamburg.

From innovation to destabilization journeys in socio-technical systems

Growing awareness of the gravity of the multiple social and environmental crises that humanity faces, combined with the insufficiency of the hitherto societal responses, has given rise to diverse research communities crossing multiple disciplines that focus on questions of transformative change. What these communities typically have in common is an understanding that grand societal challenges cannot be effectively tackled through incremental changes or technological solutions alone, but require deeper and more fundamental shifts in how humans exist. One such community, working under the banner of 'sustainability transitions', sees value in centring investigations into transformative change on the 'meso' level of socio-technical systems (Geels, 2004). This means (1) appreciating that social and technological systems are

so deeply intertwined that it is more helpful to consider them collectively and (2) considering that systems of provision (food, mobility, housing, etc.) can be a productive analytical focus to conceptualize and identify the mechanisms through which radical transformations can take place in the way these systems of provision are organized (Köhler et al., 2019).

On the flip side of this work are questions around why such transformations are *not* taking place despite the growing pressures for change. There have been helpful conceptualizations of so-called *path dependencies* and *lock-ins* (Unruh, 2000; Seto et al., 2016): These forces dynamically stabilize the prevailing arrangements, holding (often unsustainable) arrangements in place. Whilst these are helpful concepts, all too often they are considered primarily as an obstacle along the path of some predefined innovation journey (Turnheim, 2023). To compensate for this bias, researchers have begun to shift their perspective towards the mechanisms and agency underpinning the stability of locked-in constellations and improving conceptualizations of the power at play in the reproduction of such lock-ins as well as avenues for their unlocking (Stirling, 2019; Kok et al., 2021). One manifestation of this shift in perspective can be seen in the increased interest in socio-technical destabilization.

Turnheim (2023) offers an overview of the core notions in the emerging work on socio-technical destabilization. He describes it as a 'longitudinal process by which otherwise relatively stable and coherent socio-technical forms [...] become exposed to challenges significant enough to threaten their continued existence and their "normal" functioning triggering strategic responses of core actors within the frame of existing commitments (preservation) and in certain circumstances away from such commitments (transformation)' (Turnheim, 2023: 45). To understand the sources of stability, investigations into destabilization will typically start by identifying the prevailing structural and enacted forms of lock-in and path dependency. While previous work has exposed many forms of lock-in and path dependency, certain formations – particularly those with strong political, institutional, and cultural dimensions – remain particularly difficult to pin down (Simoens et al., 2022; Turnheim, 2023). Without playing down the power of such forces, it is important to recognize that *un*locking does occur (Turnheim, 2023). Sources of destabilizing change could constitute '(1) technical dysfunctions, technological discontinuities or performance erosion, (2) social and political mobilization, delegitimation, the emergence of new rules or the breakdown of existing

rules, and (3) challenges by new actor coalitions, the disbanding of existing coalitions or the accumulation of poor strategic choice' (Turnheim, 2023: 48).

Turnheim (2023) also emphasizes the role of those who hold positions of power within socio-technical arrangements: the so-called incumbents. The notion of the 'incumbent actor' is often used as a shorthand for powerful actors that stand in the way of desired socio-technical change (Turnheim and Sovacool, 2020). Powerful actors do play a central role in bringing about and inhibiting change. However, there are different forms of power to be considered through which arrangements are challenged and reproduced (Avelino and Rotmans, 2011). Therefore, the prevailing arrangements are maintained and challenged by many types of actors in many areas of social life (Stirling, 2019). Another common misconception about incumbents is that their role in transition processes is strictly to buffer the pressures to inhibit change. However, strategies employed by incumbents can be more extensive and can range from purely resistive positions to more proactive approaches and can differ greatly from one actor to another (Turnheim, 2023).

These insights provide a helpful starting point for investigations into processes of socio-technical destabilization. They do not provide a clear theoretical framework that can be easily applied to investigate such processes. On the contrary, they remind us that such processes are highly complex and context-specific, and that if analytical scopes are set too narrowly, important factors can be lost. The sources of (de)stabilization can be more or less structural, enacted, and/or elusive, and these can change over time. Therefore, there is a trade-off between getting the kinds of high-resolution perspectives that are necessary to trace the processes through which destabilization occurs and appreciating the (likely broad) spatial and temporal sources of destabilization.

Case and methods

The city of Hamburg is Germany's second-largest city, with a population of just under 1.9 million in 2023 (5.4 million if the broader metropolitan region is considered) (FHH, 2023). Hamburg is considered an important hub in the European trade and transportation network, and the city's port has historically played an important role in shaping the city physically, economically, and culturally (Lieber, 2018). Planners and politicians alike also strive to live up to the city's image as a 'green', 'inclusive', and 'growing' city by the water (FHH, 2014). This relates both to maintaining and improving its physically green

spaces and urban nature, and also to sustainability ambitions more broadly. The city has committed to achieving climate neutrality by 2045 as part of its climate protection plan (FHH, 2019a), and it was crowned the 2011 European Green Capital. Tensions between the often contradictory ambitions around economic growth and environmental protection have a long history in the city (Bauriedl and Wissen, 2002). Furthermore, Hamburg's status as both a city and a federal state (*Bundesland*) provides relative political autonomy for actors engaged on the municipal level to shape institutional arrangements and development direction. These factors – the strong tensions between the priorities of economic growth and sustainability and the relative independence of the city's decision-making bodies from the nation-state – make Hamburg a very suitable case for investigation into destabilization processes at the local level. If such processes occur and matter on this level (and do not, for example, just trickle down from higher governance levels), it can be expected that they can be observed through investigation into this case.

A case study is conducted as a research strategy to gain a full insight into one or several objects or processes confined in space and time (Verschuren and Doorewaard, 2010). As a first step in this case study, two 'helicopter' interviews (Hajer, 2006) were conducted with senior academics who have an overview of the historical development of the urban governance arrangements around urban mobility in Hamburg. Additionally, 24 semi-structured interviews (approximately 90 minutes in length) were conducted with individuals (15 male and 9 female). Interview partners include retired practitioners (4); current practitioners from a range of transportation and urban planning organizations (13); representatives of civil society organizations (3), and academics (4). The limits of the municipal administrative area were considered as a general spatial boundary. However, as the mobility system extends beyond the municipal borders, what is considered to constitute Hamburg's urban mobility system was left open to the interpretation of interview partners. In terms of temporal demarcation, the overall duration of a process of destabilization depends largely on 'when one counts' (Sovacool, 2016; Turnheim, 2023). Therefore, an inductive approach was taken to identify one particular turning point away from car-centric urban development – a perceived 'high point' of car-based automobility in this context – and then elicit development phases from that point until the present.

The approach utilizes an abductive methodology moving between observations in the data and the concept development in iterations (Charmaz, 2014). I draw upon four concepts, as articulated by Turnheim (2023), deemed help-

ful for this investigation. First, I consider the dialectical relationship between (1) *weakening continuities* (the erosion of the ties that hold locked-in arrangements together) and (2) *intensifying discontinuities* (threats and challenges to the prevailing arrangements) (Turnheim, 2023: 49). In appreciation of this relationship and the multitude of forces at play when considering socio-technical change, I further draw on the notions of (3) *pressure fronts* (observable emergent tensions) and the corresponding (4) *strategic responses* of incumbent actors to these mounting pressure fronts (Turnheim, 2023). These were not operationalized through the development of indicators that would constitute evidence of their occurring. Rather, they were considered sensitizing concepts (Charmaz, 2014) to investigate destabilization processes openly and inductively over long periods. Beyond striving for a broad range of actor perspectives, the approach sought to triangulate different sources of data, particularly transport development plans and other municipal strategic documents (Patton, 2015: chap. 9). References are made to specific interviews[1] or documents when possible, suitable or necessary.

Destabilization of urban automobility in Hamburg

A clear turning point away from car-centric urban development in Hamburg can be seen in the public opposition that emerged in response to the planned expansion of the street network that was articulated in the city's General Transportation Plan (Generalverkehrsplan, GVP) of 1976 (FHH, 1976). Attempts to implement the plan in the following years, which would have meant deep cuts in densely settled urban areas to make way for large-scale motorways, were met with strong public opposition, sending a message to politicians and planners alike that such projects to meet growing rates of motorization had become an impossibility (RP1; RP3; RP4).

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1   References have been anonymized according to the following codes: P = practitioner, RP = retired practitioner, CS = civil society (NGO), A = academic. The abbreviation is followed by a number producing a unique code for each interview partner.

1976–2001: *Accommodating* metropolitan development through incremental changes

Population decline and the regional relevance of the port during the Cold War had been playing a central role in Hamburg's urban governance since the 1960s. The city was characterized by growing unemployment, with a turn towards stronger economic growth first emerging in the 1990s. Transportation planning was embedded in the Department for Economic Development (Wirtschaftsbehörde), as transport was understood as imperative for an effectively functioning port and economy more broadly. Due to public opposition to the 1976 plan, the mandate for the unfettered development of the city's street network was lost despite growing motorization rates and suburbanization, and planners were forced into a piecemeal approach to traffic planning (RP1; RP3). Some central projects from the 1976 plan became institutionalized through separate legislation or integrated into the city's land-use plan, leading to the incremental expansion of the road network and the extension of certain rail lines (RP3; RP4). The approach still aimed to maximize performance in terms of movement of goods and people, but planners were presented with obstacles when doing so. With the growing awareness of the problems associated with auto-centric urban design, the image of the car as a symbol of progress and freedom was in decline (P2; RP3). This emerging realization of the mistakes of the preceding decades manifested in wider public discourses as critical questions were being asked about the type of city inhabitants wanted to live in (P2; RP3). Localized initiatives and individuals began pushing for low-car and traffic-calming measures in their places of residence, work, and study (RP3; A2).

In the late 1980s, planners began experimenting with speed limits, specifically focusing on residential areas (P2; RP3). Through parking controls in the city's core, and the establishment of park-and-ride (P&R) facilities, there was a steady shift towards commuting by car to public transport. Maintaining Hamburg as a strong metropolitan area was ideologically a central building block of the social democratic project of the ruling Social Democratic Party (SPD) (A2). This helped justify the expansion of the road network (as well as the public transport system) to connect the inner city to the surrounding regions. Recognizing the challenges of negotiating the increasing tensions and conflicting goals in transportation development in a growing city, policy-makers opted to develop a Transport Development Plan (Verkehrsentwicklungsplan, VEP) during the 1990s, which proposed further instruments to encourage modal shift

(FHH, 1999). The *Veloroute* (cycling network) concept was also developed in the '90s, with the first route completed in 1999. However, these early signals of the re-emergence of cycling were primarily because of activities outside of the formal planning arrangements. Within formal transport planning circles, cycling was largely neglected as a credible form of transportation during this period (CS3; A2; A4; P2; P5).

2001–2008: Hamburg first – *neglecting* the metropolitan project

After the city election in 2001, the centre-left SPD was forced into opposition for the first time since World War II. The conservative Christian Democratic Union (CDU) took over leadership, initially in coalitions and later governing alone from 2004 to 2008. Metropolitan development – connecting the city with its surrounding areas – was strongly associated with a social-democratic project embedded in a general framework of Fordist ideology: a car for every worker and the freedom to move around was a central promise to the working class in the decades prior (A1; A2). Signalling a shift towards more neoliberal logics, the new coalition was less interested in maintaining that project. This manifested in a relative indifference towards projects that would better connect the inner city and outer suburbs (whether by road or public transport) in favour of promoting growth in the urban core (A1; A2).

In terms of municipal organizational structure, transportation planning was separated from economic development to join construction in the Department for Construction and Transport (Behörde für Bau und Verkehr) and in 2004 joined the Department for Urban Development and Environment (BSU), which centralized key public authorities around urban development. The newly formed government disregarded the earlier transportation development plan and abandoned initiatives to promote cycling and reintroduce a light rail network. A selection of the planned motorway projects and extensions to the rail network (which were present in the initial plan) were continued, maintaining the overall development trajectory but forsaking early efforts to encourage modal shifts in transportation (P4; RP3). A new rail line (U4) was planned to link up the newly developing HafenCity largely because of pressure from developers of the new district (RP3). The period also saw growing pressures from other governance levels through European laws that set standards for local air and noise pollution.

2008–2011: The just-do-it interlude – *mobilizing* unsuccessfully

In 2008, the conservative CDU entered a coalition with the environmentally progressive Green Party, which required agreement on a series of contentious projects, including a range of motorway developments. In exchange, the Greens successfully negotiated a range of key projects of their own, as well as control over the influential BSU. This included the establishment of the Cycling Forum (Fahrradforum), through which the city's first cycling plan and a city-wide bike-sharing system would be developed. The unconventional coalition was understood as a marriage of convenience despite some common ideological ground around the 'creative city' (Landry, 2008; A4). The powerful position held by a Green senator in the BSU led to a strategy less focused on long-term planning as much as it was on implementing initiatives to establish concrete results (A1). However, this approach encountered formidable challenges, with two of its central projects faltering in their advanced planning stages: a shared space concept and implementation of the planned light rail system. These were both physical interventions in urban space, and they encountered significant local opposition from residents and businesses in the targeted development areas.

2011–2020: *Diverting* towards economic growth through ITS

The election of 2011 marked an important ideological turning point as the SPD returned to power, winning an absolute majority. Coinciding with mounting pressure on the city to address air quality issues, driven largely by the threat of lawsuits for systematic non-compliance with European air quality standards, the newly elected government embraced the concept of intelligent transportation systems (ITS) and smart cities (A1; RP2; RP3). Not only did ITS carry lofty promises to improve traffic flow and mitigate the negative effects of transportation, but it also promised an avenue for economic development (A1). Hamburg was thus announced as 'open for business', as companies were invited to test smart mobility solutions in the city (A1). During this time, the meaning of transport planning was further broadened beyond the creation of infrastructure to include the management of real-time traffic flows and mobility management (A1). Notably, citing budget restrictions, the SPD abandoned the light rail project that was developed under their leadership during their previous term in power. This excluded it as a potential consideration in

the transportation strategy, and the leadership instead opted to optimize the existing bus network.

These ideological shifts were manifested in the city's organizational structure. Transportation re-joined with economic development in the Department for Economic Development, Transport and Innovation (BWVI). The BWVI was consecutively led by two independent senators with close ties to the private sector, although much of the ongoing smart mobility activities were directly managed by the mayor's office (A1; RP4). Several letters of intent (LOIs) were signed between the city and companies. The mayor himself was involved in establishing the Platform for Urban Mobility (Plattform Urbane Mobilität), bringing together a range of German cities and representatives from the automotive industry, among others, to envision the future of urban mobility centred on ITS (P1). In 2014, a master plan for the city's e-mobility charging infrastructure was developed (P1). In 2015, the senate published a digital city strategy, followed by an ITS strategy the next year, including the establishment of an ITS project management office to organize activities around smart mobility in the city. Swift action was taken to modernize the city's outdated or non-existent traffic management systems, piggybacking on Hamburg's successful bid to host the 2021 ITS World Congress to justify investments in traffic management technology (RP2; P1) and the implementation of a range of urban testbeds to experiment with new mobility services and autonomous vehicles.

The Transport Development Plan (VEP) was reintroduced as an instrument for long-term planning and coordination. Additionally, a Mobility Advisory Board (Mobilitätsbeirat) was established within the framework of transportation development planning. This board was designed to integrate a broad group of stakeholders from politics, the administration, business, research, and selected civil society organizations to steer the development of the ongoing planning process (FHH, 2013).

After the election in 2015, the SPD could not maintain their majority alone and went into a coalition with the Greens. This coincided with the announcement of plans for a new heavy rail line (U5) and the role of cycling coordinator becoming formalized in the transportation department. The following year, the Alliance for Cycling (Bündnis für den Radverkehr) was endorsed by senate representatives, borough offices, councils, and the mayor to commit to developing Hamburg into a 'cycling-friendly city', striving to increase its modal share of cycling to 25%. Together with the public transport authority, an 'offer offensive' (*Angebotsoffensive*) was proposed as a means to create a 'real alternative to the car' through the improvement of public transport and on-demand shuttles,

vehicle and ride sharing, and other mobility services (FHH, 2019b). In 2019, 200 experts and around 8,000 other visitors came together in the Bauforum workshop to contribute to the development of a master plan for the city's main arterial roads, reimagining them as *Magistralen* that would 'put people first' (RP4; A2; BSW and Meyhöfer, 2020).

2020–2024: Reimagining 'smart'– *mobilizing* and *transforming*

An election in 2020 followed significant environmental protests in the city throughout 2019. The Greens experienced a notable surge in election results, nearly doubling their voter share to 24%. The emergence of a new Greens-led organizational entity, the Department for Transport and Mobility Transition (Behörde für Verkehr und Mobilitätswende, BVM), once again separates transport from economic development, establishing it as an independent department with '*Wende*' ('transition' or 'turnaround') imprinted in its title. This signalled change, fostering a new culture within the mobility department characterized by an ever-growing new generation of planners whose education extended beyond conventional transportation planning to consider more integrated perspectives on urban development and sustainability (P4; A1).

There was an important shift in the framing of ITS. The new perspective decentres the car and integrates the improvement of public transport and cycling more explicitly (FHH, 2016; 2021). The *Hamburg-Takt* became a central coordinating vision: a goal to offer every city inhabitant a mobility connection within 5 minutes of their location to anywhere else in the city through enhancing the public transportation network and integrating on-demand services. A commitment to the further development of the city's shared autonomous vehicle project was formalized through the signing of a declaration of intent between the city and national governments, aiming to position Hamburg as a Metropolitan Model Region of Mobility. Through this agreement, a goal was set to have up to 10,000 autonomous vehicles on Hamburg's streets by 2030, serving as a modern on-demand transport service. Traffic calming in the inner city was also expanded and certain areas were made car-free. Though not uncontentious, decades of incentives to encourage modal shifts for inner-city commuting helped justify these measures (A2).

Table 1: Overview of the phases.

Period	Phase	Party Control	Formal Institutional Arrangements	Mounting Pressure Fronts	Incumbent Responses
1976–2001	*Accommodating Metropolitan Development through Incremental Changes*	SPD (coalitions with FDP, STATT, Greens)	Transport embedded in Dept. for Economic Development (Wirtschaftsbehörde)	Public demand for better cycling infrastructure, safer streets, and enhanced liveability; decreasing importance of cars as a symbol of progress; growing congestion; limits on road expansion; environmental protection institutionalized	Parking management and park-and-ride; traffic calming in residential areas; incremental expansion of public transport and streets; light rail network planning; long-term planning through Transport Development Plan (VEP)
2001–2008	Hamburg First: *Neglecting* the Metropolitan Project	CDU (coalitions with Schill, FDP)	Transport joins Construction Dept. (Bau und Verkehr); later Urban Development and Environment (BSU)	Intensification of pressures, including lawsuits for forced bike-lane use and compliance with EU noise and air pollution standards	Abandonment of previous transport plans, maintaining selected projects; incremental public transport and street network expansion; rollback on metropolitan development; neglected street maintenance; discontinuation of light rail and cycling infrastructure upgrades

2008–2011	The Just-Do-It Interlude: *Mobilizing Unsuccessfully*	CDU (Green coalition)	Green control of BSU	Opposition from local businesses and residents; citizen-led referendum against light rail; budget constraints	Incremental expansion of public transport and street networks; implementation of shared space and light rail projects; development of a cycling plan and establishment of a cycling forum
2011–2020	*Diverting Towards Economic Growth through ITS*	SPD (Green coalition from 2015)	Transport reassigned to Dept. for Economic Development, Transport, and Innovation (BWVI); new organizational units for ITS World Congress	Budget constraints; referendums for green space protection and improved cycling infrastructure; legal threats over air quality; district-level experiments with car-free or low-car initiatives; climate plan and large environmental demonstrations; reimagining *Magistralen*	Mobility management and ITS; experiments with mobility services (autonomous vehicles, ridesharing); 'Offer Offensive' in public transport; revival of long-term transport planning (VEP); formalization of objectives and advisory board; institutionalization of cycling promotion
2020–2024	*Reimagining 'Smart': Mobilizing and Transforming*	SPD (Green coalition)	Transport reassigned as an independent department: Transport and Mobility Transition (Verkehr und Mobilitätswende)	Space availability (e.g., parking vs. blue/green space); sector-specific climate goals; opposition to parking management	Reframing 'smart' with public transit and cycling prioritized; redistribution of space (car-free zones and temporary bike lanes); unsuccessful attempt to expand parking management and speed limits; pledge of up to 10,000 autonomous vehicles by 2030

Source: Author.

The incoming Green senator and cycling coordinator prioritized the improvement of the cycling infrastructure, supported by the established Alliance for Cycling and substantial grassroots pressure through the *Radentscheid*, a citizen-initiated referendum demanding improvements to the city's cycling infrastructure. While previous attempts to implement the *Veloroute* concept faced frequent local opposition, the reduction in commuter traffic and the shift to remote work during the Covid-19 situation provided planners with an opportunity to implement and expand street space redistribution through 'pop-up' bike lanes. This became feasible in streets where such interventions would have encountered substantial opposition only a few years prior (P2; RP2; CS3). The significant physical transformation of the cycling infrastructure in a relatively short period was seen as somewhat radical by some (RP1; RP3). For others, it merely compensated for decades of neglect of cycling as a legitimate transport mode (P5; CS3).

Local dimensions of socio-technical destabilization

The introduced developments demonstrate that there have been significant changes to the governance arrangements around urban mobility in the city of Hamburg since a turning point in the late 1970s. Since that moment, the automobility regime has been exposed to mounting pressure fronts, with the array of problematized issues also widening over time. Initially, pressures were mainly about congestion, death and injury, and local air quality, while more recently, the scope of problems has widened to also include climate change, space scarcity, and broader questions of environmental health, quality, and justice. Throughout the observed period, five phases can be identified, reflecting changes in the incumbent response to the mounting pressures. Responses have ranged from incremental efforts to *accommodate* the mounting pressure fronts (1980–2001); to largely *ignoring* them (2001–2008); to *mobilizing* them unsuccessfully (2008–2011); to *diverting* them through reimagining the problems as new opportunities for economic growth (2011–2020); to *transforming* them into physical changes in the urban fabric (2020–2024). Each phase has its path dependencies. To name just a few examples, the implementation of car-free inner-city areas was supported by decades of incentives to discourage car travel into the city centre (A2). Rising maintenance costs to compensate for neglect of infrastructure in the 2001–2008 period contributed to budget restrictions which were a barrier for the implementation of the light rail and

shared space projects in 2009–2011 (A1). The embracing of ITS and associated projects in the early 2010s created a pathway through which the promised 'mobility transition' a decade later brought with it the involvement of Germany's largest car company in the local governance arrangements (VW through its subsidiary MOIA). Nevertheless, there is also scope within incumbents' respective terms to shape the mobility arrangements and change direction.

The turning points are typically the product of changes in government or coalition partners. Based on these patterns, it might be tempting to assign too much responsibility for changes to the government in power. However, the case shows that important shifts (such as infrastructural and technological decay, civil society organization and mobilization, staff turnover, changes in other urban contexts, etc.) are constantly influencing the governance arrangements and play a role as well. Often, the change in government and the associated reshuffling of formal institutional arrangements reflect an opening of the metaphorical floodgates, bringing about a more rapid change of direction. Formal reshuffling can also have the opposite function of stifling or diverting emerging pressures for change into other political topics (e.g. economic growth). Nevertheless, shifts are indeed clearly marked by elections, emphasizing the importance of formalized local politics and formal institutional arrangements in processes of destabilization.

To exemplify the importance of locally embedded and dialectical dimensions of *weakening continuities* and *intensifying discontinuities* that play a central role in the emergence of pressure fronts, in the following section, I bring to the fore two concrete examples that can be drawn from the case. It is important to note that these are multi-scalar in that they have both endogenous and exogenous dimensions but that they are enacted and institutionalized (or mitigated and resisted) locally.

Weakening continuities through shifts in planning logics

Changes in the logics that underpin transport planning reflect important examples of weakening continuities. One example is the weakening in the supremacy of absolute traffic performance or 'efficiency' (*Verkehrsleistung*) and a shift towards a broadening of evaluation criteria. Traffic 'performance' has typically been understood primarily in terms of efficiency in a very narrow sense, leading transport planners to focus primarily on improving traffic flow, congestion, travel time, and overall system capacity (Banister 2008). This can lead to the counterproductive assumption that if a system is delivering

maximum movement in terms of distance travelled per capita, this system is performing better than one in which there is less physical movement, even if the latter might deliver all necessary and desired trips in a safer and more environmentally friendly manner. The dogma of traffic performance and its underlying assumption that increased efficiency is inherently desirable appears to be shifting, partly through the lessons learned from other urban contexts:

> We had a brief conversation with a colleague from Vienna who is responsible for transport planning [...] and she told us [...] they don't actually look at the efficiency [*Leistungsfähigkeit*] of [...] intersections when they are being rebuilt because even if it goes down, that's the goal. [...] In order to encourage fewer people to drive, we no longer want to be so efficient.[2] (P4)

Transport planners have an important role in determining the future mobility arrangements of urban developments by anticipating dimensions such as future traffic volumes, modal split, and car ownership rates. In recent decades, there has been a shift from anticipating these factors to prescribing them, with the underlying objective of minimizing the role of the car in future arrangements. This has been supported by local legislative changes offering more flexibility on parking minimums that give planners the freedom to make these decisions, but also through planners' changing perceptions about what is plausible in terms of minimums on car ownership and use. This has partly been spurred on by car-sharing organizations, which have demonstrated that their services can offer the same mobility with significantly fewer vehicles through modelling exercises (P2; P3). These changes are evident in the layers of development behind a large urban development project, the Leap Across the Elbe. This development began with the building of the HafenCity district in the early 2000s with remarkably low ambition in terms of prescribed car ownership and use and has now become progressively more ambitious:

> I think that is what the car-sharing providers are saying: '100 to 105 vehicles per 1,000 inhabitants and we can organize everything for you.' And that would be 0.2 [parking spaces per residence], and that's Grasbrook. [...]

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2   Interviews were conducted in German; interviews and non-English quotations have been translated by the author.

> In 2000, we had a parking space ratio in the HafenCity of 1 to 1.5 per residential unit, i.e. built in Kaiserkai. And now we're doing 0.4 in the eastern part. Yes, that's also a huge step. That wouldn't have been possible back then. (P2)

These are manifestations of a departure away from logics of 'predict and provide', a shift that has been common knowledge in mobilities research for some time (Banister, 2008). However, there appears to be a difference in how long it takes for such paradigm shifts to make their way into the day-to-day activities of practitioners and to what extent they do so. In Vienna, for example, according to the quote, planners aren't looking at efficiency at all, and they have an *explicit* goal of reducing efficiency. In Hamburg, efficiency is apparently still important, but not as central as it had been.

Intensifying discontinuities through a broadening opposition to the car

Pressures on the prevailing governance arrangements have largely been driven by an ongoing and consistently growing local opposition to auto-centric urban planning. Although not only targeting the transport sector, a growing environmental movement has been central to the problematization of the negative impacts of the car. Indications of the institutionalization of the movement in the local governance arrangements can be seen in the rise of the local branch of the Green Party and the professionalization of a range of local NGOs (CS1; CS3). Growing environmental awareness has also been institutionalized in the city bureaucracy. Management of environmental issues began formalization from 1978, becoming the Department for the Environment (Umweltbehörde) in 1985 and gaining further competencies (water, energy, and waste management) in 1987. The department developed strategies for environmental protection (e.g. noise pollution, local air pollution, climate change mitigation and adaptation, green space protection, etc.). An independent Department for Urban Development (Stadtentwicklungsbehörde) was formed in 1991, marking a moment of institutionalized weighing up of an ever-growing list of urban priorities and their consideration in spatial terms (RP3). While it is impossible to account for all the work of these institutions over the period investigated, the recent Master Plan for the city's main arterial corridors, reimagined in the plan as '*Magistralen*' (as a callback to the pre-car-centric terminology), is one example of how the work of these organizations directly challenges the prevailing automobility regime. These major thoroughfares facilitate most of the

road transportation to and from the city centre from the urban peripheries. Through the process of motorization throughout the 20th century, their mono-functionality purely to facilitate traffic has made them normalized keystones of the city street network. However, urban planners have recently embarked on an initiative that builds on a large-scale visionary workshop (Bauforum) to transform precisely *this* space.

> If you look at what is being created as a vision […] you can see in this [Magistralen] Master Plan that all the authorities are involved and it's no longer just some crazy ideas from the Bauforum. Then you suddenly see that […] these major thoroughfares have been reduced from four lanes to two lanes with two lanes of greenery. […] I was totally surprised when I saw this the other day because it means that the transport department is somehow supporting this. (RP4)

> Actually, the idea of replanning the main roads, […] that was actually the first visible confrontation against the old orientation, which was to optimize commuter traffic as much as possible, and to relativize it this time. In other words, this trend, which started in the 1970s and '80s because of suburbanization, was undisputed until 2020. (A2)

These main corridors form the backbone of road-based transportation in the city. In the past, traffic-calming measures and space redistribution were always limited to residential areas. Because the logics of transportation planning were dominated by ensuring maximum 'efficiency', anything that would not enhance or maintain capacity was largely out of the question. But in this case, the effort to change the roads has come from outside formal transport planning, and this initiative seems to be supported from within transport planning, a scenario which appears not to have been plausible in the past.

Conclusion

This investigation underscores that there are fruitful insights to be gained by investigating processes of destabilization on the local level. There are myriad forces at play that contribute to the challenging and reproduction of automobility on multiple governance levels (Böhm et al., 2006; Canzler et al., 2018; Haas, 2020; Manderscheid and Cass, 2022; Hawxwell et al., 2024). However, considering the particularities of the urban in terms of obduracy (Hommels,

2005), it is not surprising that investigations into destabilization at the urban scale can expose new faces of the regime and unique dynamics of its potential unmaking (Jayaweera et al., 2023). For example, an emerging pressure front around space scarcity and the zero-sum nature of space allocated to different forms of transportation and the many other functions that urban space performs suggests that this is a particularly urban phenomenon (Petzer et al., 2021). Despite this, one should be wary not to fall into the 'local trap' (Purcell, 2006), losing sight of broader forces that extend beyond the local. This investigation is somewhat blind to the extent to which changes could more credibly be assigned to other governance levels. While it is clear that pressure fronts will have both exogenous and endogenous dimensions, focusing exclusively on the local makes it difficult to identify the relative strengths of the endogenous or exogenous forces, respectively: It is difficult to know the extent to which changes are predominantly the product of the work of actors locally.

Beyond negotiating trade-offs in terms of scale, trade-offs between breadth and depth also need to be considered when investigating destabilization journeys. A broader goal of destabilization research is to move towards the identification of common underlying mechanisms behind such processes (Turnheim, 2023). Getting at such detail likely requires high-resolution perspectives. To account for the long-term shifts away from car-centric urban development, this study was only able to sketch the contours of a destabilization journey, providing a glimpse into its dynamics. Therefore, it likely misses the nuances of particular moments but helps identify starting points for such higher-resolution investigations. These shortcomings stress the need to also move between *temporal* scales, as well as the importance of collaboration and coordination between different cases and research approaches.

Despite the long-term scope applied in the investigation, it is still difficult to assess the relationship between *destabilization* and *decline* of the role of the car in the mobility system. As has been demonstrated, there have been shifts in the underlying logics and a rising formidable force to challenge car-based automobility. Also, the portion of trips by car in the modal split has been in decline since 2000 (FHH, 2023). However, there are some developments that suggest the cracks in the regime of automobility might not be as deep as they appear. Hamburg's senate still lobbies on the national level for, and itself invests heavily in, new motorway developments to expand road-based transportation, which is an obvious contradiction to a transformation agenda. Looking at car ownership also shows a regime more locked-in than ever, with the absolute number of privately owned vehicles in the city steadily increasing until 2022, when

there were signs of levelling off (FHH, 2023). Looking at the space allocated to (road-based) transport infrastructure over time would likely tell a similar story. Another example is Hamburg's leading role in the emergence of autonomous mobility services and the associated for-profit models that have the potential to transform the mobility system into an even more problematic regime of automobility (Freudendal-Pedersen et al., 2019; Marletto, 2019). Future research could therefore investigate the forming of new ties between new and old elements that are reproducing and mutating urban mobility regimes in the making of urban mobility futures.

Identifying pressure fronts can be a helpful means of recognizing that emergent matters of concern (Latour, 2004) are the products of opposing forces coming into contact with each other rather than some objective problem. The car's impact on the city only becomes a problem when it is problematized (see also Jørgensen, 2012). The many environmental and social conflicts the car has created and continues to create only become contested under particular circumstances. Those challenging the prevailing arrangements play an important role in this process of problematization and are helped or hindered immensely by the prevailing institutional arrangements. Once a pressure front that is deemed to be of particular importance along a destabilization journey has been identified, a deeper investigation into processes of (de)legitimation and associated justification strategies could be a fruitful avenue for investigation. Furthermore, by focusing on *destabilization*, the approach is not blind to novelty or innovation. It brings to the fore precisely the innovation that can be directly assigned to the pressures that force meaningful change. This can help decipher 'what makes for a destabilising source of change' (Turnheim, 2023: 48). It can therefore be a well-justified means of identifying 'niches' that warrant 'strategic management' (see Schot and Geels, 2008). This underscores the Hoffman and Loeber claim that there is 'no clear-cut division between innovative practices on the one hand (often referred to in terms of a "niche") and the vested interests manifest in institutions, prevailing rules, and actors (alternatively referred to as "regime") on the other' (2016: 706). It further bolsters calls to, therefore, focus on the 'processes of translation' that shape interactions between 'niche' and 'regime' rather than seeing them as dichotomous entities (Raven, 2006; Smith, 2007).

The research provides important insights into questions of governance of, and intentionality behind, destabilization (Frank and Schanz, 2022; Turnheim, 2023). This Hamburg case shows that even though incumbents have not intentionally been curbing auto-centrism in any serious way, an ever-growing force

of actors (in terms of power and numbers) has intentionally been working towards dethroning the car within the urban development paradigm of the city for decades. This highlights the important processes and 'work' that occur long before more formal decisions to 'phase out' or 'discontinue' (Koretsky et al., 2023) have been taken. It shows that forces of change might lie much deeper in the historical record than one might expect. Until 2011, there was no apparent intention articulated on the side of incumbents that the system should be fundamentally changed. After that point, the intentions appear to be mainly techno-utopian promises, and later, more explicit albeit moderate efforts to discourage car ownership and use. The concessions made prior could be understood as efforts to *disarm* rising pressure fronts to *maintain* the prevailing car-based arrangements. This is exemplified considering the change to the conservative government in 2001, which marks a shift towards a more neglectful stance regarding the emerging pressure fronts rather than making incremental concessions, as the previous incumbents had done. One could speculate that this neglect played an important role in the dramatic change in the direction that came after. Therefore, investigations into destabilization should consider the question of whose intentionality matters. The case also points to the importance of more relational and emergent understandings of governance (Briassoulis, 2019) when investigating destabilization rather than limiting the scope of governance to the 'cockpit' (Smith and Stirling, 2007; Stirling, 2019). Finally, connecting to the theme of this volume, this contribution highlights that urban future-making does not take place in a vacuum. Not only do conflicts emerge between rival imaginaries about the future of urban areas, but also in the *un*making of that which has been inherited from the past.

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7.3   Interrogating transition imaginaries: Mapping present futures of urban (auto)mobilities

RESEARCH　　　　　　　　　　　　　　　　　　　　　　　　　　　**Open Access**

Interrogating transition imaginaries: mapping present futures of urban (auto)mobilities

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Abstract

Given the contested nature of urban futures, we approach the term "transition" as a floating signifier to investigate imaginaries of transformation. Focusing on urban mobility transitions, we demonstrate the plurality of associations with a post-transition future. This perspective allows the identification of underlying tensions and incommensurabilities between competing visions of the future. Q method is applied to explore imagined mobility futures among professionals working on mobility and urban development in Hamburg. The results show that even among those directly engaged in mobility transitions in their day-to-day work, there are plural and often conflicting views on what such transitions can and should achieve. The research offers insights into the coordinating role of floating signifiers in processes of socio-technical change. While these signifiers perform an important coordinating function in the governance of socio-technical change, they are inherently susceptible to capture.

Policy and practice recommendations

Possible manifestations of urban mobility transitions vary greatly, with significant implications for justice and sustainability.
Techno-optimistic mobility futures risk perpetuating the assumptions and logics that underpin car-based automobility.
Reflexivity regarding the trade-offs between different mobility futures-in-the-making is important to avoid solutions that may inadvertently deepen the entrenchment of automobility.

Science highlights

- Investigations into imaginaries can overlook contestation and conflict.
- Treating transformation-oriented terms as floating signifiers helps draw out tensions between imagined futures.
- Investigates the differences in imagined mobility futures among professionals engaged in mobility and urban development in the city of Hamburg.
- Three distinct imagined urban mobility futures are identified.
- There are notable differences among individuals across organisations in how they understand what urban mobility transitions can and should deliver.

Introduction

Terms such as *transition* or *transformation* have become so commonplace in political and scientific discourse that others have claimed they may have become "buzzwords" (Hölscher, Wittmayer and Loorbach 2018). Common reference is made to such terms at a range of governance levels from the neighbourhood to the supra-national and by a range of actors from public and civil society organisations to multinational firms. For those interested in urban transformations (Wolfram, Frantzeskaki and Maschmeyer 2016) or transformations towards sustainability more broadly (Scoones et al. 2020), the prolific reference to terms connected with ideas that connote fundamental departures from the status quo could be understood as a positive development. However, there are always questions about what constitutes a transition according to whom (Feola 2015). When one talks about *transition*, it is highly contested what is meant in terms of what changes and what remains the same once this transition has taken place. Taking the variety of images and ideas evoked under the banner of *mobility transition* (see 3.1)—as one example and the focus of this paper—makes clear that there is no consensus around what is envisioned under a given *transition*. Rather, those who proclaim to be working towards a transition are in many cases working towards very different and often contradictory political projects.

We argue that because the term gives coherence to a plurality of meanings, providing a veneer of unity among very different and often incommensurable political demands, *transition* can be understood as a *floating signifier* (Laclau 2005). This is not to suggest that *transition* is meaningless or that the work performed in its name in a given context does not matter. On the contrary, we argue contestation around the attempts to fix its meaning is a crucial dimension of the politics of transformation. These issues also have relevance for *urban* transitions (Egermann et al. 2024; Hölscher and Frantzeskaki 2021; Torrens et al. 2021; Wolfram, Frantzeskaki and Maschmeyer 2016). Others have observed that urban areas present unique conditions for enabling or constraining transformation, making them particularly promising spaces for contributing to local and global sustainability (Bulkeley, Castan Broto and Edwards 2014; Hölscher and Frantzeskaki 2021). This is reflected in the abundance of visions and imaginaries for the future of urban areas in circulation (de Jong et al. 2015). However, as Torrens et al. (2021, 104) argue, the prevailing "visions and imaginaries informing governance deserve further scrutiny. Dominant imaginaries of smart, healthy, circular cities are not bridging the sustainability gap".

To provide such further scrutiny, the paper has two main objectives. Firstly, it aims to demonstrate the utility of looking at prevailing (urban) imaginaries of transformation through the lens of the floating signifier. There is increasing academic attention paid towards understanding the co-production of socio-technical imaginaries (STI) shaping—and being shaped by—action in the present (Jasanoff and Kim 2015; Kuchler and Stigson 2024). This perspective emphasises the role of desired imagined future states of affair that prevail and influence action in the present. Yet, as we argue below, the application of STI can gloss over differences, tensions, and conflicts. The floating signifier as a concept can help bring these tensions to the fore. Secondly, it investigates the plurality of associations with *transition* by focusing on imagined mobility futures in one urban context. We use Q method (Brown 1993; Sneegas et al. 2021) to investigate inter-subjective

associations regarding the future of urban mobility among professionals working on urban and transportation development in the city of Hamburg, Germany.

In the following sections, we first demonstrate the plurality of imagined mobility futures currently in circulation. These futures, while more or less compatible with one another, all align with an imagined post-mobility-transition scenario. They also vary in their compatibility with the prevailing regime of automobility, which continues to shape the material, institutional, and cultural realities inherited from the past (Böhm et al. 2006; Sheller and Urry 2000). While imagined mobility futures can coexist in abstract form, not all can be materialised within the same urban space. Given these inherent trade-offs, we argue that examining imagined futures through the lens of the floating signifier helps to surface underlying antagonisms.

We then introduce Q method, which we used to investigate imagined mobility futures in the city of Hamburg. This application enabled us to identify three imagined urban mobility futures, which are outlined and contrasted in the section that follows. Finally, the discussion reflects on our findings in terms of the role of imagined futures and floating signifiers in urban governance. We argue that floating signifiers perform an important coordinating function in governance but remain inherently susceptible to capture. Therefore, rather than assuming their benevolence (or malevolence), it can be productive to examine what associations prevail with the signifier amongst particular groups, the activities carried out in their name and the chains of associated meaning that are built and broken over time instead of treating the signifier as essentially fixed.

Background

Mobility transition imaginaries: plural and contested

Recent years have seen a growth in academic interest in socio-technical and broader forms of imaginary in terms of their role in transformative change (Kuchler and Stigson 2024; Rudek 2022). The notion of socio-technical imaginaries (STIs) accounts for how these "collectively held and performed visions of desirable futures" influence socio-technical developments by informing decision-making, coordinating action, and allocating funding, etc (Jasanoff 2015, 4). STIs are not merely normative abstractions; they also encompass the materialities through which desirable futures are performed and enacted (Jasanoff 2015). Considering socio-technical change through the lens of STIs highlights that values, understandings, and interests are in a constant process of co-production with prevailing institutions, technologies, and materialities (Jasanoff 2015; Stirling et al. 2023).

Imaginaries are shaped by rival political forces. The definition above might lead to the presumption of a "consensus vision" among all within a given context. Indeed, the STI concept is often applied at the nation-state level and to compare multiple STIs across contexts to demonstrate their role in explaining differences (Rudek 2022). While such applications can give STIs a monothetic appearance, it is broadly understood that "multiple imaginaries can coexist within a society in tension or in a productive dialectical relationship" (Jasanoff 2015, 4). This is evidenced by the conceptualisation of "dominant" alongside "alternative" imaginaries (Delina 2018; Longhurst and Chilvers 2019; Rudek 2022). This contestation means "it often falls to legislatures, courts, the media, or other institutions of power to elevate some imagined futures above others, according them a dominant position for policy purposes" (Jasanoff 2015, 4). The conception of STIs as

plural and contested or monothetic is also a product of the techniques used to investigate them (Stirling et al. 2023).

The plural and contested nature of imaginaries can be demonstrated by examining diverse conceptualisations of imagined mobility futures. Manderscheid (2020) differentiates between three interrelated possible manifestations of transition in the transport sector. The first, drivetrain transition[1] (*Antriebswende*), would replace internal combustion engines with alternative propulsion technologies. The second, modal transition (*Verkehrswende*), envisions a broader shift in transport modes, encouraging the replacement of car trips with more sustainable options, such as cycling or public transport. The third, mobility transition (*Mobilitätswende*), involves transformative changes in mobility patterns, including the creation of conditions that allow people to be less mobile.

Imagined mobility futures are also intertwined with hype, hope, and fear about "promising" technological developments. Through the convergence of automation, electrification, and digitisation, a dominant high-tech imaginary referred to as connected and automated vehicles (CAV) has emerged (Dangschat and Stickler 2023). This imaginary is somewhat empty and susceptible to highly utopian and dystopian interpretations (Cugurullo et al. 2021). Images of clean, efficient, seamless, comfortable, accident-free, and socially inclusive car (or shuttle) travel are propagated through diverse media (Braun and Randell 2022). Mobility can be imagined as a service that is affordable and accessible to all. With "zero-emission" vehicles and intelligent traffic management, the air is clean and congestion is a relic of the past. On the more dystopian end of the CAV imaginary, automation is imagined to worsen urban sprawl and exacerbate transport justice issues (Dianin, Ravazzoli and Hauger 2021). Lower commuting costs are anticipated to encourage longer car commutes, increasing congestion and undermining AVs' potential efficiency benefits and fostering a modal shift away from public and active transport (Milakis, van Arem and van Wee 2017).

Urban mobility futures must compete not only with each other but also with the material, institutional, and cultural realities inherited from the past which are highly spatially specific. Braun and Randell (2022) argue that automobility itself can be considered an imaginary: "The automobility imaginary is an imaginary that is oriented not toward the future but is a singular and enduring imaginary located in a continuous present composed of past, present, and future. It is an imaginary composed not only of discourses, representations, images and visions but also the ostensible materiality of automobility" (Braun and Randell 2022, 2). There is little doubt that this automobility imaginary is a central reason for the "closure of political non-car mobility imaginaries" (Cox 2023, 265). Also, why for some it "remains easier to imagine the end of the world than the end of the expressway" (Jones and T 2022, 19).

What these contributions make clear is that urban mobility transition imaginaries are plural and highly contested (also see Nikolaeva et al. 2019; Schwanen 2021). There are also clear mutual incompatibilities: a transition that is largely limited to substituting vehicle drivetrains is not compatible with the deep socio-technical reconfiguration

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[1] Others translate '–wende' with 'turn-around' which may sometimes be more appropriate than 'transition'. In reference to fundamental change in transportation systems, traffic or mobility 'turnaround' is not a term often referred to in the English academic or practice discourses. Therefore, we consider transport or mobility 'transition' to be a more suitable translation. Furthermore, we consider all three (–*wende, transition,* and *turn-around*) to have the same 'floating' function in both languages and being equally ambiguous as they all depict some sort of divergence from the status quo without defining precisely what that might entail.

imagined with a transition that allows less movement overall, as well as slower, softer, safer, and more sustainable forms of mobility. A "just" mobility transition is not compatible with the prevailing and inherent injustices of automobility (Sheller 2018).

While different imagined mobility futures can coexist in an abstracted form, they cannot all be materialised in the same space. The abstract imaginaries described above become more complex and contested when considered as enmeshed with local spatial realities. The prevailing socio-technical configurations that constitute urban mobility differ significantly across space (Prieto-Curiel and Ospina 2024). How global imaginaries are translated into local contexts and how they manifest will, therefore, vary between urban areas (Fratini, Georg and Jørgensen 2019). Likewise, manifestations of localised place-making can also be highly context-specific. Hoffman et al. (2021) demonstrate that effective transformative change is not only the product of the work of actors in re-imagining but also of the work that follows in re-coding institutions and reconfiguring materialities in a given context. Re-imagining is just one contested step along the journey towards reconfiguring urban space, with trade-offs becoming more apparent along the way.

Transition as a floating signifier

To appreciate these trade-offs and the contested nature of imagined transitions, we argue that it is helpful to consider transition as a floating signifier. According to this perspective, words have two dimensions: the *signifier* (their form, e.g., written or spoken) and the *signified* (their meaning), with the links between them contingent and shaped by social construction (de Saussure 2006). The spaces between signifier and signified can be understood as central sites of political contestation (Gunder and Hillier 2016; Laclau 1990, 2005).

Laclau (2005) differentiates between *empty* and *floating* signifiers: "The first [empty signifier] concerns the construction of a popular identity once the presence of a stable frontier is taken for granted; the second [floating signifier] tries conceptually to apprehend the logic of the displacements of that frontier" (2005, 133). Empty signifiers are characterised by being devoid of concrete meaning and can be understood as representational forms that encapsulate, "quilt" or fix a meaning around a plurality of different identities and political demands in *opposition* to a rival political project. Empty signifiers thus can obscure differences in specific political demands, establishing a unified identity (even though this is never complete). Floating signifiers are comparably unfixed and constitute central linguistic links *across* dichotomic frontiers (Laclau 2005). They are not empty but rather *overflowing* with meaning, with competing groups trying to fix their meaning. While a case could be made that (urban mobility) *transition* can also perform the function of an empty signifier, given the abundance of ongoing work to fix its meaning from opposing political projects, we treat transition as a floating signifier.

So, a floating signifier gives coherence to a range of different meanings, providing a veneer of agreement among (at times) contradictory perspectives. For those interested in transformation, floating signifiers provide an important coordination mechanism, unifying potentially divergent demands under a common banner. However, when the mutual incompatibility of multiple discourses becomes apparent, antagonism emerges: "when the presence of one prevents the other from constituting itself as an objective reality" (Brown 2016, 118). A central process through which opposing sides gain or lose

discursive ground is through signification: "The creation of a hegemonic discourse is the result of complex struggles in which opposed political forces ('discourse coalitions' or 'hegemonic projects') each seek to 'universalize' their particular storylines and interests. This is accomplished by articulating a common discourse that can win the support of affected parties while securing the compliance of others" (Griggs et al. 2017, 37).

We argue that these struggles play an important role in the shaping of imaginaries which—as argued above—is an important dimension of the politics of transformation. Considering *transition* through the lens of the floating signifier allows for closer examination of discursive frontiers between imaginaries: to bring the contestation to the fore. It is to appreciate that transitions are constantly shaped by opposing political projects, with some projects more successful in this shaping than others. Previous contributions have demonstrated the usefulness of considering socio-technical change through the lens of the floating (or empty) signifier in revealing under-appreciated political dynamics at play in the making around terms loaded with promise (e.g., Brown 2016; Sihlongonyane 2015; Ertelt and Hawxwell 2025), also specifically connected to the urban scale (e.g., Davidson 2010; Griggs et al. 2017; Gunder and Hillier 2016). We add *transition* to the list of such terms and make an attempt to interrogate its meaning in relation to mobility in one urban context.

Interrogating imagined futures through Q method

Q method is an approach that combines qualitative interpretation with quantitative factor analysis to study subjectivity by identifying shared patterns in how people rank-order a set of statements about a topic. This approach has been used to map subjectivities around various topics, facilitating the exploration of diverse viewpoints (Brown 1993; Sneegas et al. 2021). It has specially been demonstrated as an effective means to inquire into transition imaginaries (Cairns et al. 2022). The process typically involves defining a concourse (a full range of ideas or opinions on a given topic), selecting a subset of statements (Q-set), and having participants (P-set) sort these statements according to structured instructions to reveal patterns in their perspectives (Brown 1993).

Applications of Q method can often have a strong *pragmatic* orientation. This view sees Q method as a tool to identify points of tension and overlaps in the opinions of individuals and groups as a step in reconciling conflicting goals and identifying optimal solutions. Beyond such pragmatic applications, Q method can also be deployed to *pluralise*: to open up complexity rather than seek an optimal solution. Examples include mapping different understandings around notions such as "sustainability" (Barry and Proops 1999; Griggs et al. 2017; Cairns et al. 2022) or bringing marginalised perspectives to the fore on a particular topic (Milakis, Kroesen and van Wee 2018). Compared with pragmatic counterparts, these pluralistic approaches are not typically deployed with the explicit purpose of overcoming conflicting viewpoints as much as they seek to reveal them. If deployed to open up the array of imagined futures in a particular context and pluralise, Q method can be a helpful tool to interrogate and pluralise often assumed monothetic notions such as *transition* (Stirling et al. 2023).

Whether a given application tends more towards the pragmatic or the pluralising is the product of the methodological design. A common approach to developing a credible concourse, P-set, and Q-set is to ensure that as many viewpoints as possible are considered. Therefore, the focus is on input legitimacy, which can be an effective strategy.

However, when considering that a typical Q-set to be sorted consists of 35–40 statements by an average of around 40 participants (P-set) (Sneegas et al. 2021), the limits regarding how much complexity can be built into such an approach become obvious. Furthermore, there is a tendency when engaging with (mobility) futures to draw disproportionately on the perspectives of actors already embedded in the incumbent system while perhaps integrating a few critical voices for good measure (Hawxwell, Hendriks and Späth 2024).

Hence, we apply a different strategy. To ensure a balanced spectrum of imagined urban futures, we draw on two interdependent archetypal imagined mobility futures, which can be understood as building a discursive frontier. The first represents the reproduction and extrapolation and/or mutation of the prevailing automobility regime (Böhm et al. 2006) into the future. The second is a future developed as a counterpoint to the dominant automobility imaginary: autonomobility (Cass and Manderscheid 2018; Manderscheid and Cass 2022). This mobility future was developed in response to an observed tendency among attempts to imagine (and make) alternative mobility futures to reproduce the underlying problems of automobility (also see Bergman, Schwanen and Sovacool 2017; Haarstad et al. 2022). There is a tendency to "ignore systemic issues, the increasing compulsions to travel, social injustices, and freedom constraints" (Cass and Manderscheid 2018, 102). Rather than address these underlying problems, it is often assumed that tinkering with the artefact can solve the problems of automobility with no significant changes to its cultural and economic foundations. Autonomobility questions these foundations. It does not simply negate automobility; rather, it offers a positive vision for an alternative mobility system that challenges the underlying logics and assumptions that power the reproduction of automobility. The negation is a pivot towards a utopian ideal.

These two rival imaginaries—automobility and autonomobility—present an opportunity to consider possible and desirable mobility futures from different vantage points. They are deliberately unclear, archetypal, and relational to invite contextualisation into different spatial and institutional arrangements. At each pole of a hypothetical spectrum is not a particular technology, but a set of assumptions, priorities, logics, and ways of understanding movement (see Table 1). These two concepts played a role in the development of the concourse and Q set. The goal was to compile the set of statements for

Table 1 Underlying assumptions, priorities and values associated with automobility and autonomobility respectively (developed by the authors, inspired by Cass and Manderscheid (2018) and Sheller (2018))

	Automobility	**Autonomobility**
Speed and safety	Speed over safety	Safety over speed
Transport induced death and injury	Seen as collateral damage	Seen as unacceptable
Commodification	Profit over access	Access over profit
Ownership	Private over public/collective	Public/collective over private
Freedom	Freedom to over freedom from	Freedom from over freedom to
Limits in focus	Political expediency, user and incumbent actor acceptance	Ecological limits, human health and wellbeing, physical space
Valued types of movement	Automated movement over human movement	Human movement over automated movement
Growth model	Expansion over sufficiency	Sufficiency over expansion
Urban space exclusively for moving goods and people	Remains the same or grows	Declines
Urban development paradigm	Vehicle-centric	(more than) Human-centric
Prevailing political-economic arrangements	Unquestioned	Questioned

participants to sort, ensuring a balanced representation of perspectives that, in the authors' interpretation, reflect the sentiments underpinning both automobility and autonomobility in somewhat equal terms.

Case: mobility futures in Hamburg

We investigate imagined futures among professionals involved in urban and mobility planning in Hamburg, Germany. As the country's second-largest city, Hamburg had nearly 1.9 million residents in 2023, expanding to 5.4 million with its metropolitan area (FHH 2023). The city's port has shaped its physical, economic, and cultural landscape (Lieber 2018), often creating conflicts with sustainability goals (Bauriedl and Wissen 2002). As both a city and a state, there is more direct influence over institutional changes, making locally imagined futures particularly important. The city council has committed to a "mobility transition", reflected in a renaming of the transportation department and a reframing of the urban mobility plan as a Strategy for the Mobility Transition (*Strategie Mobilitätswende* (FHH 2023)). In recent years, the city has seen significant increases in cycling and a growing number of initiatives to reclaim urban spaces from cars (Hawxwell 2025). Hamburg is also seen as a leader in smart mobility and ITS projects (Späth and Knieling 2020), hosting the ITS World Conference in 2021 and committing to be at the forefront of developments around autonomous mobility.

Statements for the concourse were sourced from various materials, including parliamentary debates, newspaper articles, strategic documents, city mobility council protocols, and stakeholder interviews, resulting in 333 initial quotes. These were refined to a final Q-set of 33 statements inductively, trying to achieve thematic balance (focal technologies, priorities, governance instruments, etc.) and equal representation of statements that seemed to reflect the sentiments of automobility and autonomobility, respectively. The participants[2], 46 professionals (27 male, 18 female, and 1 undisclosed) involved in urban development and transportation planning in Hamburg, ranked the statements using an online Q-sorting tool based on a predefined distribution from "more in disagreement" to "more in agreement". The organisations involved in the city's Mobility Advisory Council (*Mobilitätsbeirat*) were the primary orientation for identifying participants. This institutionalised body is designed to facilitate exchange between politics, administration, business, science, and associations around the long-term planning of urban mobility in the city. All organisations represented in the council were contacted and invited to participate. Although not all participated, participants covered a broad spectrum of political factors and vested interests. Unlike a survey, the proportion of participants does not need to be representative of a broader context because the method is concerned with capturing the diversity of discourses and revealing patterns of subjectivity, rather than measuring the distribution of opinions. Instructions and a control survey ensured reliability and addressed any sorting issues. Factors were generated using Ken-Q software (CFA with varimax rotation), identifying three factors. Factors represent shared viewpoints or perspectives that emerge from the analysis of participants' Q-sorts (i.e., their ranked statements). Additional extraction methods and rotation techniques were tested for triangulation. The narratives below we term "imagined

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[2] Department for Transport and Mobility Transition (18), Other Public Administration Bodies (8), Political Parties (5), Environmental NGOs (4), Other NGOs (1), Business Associations (2), Research Organisations (2), Municipal Companies/Public Service Providers (2), Planning Offices/Consultancies (4).

futures" were developed inductively through comparing the statement scores across the factors, forming the basis for storylines (see Table 2 in annex).

Three imagined mobility futures for Hamburg

Through the analysis, three distinct imagined futures were identified. We introduce these one by one and make reference to the respective statements from the Q method outputs when appropriate (see Table 2 in annex).

Low-tech transform

This imagined future foresees the need for fundamental changes to Hamburg's transportation system. A mobility transition requires a significant reconfiguration of transport infrastructure and public spaces and deeper changes in residents' daily mobility practices. Car ownership and use is significantly reduced to liberate space for alternative modes like cycling and public transport and to serve other important urban functions (16). According to this view, there are apparent conflicts between optimising car traffic and achieving the goals of a true mobility transition. Technological solutions like smart traffic management can be helpful. However, if they are not explicitly designed to reduce car use, could exacerbate the problem (2, 6). There is also a preference here for movement on foot, cycling and more conventional forms of public transportation (19). Specifically, the (re)introduction of the city's light-rail system (24). To achieve this transformation, the city needs to introduce measures that liberate space currently dominated by cars. This includes significantly increasing parking fees (27), establishing low-car and car-free zones, and implementing appropriate speed limits (4).

Incremental tinkering

This imagined future foresees the preservation and gradual improvement of the existing transport system, rather than radical changes. The belief here is that all modes of transport—cars, public transport, cycling, and walking—can be improved simultaneously to meet the diverse needs of the population (12). Changes that have taken place recently under the banner of mobility transition are perceived as radical and polarising (15). Because people who own cars generally need them, interventions to reduce car traffic are an unnecessary and unjust burden on citizens (5, 7). There is therefore a general opposition to speed limits (4), higher parking fees (27), low-car and car free areas (17), and generally reducing the space devoted to transportation (16). Such interventions also threaten the economic foundations upon which the city maintains its high quality of life (31, 4). The focus should be on improving current infrastructure through smarter management and infrastructural upgrades. This includes measures like enhancing traffic flow with intelligent traffic control systems (2), expanding capacity on main roads to draw traffic away from residential areas (14), and improving parking management (6). The best chance to encourage modal shift is seen in the ambitious "Five-Minute Promise" (Hamburg-Takt), which is envisioned to significantly improve the accessibility, frequency and reliability of public transport (33).

High-tech reform

This imagined future foresees a "High-Tech, Low-Car" future, where electric vehicles and autonomous on-demand shuttles are important dimensions of the future system

(11). These technologies could reduce the need for private cars while maintaining mobility and convenience (5). Despite the importance of such innovations, conventional soft modes like cycling remain important. Innovations that draw drivers of conventional into electric vehicles would be a significant improvement (1). Because people who own cars are dependent on them, real alternatives need to be created to induce behavioural shift, and technological innovation can help fill this gap (5). This will not happen automatically but will require a smart mix of both push and pull measures. Car ownership and driving does need to be made less attractive (19, 17). However, the alternatives to car ownership should be made significantly more attractive. This includes the holistic integration of alternative transport modes (public transport, cycling, sharing offers) into a more seamless system (8) and making electric vehicle charging stations widely available (1). Striking a balance between these approaches will not only mean that we can bring about a transition that is supported by the city's inhabitants (29) but also create opportunities for Hamburg to become a leader in urban mobility solutions (11).

Alignments and misalignments between imagined futures

There appears to be some alignment or at least some shared ambivalences between the imagined futures. Despite uncertainty about the potentials and pitfalls of emerging (autonomous) ride-hailing and on-demand services (23, 11), there is broad scepticism that these will emerge as sustainable and just alternatives if governed solely by market forces (20, 13). Furthermore, there is shared optimism regarding the potential of car-sharing, and the developments thus far are seen as largely positive (26). There also appears to be (largely) shared ambivalence around the question of traffic concentration (14). Should traffic be concentrated and optimised on a few selected major thoroughfares to ease pressure on more residential areas? Or are these major thoroughfares themselves residential enough to warrant their own traffic calming measures? Moreover, there is widespread recognition of the limitations inherent in simply creating off-street parking facilities, suggesting that a significant absolute reduction in parking will be necessary if space is to be liberated from cars in a growing city (9). Additionally, although not all agree that "vision zero" should be *the* main objective, there seems to be a shared understanding that the current mobility system induces too much death and injury (25).

There are also significant misalignments between the imagined futures. Obvious differences can be identified between *Incremental Tinkering* and the other two futures. Most notably, while the former does not envision a fundamental questioning of the status quo, the latter two see questioning the hegemonic position of the car in its current form as both possible and desirable. Yet there are also important differences between *Low-tech Transform* and *High-tech Reform*. Most significantly, there seem to be differing assumptions about technology's potential to address the comfort and convenience gap created when the personal car is removed from an imagined future arrangement. *High-tech Reform* appears more optimistic, albeit aware that this will not happen automatically. As with *Low-tech Transform*, creating powerful incentives to discourage car ownership and use is necessary to realise desirable outcomes.

Discussion

In this section we reflect on the findings in terms of the role of imagined futures in shaping urban development and connect these insights back to the concept of the floating signifier. The results reveal marked divergences in opinion and belief about what a mobility transition in Hamburg can and should deliver. This is despite participants of the study already engaging with imagined mobility futures that are not purely abstract but deeply entangled with the spatial realities of their everyday professional work—work that inevitably includes regular confrontations with the "impossible". Even in Hamburg, where an official strategy for the mobility transition has been published—a strategy one might expect to align imaginaries and translate particular elements of mobility futures into concrete expectations while excluding others—significant differences in perspective remain.

While vested interests undoubtably play a role in these differences, the situation is more complex. There is significant variation not only between but also within organisations (see Table 3 in annex). Even within organisations that would not be expected to have a clear vested interest in one mobility future over another. This indicates that the coalitions forming around particular agendas can be less driven by rational interests and more by deeper ideological forces (see Hajer 1995). The imagined futures can also be understood as embedded in broader discourses that extend far beyond the topic of day-to-day movement of goods and people. Each of the introduced imagined futures are underpinned by their own value structures and assumptions around priorities, limitations, and (im)possibilities. This demonstrates that debates about the future of urban mobility transcend technocratic or managerial questions about how best to facilitate the movement of people and goods in the most environmentally efficient way. Rather, such debates can represent a microcosm of broader societal contestation about values and priorities around (urban) development.

Despite the significant misalignments between imagined futures, these futures seem to be able to maintain their performativity independently of each other, apparently shaping action in the present at different times, in different spaces, and to varying extents. A pure version of one or the other is unlikely to emerge as the unrivalled victor, manifested in the configurations determining movement. Rather, one might suspect traces of each imagined future captured in urban space, with one or the other "winning the day" in the negotiations over priorities constantly occurring in the messy day-to-day of urban development. One might also expect thicker layers of urban development where these traces are particularly reminiscent of one imagined future because of a ruling party forcing an artificial alignment of a particular imagined future through top-down pressures. However, the remarkable variation in plausible and desirable futures among the participants in this study suggests that these individuals are engaged in ideological contestations in their everyday work, the outcomes of which have significant implications for the types of urban areas inhabitants have to enjoy or tolerate in the future.

The outcomes also highlight the relational nature of such imagined futures: each is defined largely in relation to others. To give some examples, more techno-optimistic beliefs are likely fostered in response to the challenges associated with the interventions necessary according to the more low-tech future: reducing car-dominated space in urban areas is not typically an easy political endeavour. This might lead some to believe that it is more plausible to substitute the convenience of the car with technological

innovation than to negotiate such difficult political terrain. The *Low-tech Transform* imagined future likely prevails at least partly in response to years of unfulfilled techno-optimistic promises (Hawxwell 2025).

Floating signifiers in (urban) governance: between coordination and capture

It is interesting to note that despite the fundamental differences between the imagined futures in terms of content, each could be plausibly argued as fundamental reorganisations of a system of provision: i.e. as a "transition". A possible exception could be the imagined future titled *Incremental Tinkering.* For some, the term "incremental" might suggest the antonym of transition. Yet the drive-train transition imaginary (see 3.1) that underpins this imagined future would likely constitute a fundamental reorganisation of the supply side in the transport sector, which could be argued to constitute a "fundamental reorganisation". Nevertheless, these very different imagined mobility futures can maintain association with the same transition signifier.

These findings demonstrate the important coordination function that floating signifiers play in processes of socio-technical change. The case demonstrates a broad spectrum of specific demands (safety, overcoming congestion, improved health, liveability, business opportunities, economic growth, freedom, environmental protection, etc.) connected through chains of equivalence and united under the banner of *mobility transition.* This makes it possible for actors with different agendas and underlying value preferences to (at least appear to) be working towards the same ends. However, through this process, individual demands can be weakened as they are distorted into a collective whole that appears to be a stable and closed identity but is actually fractured (Laclau 2014). The longer these chains of equivalence become, the more diluted the individual demands, and the more powerful the uniting whole must be to maintain coherence (Laclau 2014).

Rather than viewing this as a problem, it can be understood as a fundamental condition of the politics of socio-technical change. Floating signifiers have a productive coordination function, uniting divergent interests around a common vision without precisely determining its content (Brown 2016). That the term *transition* has become commonplace in Hamburg signals that the discussion is not just about whether to fundamentally change the transportation system but how these changes should manifest. This mainstreaming can be beneficial (and perhaps necessary) for the political project(s) through which the signifier originated (Pel 2016).

Yet, there is no reason to suggest that the post-transition arrangement will be any better (and not worse) than the present, regardless of the normative lens that may be used to judge this. The moment a signifier (such as *transition*) is adopted by the incumbent arrangements also marks the moment those incumbent arrangements begin to mould its meaning. This can lead to the co-optation of potentially transformative ideas, which is argued to be a central mechanism that undermines deeper forms of socio-technical change (Simoens, Fuenfschilling and Leipold 2022; Späth, Rohracher and von Radecki 2016).

Insights from the Hamburg case demonstrate a kind of emergent co-optation of the pressures for transformation through techno-optimistic imaginaries. Others have observed that developments occurring under the banner of *smart mobility* tend to reinforce and reproduce automobility rather than fostering any real alternative (Freudendal-Pedersen, Kesselring and Servou 2019). The *High-Tech Reform* imagined future appears
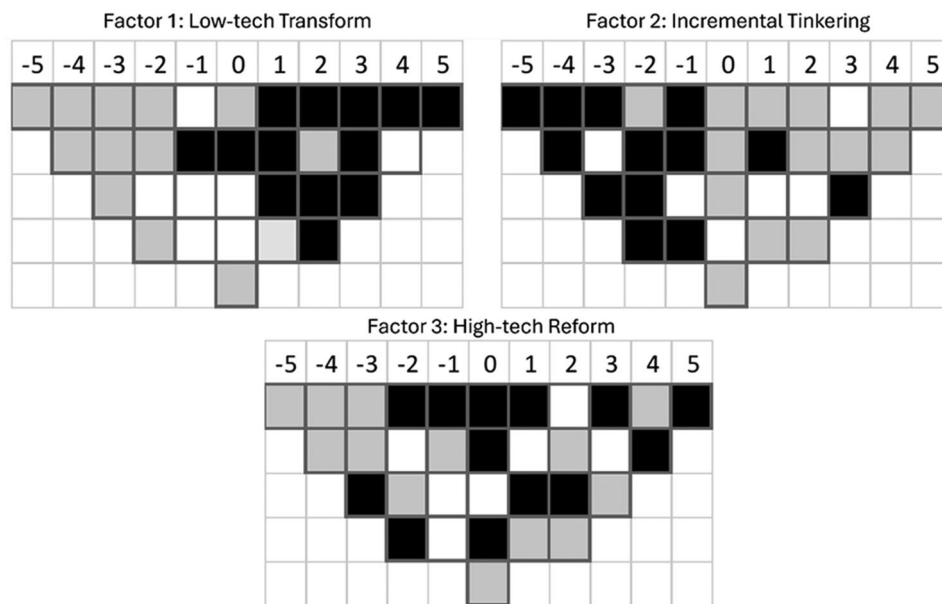
Fig. 1 Factor structures according to statements reflecting automobility (grey) and autonomobility (black) sentiments. White boxes reflect statements that are deemed compatible with both automobility and autonomobility

to ride the wave of transformative spirit, foreseeing fundamental changes in the mobility system, but still reproduces certain automobility logics and impossibilities. This emergent co-optation is illustrated in Fig. 1, which depicts the different factor sort structures with statements marked according to whether they reflect automobility or autonomobility sentiments. While the distribution of sentiments is clearly divided between the other two imagined futures—with autonomobility aligning closely with the *Low-tech Transform* and automobility aligning closely with the *Incremental Tinkering* future—the *High-tech Reform* future presents a more mixed picture, still reinforcing particular assumptions associated with automobility. For example, there seems to be a comparative discounting of environmental and social costs embedded in the production and use of electric vehicles (28 – Table 2 in annex), loose interpretations of what it means to "need" a car, and the assumption that the convenience and comfort of the car can and should be replicated without questioning the desirability of this (5 – Table 2 in annex).

Conclusions

This research aimed to interrogate the meanings attached to a notion loaded with promise for a better world. Like the many promising signifiers that have come before it, *transition* as a signifier is susceptible to being connected with a variety of different meanings from a variety of (at times contradictory and antagonistic) political projects. We demonstrated this by investigating imagined futures around urban mobility in an urban context where a *mobility transition* has begun to be broadly articulated as expectation rather than pure hope or aspiration.

We used Q method to investigate the inter-subjective associations between actors working on the future of urban mobility in their day-to-day work in Hamburg. In light of a tendency among those engaged in future-making practices to reproduce the very logics and assumptions of the systems they seek to transform (Hawxwell, Hendriks and Späth 2024), we built in a mechanism to systematically counter this tendency. Through

populating the array of statements to be sorted by participants with a balance of sentiments that reflect both automobility and autonomobility-two inherently antagonistic and incommensurable imaginaries—we could work against the tendency of reproducing assumptions embedded in the imaginaries inherited from the past when we engage with the future. The approach allowed the (albeit modest) questioning of the rarely questioned truths underpinning automobility while remaining accessible to actors embedded in the system rather than limiting such attempts at imagining fundamentally differently to more "vanguard" or "niche" future-making practices. Without downplaying the importance of creativity in conceiving different techniques for engaging with the future, we see potential in constantly tinkering with existing approaches to futuring to integrate a more critical orientation.

The research demonstrates the plurality of imagined urban mobility futures and the relational, often antagonistic, relationship between them. The three imagined futures may not be surprising to some. We might expect similar outcomes in similar urban contexts, including those where the term transition has not been formally embraced. However, the approach has proved an effective means to investigate how these different imaginaries are articulated locally and the important lines of contestation between them. It provided insights into the extent to which and how these imagined futures are dispersed and embedded among organisations that are currently playing a central role in realising the mobility system of tomorrow in this context. These tensions arise not only from divergent views about what can or should happen in the future but also from an enduring automobility imaginary inherited from the past—manifested in different urban contexts in various ways and to different extents. Considering *transition* through the lens of the floating signifier helped to account for this contestation. Addressing latent incommensurabilities and trade-offs in place-specific debates about particular sustainability transitions—unpacking what a floating signifier is meant to disguise—can be a helpful way to account for the politics underpinning the processes of socio-technical change.

In terms of broader implications for research engaging with urban transformation, conceptual disambiguation remains an important academic exercise. The work of scholars pluralising associations with mobility transition offers an important starting point for thinking about difference and chains of equivalence (see e.g. Manderscheid 2020; Nikolaeva et al. 2019; Schwanen 2021; Temenos et al. 2017). Yet, the connections between signifier and signified are also forged outside academic settings. Beyond disambiguation, it can be productive to pay more critical attention to the types of imagined futures and the institutional and material changes made under the banner of such signifiers that promise positive change, rather than assuming their benevolence. Additionally, it is important to investigate how chains of equivalence are built and broken under the banner of other such terms, rather than assuming an essential meaning. Reflexivity requires acknowledgment that academic work is not just observing the battle over such floating signifiers but is also engaged in it. This means recognising that attempts at bringing about a "green transition" can tend to discount and outsource the social and environmental costs beyond the spaces for which the "sustainable" futures are being imagined (Deberdt and Le Billon 2024). Such reflexivity is a necessary prerequisite to give a promised transition the best chance of becoming part of an emancipatory project, rather than another mechanism of status-quo reproduction.

Annex

Table 2 Sorted Q-statements (own translation) with their factor scores for each extracted factor. Each factor (F1, F2 and F3) represents a shared way of ranking the statements. These were interpreted and developed into narratives that articulate distinct perspectives (see section "Three imagined mobility futures for Hamburg"). Factor scores indicate the normalised position of each statement within a factor array, showing how strongly it is ranked for that factor. Positive values signal stronger agreement or salience, negative values reflect stronger disagreement, and values near zero suggest relative neutrality. "The column 'var.' in reports the communalities (explained variance) for each statement across the three retained factors. These values indicate how much of the variability in participants' rankings of a given statement is captured by the factor

Nm	Statement	F1	F2	F3	Var.
19	Getting around on foot, by bike or by public transport should be easy, safe and convenient. At the same time, driving should be less comfortable and slower, and owning a car less attractive.	3	−5	5	2,896
27	Resident parking fees in densely populated areas with good transport alternatives should be at least between 300 and 600 euros per year to adequately reflect the use of public space.	3	−4	2	2,242
4	The introduction of 30 km/h (instead of 50 km/h) as the standard speed in Hamburg poses a threat to maintaining and safeguarding commercial traffic.	−5	3	−5	1,652
17	Bicycle traffic should have absolute priority within Hamburg Ring 2. Parking within Ring 1 should only be permitted for people with restricted mobility and limited delivery traffic.	2	−4	4	1,481
5	As many people are dependent on their vehicles, we should first create real alternatives before measures are taken to reduce car use.	−3	4	2	1,46
21	The proportion of children who cycle to school is a better indicator of the success of the mobility transition than the proportion of electric vehicles on the roads.	5	−1	−2	1,329
12	The transport debate has often been conducted along the lines of "either or". However, Hamburg needs both an improved public transport and cycling network and a targeted expansion of the road network.	−2	4	−1	1,17
28	E-cars are still cars. When you consider the space they take up and the emissions and resource consumption involved in their manufacture, they are not a truly sustainable alternative to combustion engines.	2	−2	−3	1,013
32	The construction of the A26 highway is a good and important project for improving mobility in Hamburg.	−3	2	−4	1
7	It is unfair to make private car ownership affordable only for the wealthy. Excessive parking fees are not a problem for the rich, but they are for the average user.	−1	3	−1	0,915
24	The phase out of the tram system in Hamburg was a mistake and it still makes sense to consider building a light rail system.	3	−2	−2	0,855
2	Although synchronised traffic lights (green waves) for public transport and cycling are important considerations, solving congestion problems in the city should be a priority.	−4	1	−4	0,753
6	A significant proportion of traffic congestion and the associated emissions are caused by the search for a parking space. Targeted optimisation of parking could improve the situation considerably.	−3	2	−2	0,66
15	The strategy currently being pursued in Hamburg clearly shows that politicians are still under the illusion that a mobility transition is possible without stepping on anyone's toes.	1	−3	0	0,548
29	Change takes time. If we push too hard, we risk backlash. This could jeopardize the progress we have made so far. It is important to drive change at a pace that is supported by the population.	−1	1	3	0,548
31	The port and freight traffic are the economic basis of this city. If we take the risk of jeopardizing the port, we are jeopardizing the basis that makes the quality of life in this city possible.	−2	2	0	0,466
1	If we no longer want to have combustion engines in the city for climate protection reasons, we must promote electro mobility. This means the city-wide expansion of fast-charging stations without a price explosion.	0	0	4	0,447
18	Hamburg could achieve similar or even higher cycling rates than Amsterdam or Copenhagen if massive investment is made in safe and comfortable cycling infrastructure.	2	−1	3	0,413

Table 2 Sorted Q-statements (own translation) with their factor scores for each extracted factor. Each factor (F1, F2 and F3) represents a shared way of ranking the statements. These were interpreted and developed into narratives that articulate distinct perspectives (see section "Three imagined mobility futures for Hamburg"). Factor scores indicate the normalised position of each statement within a factor array, showing how strongly it is ranked for that factor. Positive values signal stronger agreement or salience, negative values reflect stronger disagreement, and values near zero suggest relative neutrality. "The column 'var.' in reports the communalities (explained variance) for each statement across the three retained factors. These values indicate how much of the variability in participants' rankings of a given statement is captured by the factor

Nm	Statement	F1	F2	F3	Var.
33	The key to the mobility transition is the five-minute promise (Hamburg-Takt: a reliable public transport connection within 5 minutes of any location in Hamburg).	2	5	1	0,4
16	"Smart" mobility solutions such as micromobility, charging infrastructure, delivery services and mobility hubs generally lead to a greater appropriation of public space. However, they should aim to systematically reduce the amount of space taken up exclusively by traffic.	1	−3	0	0,398
30	Many have clearly not yet recognised the seriousness of the situation. We need to change the city's transportation system quickly and fundamentally. Paris shows that this can be implemented quickly with the necessary political will.	4	0	2	0,352
25	Vision Zero, the goal of having no deaths or serious injuries on the roads, should be the top priority in transport planning.	4	3	0	0,304
13	It is entirely possible to realize a fair and sustainable mobility system through networked autonomous vehicles, even if a large part of the services and infrastructure were not publicly owned.	−2	−1	0	0,214
11	As soon as autonomous on-demand shuttles reach a critical mass, things will get really exciting. If such mobility services can be operated economically, they could revolutionize urban mobility - not only in Hamburg, but also beyond.	0	0	2	0,202
23	We will never know exactly what impact autonomous on-demand shuttles will have on the mobility system until a critical mass of vehicles is on the road in the city. After this point, it will hardly be possible to abolish these systems.	−1	−2	1	0,194
9	I understand why the number of street parking spaces needs to be reduced. But the cars have to go somewhere. As a rule, the removal of an on-street parking space should be supplemented by the creation of a parking space in a neighbourhood garage.	−2	0	−3	0,188
10	A large part of the traffic problem can be solved by intelligent traffic control and autonomous driving. The majority of traffic jams, emissions and accidents are avoided by electric autonomous vehicles.	−4	−2	−3	0,123
14	If you want to protect residential areas, you have to concentrate traffic on the major arteries and bypasses and maximise efficiency there.	0	2	1	0,121
26	There is excessive optimism about car sharing. In particular, free-floating car sharing often leads to people cycling or taking the train less and using cars more instead, which is a counterproductive development.	−1	−3	−2	0,116
3	It would make sense to design the traffic space to be flexible and open, as developments over the next 20 to 30 years, particularly in the area of autonomous driving, are difficult to predict.	0	0	−1	0,095
8	Hamburg is neither Copenhagen nor Amsterdam. The Hamburg way should be to take a holistic view of the soft modes and public transportation and to network mobility intelligently.	1	1	3	0,095
22	When it comes to mobility, the focus should be less on movement and more on spending time in comfortable, green and attractive public spaces.	0	−1	−1	0,026
20	When you see how ride-hailing systems (e.g. Moia) have established themselves in the city, it becomes clear that the focus is more on business than on mobility. If mobility were the main goal, they would focus on the outlying areas where the need is greater, rather than the already well-served city center.	1	1	1	0,01

Table 3 Factor loadings. The actor types in the table are coded as follows: municipal department for transport and mobility transition (BVM); other public administration (Verwalt); political party (Partei); NGO/Civil society organisation with environmental focus (ENGO); NGO/Civil society organisation with other focus (NGO); company or association of companies (Unterneh); research organisation (Forsch); municipal company or public Service (KomUnt); planning office or consultancy (Berat)

Nm	Q-sort	Factor Group	Factor 1	Factor 2	Factor 3
46	BVM18	F1-1	0.8671	−0.1611	0.0991
36	BVM10	F1-2	0.8096	0.0566	0.2098
2	BVM1	F1-3	0.726	−0.2262	0.0282
25	ENGO3	F1-4	0.7099	−0.2288	0.1896
34	BVM8	F1-5	0.6934	−0.186	0.1612
19	Partei4	F1-6	0.691	−0.029	0.0829
20	Forsch1	F1-7	0.6858	−0.1451	0.1636
24	Forsch2	F1-8	0.6517	−0.5994	0.1125
17	ENGO1	F1-9	0.6469	−0.3301	0.1505
11	Berat2	F1-10	0.6314	−0.3151	0.151
31	BVM5	F1-11	0.6243	0.1348	−0.0913
39	BVM13	F1-12	0.6238	−0.2064	0.1915
32	BVM6	F1-13	−0.612	0.4097	−0.1006
10	Berat1	F1-14	0.6088	−0.4594	0.245
35	BVM9	F1-15	0.6034	−0.0842	0.2486
27	ENGO4	F1-16	0.5991	−0.4258	0.1042
23	Berat4	F1-17	0.5902	−0.2879	0.2101
30	BVM4	F1-18	0.5536	0.1275	0.1674
5	BVM2	F1-19	0.5422	−0.1101	0.3189
9	Verwalt3	F1-20	0.5023	−0.1797	0.1065
3	Verwalt7	F1-21	0.4971	−0.3449	0.1066
45	Verwalt6	F1-22	0.4807	−0.3412	0.3376
1	Partei1	F1-23	0.48	0.014	0.05
14	Berat3	F1-24	0.4181	0.257	0.4118
21	NGO1	F2-1	−0.3563	0.7152	−0.2218
15	Partei3	F2-2	−0.1085	0.7116	0.2063
38	BVM12	F2-3	0.2319	−0.6837	−0.0046
40	BVM14	F2-4	0.3481	0.6213	−0.0984
29	BVM3	F2-5	−0.151	0.5611	−0.3688
16	Unterneh1	F2-6	−0.2034	0.4282	−0.0296
26	Unterneh2	F2-7	−0.3282	0.4231	0.3118
4	Verwalt8	F2-8	0.3217	0.4027	−0.0821
12	Verwalt4	F2-9	0.0287	−0.308	−0.1212
44	BVM17	F2-10	−0.0148	0.2447	0.2027
6	Verwalt2	F2-11	0.1127	−0.2301	0.0258
13	Verwalt5	F2-12	−0.1088	0.1671	−0.0453
22	KomUnt2	F3-1	−0.0063	0.0544	0.6993
28	Verwalt1	F3-2	0.2439	0.2197	0.6498
7	Partei2	F3-3	0.2882	−0.1415	0.6178
33	BVM7	F3-4	0.5116	−0.2664	0.5999
41	Partei5	F3-5	0.3965	−0.361	0.4699
42	BVM15	F3-6	0.1184	0.0188	0.4528
43	BVM16	F3-7	0.0337	0.3254	0.4246
8	KomUnt1	F3-8	0.2502	−0.023	0.3394
18	ENGO2	F3-9	0.1077	−0.2073	0.3108
37	BVM11	F3-10	−0.0028	0.1249	−0.1669

Declarations

Competing interests
The authors declare no competing interests.

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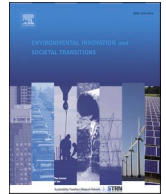
Publisher's Note

7.4 The polysemous nature of the German Verkehrswende: Exploring the role of floating signifiers in shaping mobility futures

Research article

The polysemous nature of the German Verkehrswende—Exploring the role of floating signifiers in shaping mobility futures

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ABSTRACT

The German transportation sector's negative contribution to climate change amongst broader social, environmental, and economic problems is applying evermore pressure to the prevailing automobility regime to bring about its transformation. However, the vision of this transition, referred to as the *Verkehrswende* or *Mobilitätswende*, is highly contested, with varying conceptions of different actors about the future of mobility in Germany. A discourse network analysis (DNA) is performed to examine the development of the related policy debate, identify key problem and solution framings and analyse the overall discourse evolution from 2018 to mid-2023. The findings highlight how recent exogenous events shape and reframe the discourse, inciting debates around viable mobility futures. Further, our analysis uncovers a novel discursive strategy termed repugnostic framing, through which incumbent actors aim to oppose the framings of other discursive agents, leading to increased lines of conflict and polarisation, thus possibly hindering effective policy implementation.

1. Introduction

Despite a broad understanding in Germany amongst politicians, industry actors, and the wider public that reducing transport-related emissions is urgently needed and legally justified, the transport sector's emissions continue to grow (UBA, 2022). In 2022, 68,4 million private cars populated German roads and cities, most of which were propelled by fossil fuel-powered internal combustion engines (ICEs) (KBA, 2022). Beyond its contribution to climate change, the unsustainability and persistence of a prevailing 'regime of automobility' in the face of massive social, environmental, and economic consequences make apparent the necessity of its fundamental transformation (Böhm et al., 2006; Paterson, 2007). In recent years, an intensifying debate around plausible and desirable futures for a *Mobilitätswende* or *Verkehrswende*[1] can be observed. Still, the future of the German mobility sector remains highly contested, with vastly varying conceptions of different actors regarding how a transition towards more sustainable mobility practices can occur and precisely what such a transition might entail (Ruhrort, 2023; Manderscheid, 2020). Literature portrays Germany's mobility future as dominated by incremental technology improvements and moderate shifts towards eco-friendly drivetrains, preserving the car's hegemonic status (Wentland, 2017; Haas, 2020; Manderscheid, 2020). However, mobility futures that would constitute a significant decline in the car's privileged position in the mobility system can be imagined (Hawxwell et al., 2024). Mobility futures that constitute wider-reaching

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[1] Throughout the text, the German mobility transition is referred to by the term Verkehrswende; however, analytically, the related signifier Mobilitätswende and its varying meanings are also investigated.

modal shifts, more profound spatial transformations, and broader cultural and political-economic changes are possible (Wentland, 2017; Haas, 2020; Manderscheid, 2020). The socio-material arrangements that would eventuate from the *Verkehrswende* hence will differ significantly depending on the extent to which particular imagined mobility futures emerge as dominant. Nevertheless, these mobility futures are largely still uniformly debated under one all-encompassing 'transition' signifier.

The word *Verkehrswende,* which signifies the urgently needed transition of the German mobility sector, can, therefore, be considered a floating signifier: a term that different discursive agents "struggle to invest with meaning in their own particular way" (Jørgensen and Philips, 2002, p. 28). Floating signifiers are effective mechanisms for coordination because different actors with potentially divergent interests can mobilise around a common concept. However, such floating signifiers are also susceptible to capture. Their lack of clear definition and lack of commonly agreed upon problem and solution framings allows actors with varying interests to challenge prevailing understandings and explore new ideas and practices (Christensen, Morsing and Thyssen, 2015). The German mobility transition, in particular, has become a discursive battleground (Rurhort, 2023), where varying actors with different vested interests jostle to impart their understanding of a mobility transition in the broader transportation policy arena (Haas, 2020). However, the investigation of different discursive strategies (Lee and Hess, 2019) that actors may utilise to influence transition discourse and the policy-making process (Rosenbloom et al., 2016; Kuokkanen et al., 2018; Markard et al., 2021) represents an emerging yet under-explored research topic. A systematic analysis of the competing content ascriptions to the floating signifier *Verkehrswende* is thus warranted to improve our understanding of how these discursive framing struggles may affect the directionality and speed of socio-technical change. Terms such as the 'circular economy' (Rödl et al., 2022; Niskanen et al., 2020), the 'bioeconomy' (Mijailoff and Burns, 2023), 'sustainable development' (Kögle and Kurze, 2013) or 'frugal innovation' (Tesfaye and Fougère, 2022) have previously been investigated through the lens of the floating signifier to better understand the ambiguity of these terms. However, enquiries into the notion of the 'transition' itself (e.g., energy transition, mobility transition, food transition) as floating signifiers, to the best of our knowledge, have not yet been done.

To address this gap, this study aims to increase the conceptual understanding of the functioning of floating signifiers in sustainability transitions by unpacking the discursive contestation and framing struggles around the German mobility transition, specifically by investigating how the term *Verkehrswende*–and the ideas transported through its use–is mobilised by different actors over time to promote varying mobility futures. Empirically, we draw on text data from German newspaper articles published between 2018 and mid-2023 to conduct a discourse network analysis (DNA). DNA is a mixed method approach wherein, as a first step, we performed a content analysis of selected newspaper articles to detect actor statements on the German mobility transition that were then aggregated into networks utilising social network analysis tools (Leifeld, 2016; 2017). Using DNA allowed us to examine the development of the public debate and its connected actor networks and thus draw insights into how these impact continuity and change (Eder, 2023). We focused primarily on three dimensions to examine key problem and solution framings within the evolving public discourse: (1) changes in framings of sustainable mobility over time and the events that influenced these changes, (2) the role of different actors, discursive strategies and coalitions in shaping mobility discourse, and (3) the dominance of certain framings that support specific mobility futures over time.

Our study makes three broad contributions: First, it showcases how the floating signifiers *Mobilitätswende* and *Verkehrswende*, embodying a myriad of evolving interpretations, play an important role in shaping the directionality of socio-technical change in the German mobility sector by representing a discursive platform upon which several mobility futures can be identified. Second, the study sheds light on the argumentative tactics of discursive agents in transitions by identifying two discursive strategies of actors, including polarising the discourse through repugnostic framing storylines and strategic switching of discursive positions by actors to align with the changing discourse. Beyond the empirical case, we call attention to the ambiguous nature of floating signifiers within the discourse dynamics of transition processes by highlighting how they represent common terms that create grounds for consensus-building yet simultaneously pose the risk of strategic exploitation and can cause discursive fragmentation that might delay policy action.

The paper is structured as follows: Section 2 introduces our theoretical background, including relevant discourse analytical concepts for this study and presents a literature review of previous research on discourse in the German mobility sector. Section 3 presents the methodology and operationalisation of the DNA approach, followed by the results (Section 4), discussion and concluding remarks in Sections 5 and 6, respectively.

2. Theoretical background

2.1. Discursive framing struggles in sustainability transitions

Researchers aiming to better understand sustainability transitions have begun to pay more attention to the discursive dimensions of socio-technical change (Simoens et al., 2022; Rosenbloom, 2018; Geels, 2014). A discursive perspective acknowledges that public policy problems and potential solutions are socially constructed as actors participate in an argumentative exchange in which they continuously modify and adapt their problem and solution framings in response to actors with competing transition narratives (Späth, 2012; Rosenbloom et al., 2016). Sustainability transitions, therefore, can be conceptualised as evolving fields of discursive framing struggles of actors over desired future pathways (cf. Späth, 2012; Funke and Ruppert-Winkel, 2020; Markard et al., 2021). The power of discourse consequently lies in its ability to legitimise specific problem definitions and solution framings at the expense of others, and thus both enables and restricts action (Feindt and Oels, 2005). Therefore, by examining how problems and solutions are being framed and reframed by these different actors, discursive approaches can offer insights into the underlying dynamics that influence socio-technical change (Geels, 2014; Kuokkanen et al., 2018; Brugger and Henry, 2021).

Following Hajer (2006; p. 59–60), discourse is defined as "an ensemble of notions, ideas, concepts and categorisations through

which meaning is allocated to social and physical phenomena, and which is produced and reproduced in an identifiable set of practices". According to this view, discourse extends beyond language, including practices, assumptions and power relations that shape how issues are discussed and understood. To make sense of the role of discourse for stability and change, Hajer (1995) further differentiates between three forms of storylines, condensed statements of factual information intermixed with normative assumptions and value orientations that assign meaning to specific terms: (1) Dominant storylines, (2) marginal storylines and (3) radical storylines. Dominant storylines represent a particular meaning of an issue that prevails over other possible interpretations within a given societal context. Marginal storylines can be understood as those whose meaning systems do not diverge as significantly from the dominant storylines. The resulting interaction can potentially lead to shifts in understanding and changes in the configuration of a socio-technical system (Simoens et al., 2022). Radical storylines counter the dominant ones by proposing a significant departure from the status quo, which fundamentally challenges the assumptions, practices and power relations embedded in the dominant discourse (Hajer, 1995). However, these alternative storylines are subject to a "discursive dilemma" (Hajer 1995, p. 57), as marginal storylines risk 'capture' if they align too closely with those terms of the dominant storylines while risking the loss of legitimacy altogether if they stray too far from these. Capture of potentially transformative storylines by dominant arrangements and the consequent incremental change has been identified as an important discursive lock-in undermining transformative change (Simoens et al., 2022).

As individual actors engage in meaning-making through discursive exchanges, discourse coalitions may form amongst actors that share similar views and common understandings of the issue at hand (Hajer, 2006) and try to leverage larger networks to create public acceptance of their preferred direction of socio-technical change (Kuokkanen et al., 2018). Discourse coalitions are actor configurations that repeatedly evoke a particular set of storylines (Hajer, 1995). Discourse coalitions seek to dominate the discourse by shaping a particular view of reality and, in turn, the policy-making process (Hajer, 2006). Meanings assigned to a signifier, such as the *Verkehrswende*, are thus neither neutral nor objective but are constructed based on different actors' views on reality, their interests (Barnes and Hoerber, 2013) and problem framings (Benford and Snow, 2000). If a signifier is articulated in several discursive formations, its discursive meaning gets blurred as it oscillates between different discursive contexts (Barnes and Hoerber, 2013; Mijailoff and Burns, 2023). This is conceptualised as the *floating* of a signifier (Jørgensen and Philips, 2002). In this process of meaning-making, actors draw on different storylines and through these storylines, actors can frame how certain problems should be perceived and solved (Smith and Kern, 2009) and convince decision-makers of their favoured course of action (Stone, 2001). Storylines, thus, represent strategic tools that actors can evoke to give signifiers specific meanings, impact policy-making processes (Hajer, 2006) and, ultimately, influence the directionality of socio-technical change (Rosenbloom et al., 2016; Kuokkanen et al., 2018).

During times of significant exogenous landscape developments, shocks, and societal or political shifts, floating signifiers often undergo rapid re-articulation as different actors struggle to impose their preferred meanings (Hall, 1988; Howarth et al., 2000; Farkas and Schou, 2018). Such specific, observable events where the established order is challenged, also referred to as critical moments, open up opportunities for discursive battles that can shift dominant storylines and alter socio-technical trajectories (Hajer, 2009; Yuana et al., 2020). During such periods of intensified discursive struggles, actors may draw on various discursive strategies to frame issues and influence the meaning-making process (Simoens and Leipold, 2021; Rosenbloom et al., 2016). Previously identified strategies in the transition literature include (1) diagnostic framing as attempts to define prevailing problems, (2) prognostic framing as attempts to propose solutions to such problems, (3) motivational framing including storylines that offer a rationale for action (Geels 2014), (4) delegitimising framing towards the dominant discourse and its proponents (Markard et al., 2021; Simoens and Leipold, 2021) and (5) (re)legitimising framing to support the dominant discourse (Markard et al., 2021).

2.2. Discourse contestations around mobility futures for Germany

Although mobility futures are contested in (and beyond) any national context, the shaping of meaning around the mobility transition in Germany can be considered to be of particular interest because of the embeddedness of the automobile industry in the national economy. Germany is among the top three vehicle producers in the world, with an annual turnover of approximately €422.8 billion and 820,000 workers directly or indirectly employed in the German car manufacturing industry (VDA, 2022). The result is the presence of powerful actors with strong vested interests in particular mobility futures over others.

In recent years, the concept of the *Verkehrswende* has become a mainstream term in the German transport policy discourse and has been utilised by a broad range of different actors, such as political parties, NGOs or research institutes, to describe varying visions of how to transform the transport sector (Ruhrort, 2023). The term embodies a transformation of transportation, advocating for systemic changes in transport infrastructure, policies and technologies towards more sustainable, efficient and environmentally friendly modes (Canzler et al., 2018). It emerged in response to the environmental movements of the 1960s and 70s, initially suggesting a shift from car dependency towards active forms of mobility and public transport (Urry, 2004). While the compound noun is frequently translated to 'mobility transition', its direct translation, 'mobility turnaround',[2] gives a better understanding of the required departure from the prevailing arrangements of the car-centric mobility regime (Haas, 2020). In parallel with the emergence and growing importance of the field of mobility studies, a second term, *Mobilitätswende*, has become more commonly utilised, reflecting a paradigm shift away from the vehicle-centric notion of 'transport' to a more human-centric notion of 'mobility', combined with a deeper appreciation of the social, cultural, ecological and behavioural aspects associated with (non-)movement (Sheller and Urry, 2006; Banister, 2008; K.

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[2] Others have translated '-wende' this way. As 'turnaround' is not commonly referred to in the English language in reference to changes in socio-technical systems and because the terms 'Mobilitätswende' and 'mobility transition' perform essentially the same function in their respective languages, we see '-transition' as a more suitable translation.

Manderscheid, 2022). However, the two terms are frequently used interchangeably (Manderscheid, 2020; 2022), and the signalling of change is inherently embedded in both terms. Which dimensions of socio-technical change (technological, behavioural, political-economic, cultural, etc.) will manifest as the promised 'mobility transition' nonetheless remains contested and likely dependent to some extent on which meanings of the signifier *Verkehrs- or Mobilitätswende* will become fixed.

Recent academic work on the *Verkehrswende* has been important for highlighting the spectrum of mobility futures deemed plausible within prevailing discourses. Manderscheid (2020) differentiates between three types (or extents) of change to the mobility system. According to the first (*Antriebswende*), changes are mainly limited to the technology that propels the vehicle (such as through a replacement of ICE with electric drive-trains). According to the second (*Verkehrswende*), the envisioned changes would include broader shifts in transport modes, such as through a replacement of trips by car with more sustainable modes such as cycling and public transportation. The third (*Mobilitätswende*) envisions more radical changes in movement patterns as people might travel less (such as through the substitution of physical with virtual meetings or even through having the freedom to be less mobile). All these envisioned futures would have to be accompanied by changes to the wider material, institutional and cultural contexts that would make such shifts in everyday mobility practices possible.

Haas (2020, 2021) develops a similar differentiation from a political-economic perspective, demonstrating how the respective plausible mobility futures are not politically neutral and that powerful actors will have an interest in particular futures over others. He highlights how activities conducted in the name of the *Verkehrswende* tend to reinforce the prevailing hegemonic status of the automobile and allow for the capture of attempts at its transformation by powerful industry actors. The articulated mobility futures for the German regime of (auto)mobility thus limit the *Verkehrswende* to incremental improvements of existing technologies and the "renewal of car hegemony" through electrification (Haas, 2020). Similar observations have been made elsewhere, referring to *rearticulating the old promise* (Wentland, 2017) as narrow ecological modernisation through the uptake of post-fossil drivetrains.

However, the renewal of car hegemony is not inevitable. Futures that decentre the car have also been articulated. Such futures could include a detachment from status expressions through individual car ownership, a shift away from private car ownership, a wide-reaching redefinition of the mobile subject (Wentland, 2017), and a radical reduction of car traffic in cities (Haas, 2020). Those mobility futures also entail a move towards a more just and equity-informed mobility regime (Wentland, 2017; Haas, 2020; Manderscheid, 2020). Table 1 offers an attempt to synthesise these different possible mobility futures. These different typologies help orientate plausible mobility futures through the articulation of potential trajectories of a mobility transition in Germany.

As seen in Table 1, the articulation of such varying meanings of the *Verkehrswende*, each underpinned by different assumptions and values, not only draws attention to the polysemous nature of the German mobility transition but also reveals how deeply the term has

Table 1

Articulated possible mobility futures in the literature.

	Name and author	Description of articulated mobility future
Car continuity	*Antriebswende* (Manderscheid, 2020)	Decarbonisation of the automobility regime through substitution of propulsion technologies (predominantly electrification). Adjustments needed to the urban built environment are in the realm of public and private charging infrastructure. Urban issues such as traffic congestion and space constraints remain unaddressed.
	Rearticulating the old promise (Wentland, 2017)	EVs are perceived to be inferior to their ICE counterparts. Focus on incremental improvements to existing technologies and vehicle designs that deviate as little as possible from the dominant artefact. Continuous renewal of the symbolic significance of the car.
	Renewal of car hegemony (Haas, 2020)	Slow shift to battery electric vehicles. Continuous renewal of the symbolic significance of the car. Increasing intermodality yet still car-dominated regime
Modal transition	*Verkehrswende* (Manderscheid, 2020)	Intermodality and sharing as the new central paradigms. Clear modal shift away from car-centric forms of mobility. Focuses on a modal shift in favour of public transport, cycling and walking and related infrastructure.
	Moderate *Verkehrswende* (Haas, 2020)	Restricted car use in cities. Expansion of low-carbon infrastructures. Modal shift in favour of public transport, cycling and walking. Mobility services such as car sharing powered by digital technology. Clear modal shift away from car-centric forms of mobility.
Mobility transformation	*Mobilitätswende* (Manderscheid, 2020)	Emphasises a broader understanding of mobility and extends beyond the physical movement of people and goods on the roads to include social and spatial implications. Clear departure from car-centric forms of mobility.
	Redefining the citizenship of mobility (Wentland, 2017)	Detaching the car from the perception of socioeconomic achievement. Shift away from private ownership of cars. Sharing through new forms of digital mobility as the central paradigm. Fully Electrified but mostly car-free cities. Strong focus on social inclusiveness.
	Radical *Verkehrswende*/car-free society (Haas, 2020)	Marginalisation of cars that promotes a shift away from private car ownership. Degrowth of the transportation system (Verkehrswende as an element of a socio-ecological transformation). Commoning of transportation.

become entangled with broader power struggles. Different actors, ranging from policymakers, the automotive industry, and environmental organisations to urban planners and citizen movements, vie to inscribe their preferred meaning into the signifier to steer the *Verkehrswende* towards a desired mobility future that serves different (both more private and more collective) interests to different extents (Ruhrort, 2023). While each author considers possible mobility futures through different theoretical lenses, their analyses collectively address diverse dimensions of these futures, including economic, technological, and social implications, as well as those pertaining to the built environment. Despite their distinct perspectives, as demonstrated in Table 1, there is considerable overlap in their typologies, highlighting common themes in the articulated mobility futures.

To generate an in-depth understanding of how varying ascriptions of meaning to the floating signifier *Verkehrswende* may result in the articulation of vastly different mobility futures, we, therefore, propose three overarching analytical categories aimed at capturing the level of transformative impact and deviation from prevailing arrangements. We refer to these as 'car continuity', 'modal transition' and 'mobility transformation' (see Table 1). It becomes clear that the *Verkehrswende* is floating between multifaceted interpretations of possible mobility futures, and analysing it provides valuable insight into the contested nature of sustainability transitions and the role of discourse and meaning-making in shaping these processes. Consequently, our research contributes by investigating how a transition-related term may act as a floating signifier by analysing the emerging and shifting framings of the *Verkehrswende* in German public discourse. It covers three different analytical dimensions of the discourse developments on the German mobility sector, each with related research questions.

(1) Evolving content of the discourse. What interpretative problem and solution frames about the conceptions of a sustainable mobility transition have emerged, and how have these changed over time in relation to different events? To answer this research question, we identify the key problem and solution framings and their related mobility futures in the German mobility discourse, map their evolution and consider the events that influenced these changes.

(2) Actors, discursive strategies and coalitions. Different societal actors have vastly differing power to shape transition narratives (Beck et al., 2021; Simoens et al., 2022) and may form coalitions over particular problem and solution framings and, thus, discursively seek to promote, from their standpoint, desirable future pathways (Markard et al., 2021; Ohlendorf et al., 2023). We, therefore, investigate how varying actors shape the mobility discourse through different strategies and the extent to which associated discourse coalitions can be identified based on shared framings over possible mobility futures. We thus also respond to the question: Who participates in the German sustainable mobility transition discourse, and to what extent can coalitions around shared problem and solution framings be identified?

(3) Discourse structuration and discursive closure. To what extent do specific framings dominate during certain points in time? Previous policy discourse studies have highlighted the role of discursive closure - the reinforcement of a particular problem and solution-framing storylines in the discourse that manifests in concrete political action (Barnes and Hoerber, 2013; Markard et al., 2021). Hence, we examine how the structure of the discourse networks evolves, if a mutual alignment of problem and solution framings can be observed amongst actors and if certain conceptions of desired mobility futures become dominant or polarisation occurs.

3. Methods

3.1. Data sources, article selection and time sequences

To investigate what different problem and solution framings can be ascribed to the signifier *Verkehrswende*, our analysis draws on German newspapers as a data source. Newspapers have previously been acknowledged as a reliable source to map changes in the wider public discourse (Markard et al., 2021), particularly because, compared to policy documents, they capture a broader range of actors participating in a political debate (Leifeld, 2013). The national daily editions of *Süddeutsche Zeitung* (SZ), *Die Welt,* and the weekly national edition of *Die Zeit* were selected as outlets for the data collection. SZ is known for its centre-left editorial stance, while *Die Welt* has a centre-right orientation, and *Die Zeit* can be considered a somewhat centrist publication (Kranert, 2020; Wallaschek et al., 2023; Secen, 2022). Together, SZ and *Die Welt* represent two of the most circulated daily newspapers in Germany, and *Die Zeit* is Germany's most-sold weekly newspaper (Statista, 2021, 2022). Consequently, drawing on these three newspapers allowed for the development of an ideologically balanced data set whilst capturing the mainstream public discourse.

Articles of the respective outlets were accessed through the LexisNexis database (*Die Zeit & Die Welt*) and the SZ Archive (https://archiv.szarchiv.de). The search strategy to identify relevant articles was developed inductively through experimentation with different keywords and keyword combinations over different periods by both authors and was refined iteratively. Table 2 lists our final search string used to identify articles during a period of increased discursive debates on the directionality of the German mobility transition starting from the year 2018. This year can be considered significant because the German government introduced the first sectoral climate change mitigation goals, thus marking a pivotal shift in policy that sparked intensified discursive debates around plausible mobility futures for the country. Focusing on this year, hence, allowed our analysis to capture the critical moment when these discursive struggles gained prominence. After removing doubles and false positives, as well as applying a range of selection criteria (see Table 2), our final data set comprised 456 articles.

Following Belova et al. (2023), we utilised a discourse sequencing approach. This approach offers several advantages over previous studies that focus on synchronic analyses (cf. Ohlendorf et al., 2023). First, it enabled us to trace the temporal development of the discourse, revealing how the meanings of the *Verkehrswende* and related storylines developed and changed in response to different events. It also enabled a comparative analysis of the evolution of the discourse. Second, it allowed for the identification of such events

Table 2
Overview of the search parameters for the text corpus creation.

Sources	Period	Search String	Selection Criteria
SZ Archive (*Süddeutsche Zeitung*) LexisNexis (*Die Welt* & Zeit)	Jan. 2018-until Aug. 2023	Verkehrswende* OR Mobilitätswende*	- Print articles only - Keywords in text or title - ≥300 words - Must contain at least one full sentence of relevance - Must refer to Germany - Must allow for a clear identification of a relevant actor
		$n = 1114$ (SZ 593, Welt 361, Zeit 160)	$n = 456$ (SZ 211, Welt 183, Zeit 62)

(i.e., critical moments) and helped better understand their impact by providing insights into how they influenced policy debates. Sequencing, thus, contextualised discourse content regarding political, societal, and economic circumstances, avoiding mis-interpretations of discourse evolution as static conflicts (Belova et al., 2023). Based on our initial screening and subsequent coding of the articles, we identified the Corona pandemic as a critical event that significantly influenced the discourse around the *Verkehrswende*. Consequently, we divided our analysis into three phases: pre-COVID (2018–2019), COVID (2020–2021), and post-COVID (2022–mid-2023). However, within each phase, we further identified several other events that influenced the meaning-making around plausible mobility futures in Germany, and these are elaborated in Section 4.1.

3.2. Discourse network analysis

For the data analysis, this study employed the discourse network analysis (DNA) (Leifeld, 2009; 2017) approach, which examines actor-based debates in policy discourse and generates relational data on actors with congruent arguments or policy stances over time. The method has been previously applied in transition studies to investigate public policy debates (Schmidt et al., 2019; Schmid et al., 2020), explore discourse coalitions around the German coal phase-out (Markard et al., 2021) as well as lines of discursive conflict (Ohlendorf et al., 2023) and the evolution of the discourse structure (Belova et al., 2023) in the German hydrogen debate.

As a first step, the application of DNA and subsequent content analysis of selected text material required the set-up of a coding scheme for the following variables: (1) specific storyline(s) revealed in a statement and (2) name and potential organisational affiliation of the actor making the statement. Storylines in a statement are analysed based on their problem framing: what actors perceive as the problem that the *Verkehrswende* must address, and their solution framing: how actors envision a sustainable mobility transition and which solutions the *Verkehrswende* should involve (Geels, 2014). Thus, unlike some previous DNA studies in transition research (cf., Markard et al., 2021; Ohlendorf et al., 2023), our coding framework did not focus on specific storylines that represented points of controversy or conflict. The aim of developing our coding framework was instead to capture the ongoing discursive framing struggles around the German mobility transition in their entirety to be able to systematise patterns of discursive evolution (Buckton et al., 2019).

The coding scheme was developed by randomly selecting 10 % of articles and independently eliciting problem and solution-framing storylines and actor categorisations. The coding scheme was developed following an abductive approach and iteratively refined based on the text data, emerging storyline patterns, and existing work on the German mobility sector and previously outlined possible mobility futures. Identified storylines could consist of one or multiple sentences, and in the case of long paragraphs that covered several problem and solution frames, the different storylines were coded separately. After this first round of coding, the authors compared and discussed their identified storylines and actor categorisations to establish an initial coding scheme, which was then applied to the entire data set with equal coding contributions from both authors. ,[34] Inter-coder reliability was ensured through frequent meetings and iterative adjustments to the coding scheme.

Once the coding process was completed, the resulting structured data set was exported into a social-network mapping software[5] to visualise the discursive framing struggles and related actor coalitions and their evolution over time through network graphs. To focus the networks on the most relevant aspects of our analysis, we excluded storylines that were only evoked once and did not visualise actors that made less than three statements during any of the three time periods. To systematise the analysis, further structured data sets were created that grouped the storylines into one of the three possible mobility futures categories (i.e., 'car continuity', 'modal transition', 'mobility transformation') previously proposed based on the literature review in Section 2.2 Accordingly, Fig. 1 shows a classification tree based on which the different problem solution and repugnostic storylines were allocated to the different mobility futures. However, it is worth noting that overlap between the three classifications exists. For example, concerns about the negative impact of the prevailing regime on climate change are present in all three futures, and both the 'modal transition' and 'mobility

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[3] Following (Miörner et al., 2022), the developing data set data was exported several times into social network software to generate network visualisations of the emerging affiliation and congruence networks around different discursive meanings of the Verkehrswende to receive feedback on the coding scheme.

[4] All articles were manually coded using the qualitative data analysis software MAXQDA.

[5] For data visualisation and network analysis, both Visone & Kumu were utilised.
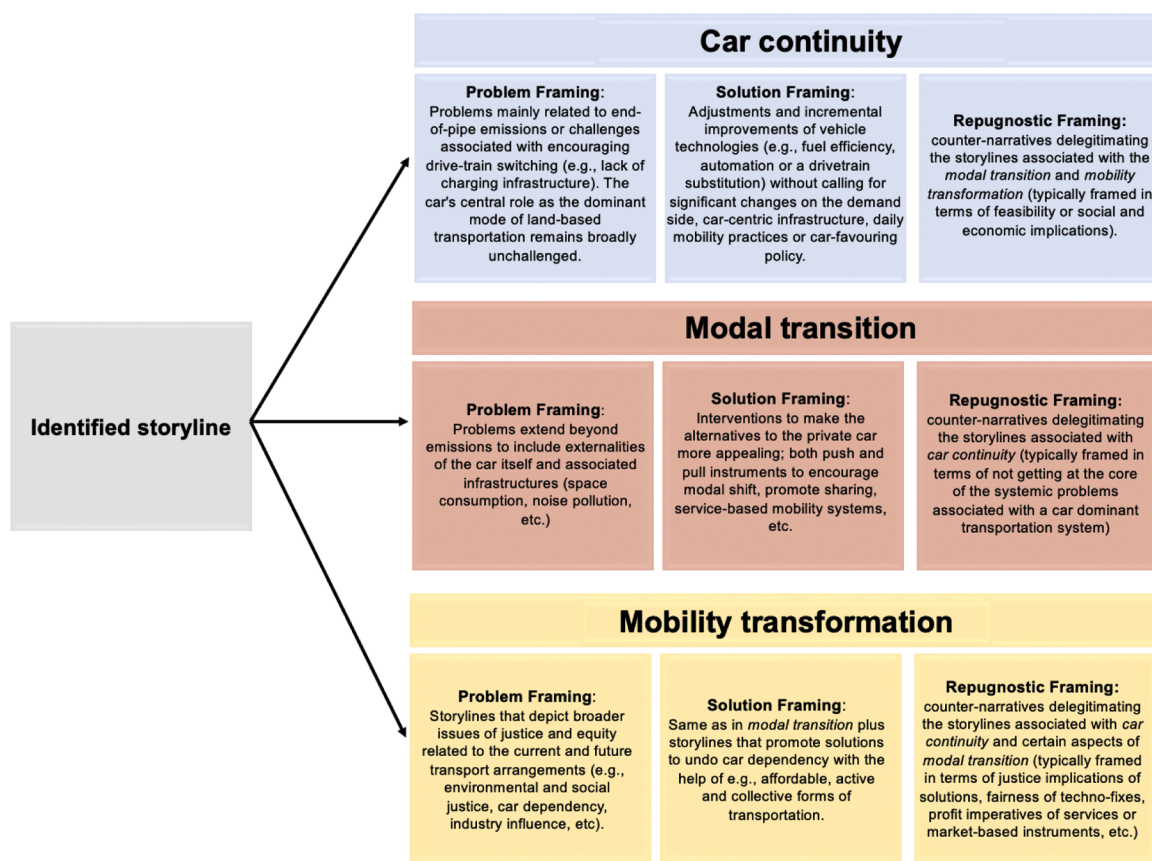
Fig. 1. Storyline allocation tree for different mobility futures in the analysis.

transformation' include storylines that promote alternative forms of mobility such as cycling or public transport.[6]

As seen in Fig. 2, DNA can be used to produce congruence networks in which actors are connected through the shared use of storylines and actor-concept networks that visualise the relationship between actors and storylines by connecting the former with the latter. We first generated both congruence and actor-concept networks for each time phase to gain an understanding of the overall discourse structure, its evolution, which actors promote which storylines and potential discourse coalitions. For the three mobility futures across the different time phases, only congruence networks were created.

Lastly, we employed Social Network analytical measures (Leifeld, 2017) to investigate the evolution and structuration of networks from 2018 to 2023. Beyond identifying top discursive agents and storylines for each of the three periods, we focused on potential discourse coalitions, clusters of nodes in congruence networks that are more densely connected due to shared storylines. However, the core-periphery structure typical in congruence networks, characterized by central actors with high discursive engagement, such as government bodies and political parties (Leifeld, 2017), complicated the identification of such coalitions. To address this, we corrected for potential biases by adjusting edge weights (Markard et al., 2021; Ohlendorf et al., 2023), employed a backbone visualisation algorithm[7] to highlight significant connections, and applied the Louvain clustering algorithm to detect clusters within the resulting networks (Leifeld, 2017; Blondel et al., 2008). While Louvain clustering provided modular groupings, interpreting these clusters required a qualitative analysis, we thus systematically reviewed the associated storylines to identify recurring framings that aligned actors within the same coalition. We reflect on the implications of our approach in Section 5.3.

In addition, we analysed the congruence networks for ideational congruence, assessing how many actors used shared storylines to gauge discursive closure within each network. Following Markard et al. (2021) and Brugger and Henry (2021), we used network density as an indicator, with higher density scores reflecting greater congruence in storyline usage. To account for differences in network size across phases and mobility futures, density scores were normalised. To further examine polarisation within the networks, we combined network diameter, which measures the maximum distance between nodes, with average path lengths, providing insights into actor separation and interconnection (Yang et al., 2016). A shorter average path length indicated stronger interconnection

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[6] A full classification table can be found in Appendix I.
[7] For the backbone strength, we used non-parametric redundancy which does not rely on predefined thresholds, thus minimising the risk to introduce bias.
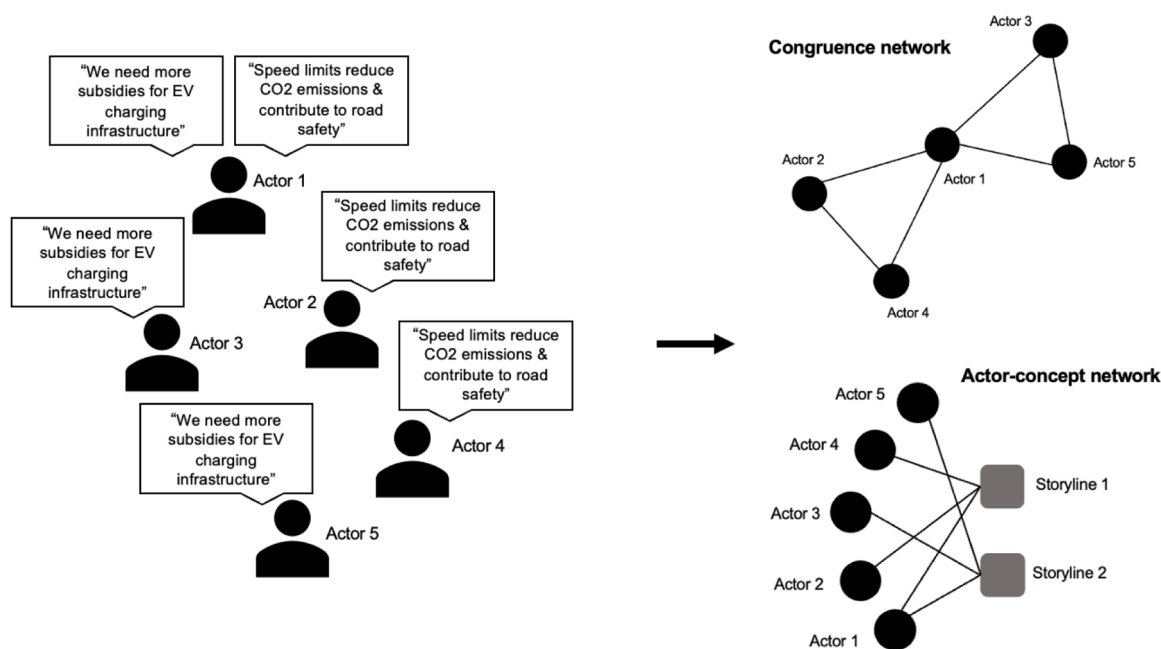
Fig. 2. On the left, actors evoke a certain storyline in the discourse. On the top right, based on the analysis of the shared storylines amongst actors, congruence networks can be visualised in which actors are connected with other actors based on their use of the same storylines. On the bottom right, actor-concept networks can be visualised in which actors are connected to the storylines they draw upon.

through shared storylines, whereas a longer one suggested greater separation, thus highlighting polarisation tendencies. By considering both measures, we ensured a balanced understanding of polarisation, accounting for both storyline separation and overall interconnectedness through shared storylines among actors in congruence networks.

Moreover, degree centrality, measuring the extent to which actors connect through shared storylines, was used to reveal actor influence in congruence networks (Eder, 2023; Brugger and Henry, 2021). In our analysis a higher centrality indicates greater influence, as actors with more connections evoke more shared storylines. was used for both actors and storylines, indicating how many storylines an actor is connected to and how many actors discuss a particular storyline. A higher degree of centrality suggests that a storyline is more frequently drawn upon and thus has higher support (Brugger and Henry, 2021). Lastly, average degree, representing the mean number of shared storylines per actor, was also used as an indication of the presence of influential actors in congruence networks (Yang et al., 2016). Table 3 sums up all network and node-level measures employed and their interpretations in this study.

4. Results and analysis

4.1. Evolution of problem and solution framings in the German mobility transition discourse

In analysing 406 newspaper articles, over 4000 passages were coded. The term *Verkehrswende* was invoked 576 times, while *Mobilitätswende* was referred to 159 times by discursive agents when making statements about Germany's mobility transition. Across all three periods, 17 problem-framing storylines and 46 solution-framing storylines were identified, thus giving a first indication that the discursive framing struggles around the *Verkehrwende* predominantly occurred over *how* a sustainable mobility transition may be brought about and *what* concrete solutions (i.e., technologies and policies) such a transition should entail. Additionally, the period 2022–2023, in particular, sees the emergence of a novel discursive strategy that cannot be categorised under diagnostic or prognostic framing (as defined by Geels, 2014). Instead, these actor statements in the discourse are aimed at pointing out potential flaws, questioning feasibility or disputing the perceived benefits of proposed solutions of other discursive agents. Therefore, we refer to this as repugnostic-framing (Latin for fight back, oppose), and 28 were identified over the analysis. This framing builds upon the previously expressed characteristics of delegitimising framings (cf. Markard et al., 2021) but evolves into a more targeted and confrontational discursive strategy. While delegitimising framings broadly undermine the legitimacy of a policy or technology by highlighting its flaws or contradictions, repugnostic framing directly opposes specific solutions to address identified problems, portraying them as fundamentally undesirable or harmful. This distinction reflects an intensification of conflict, where discursive agents perceive immediate threats posed by concrete solutions and escalate (discursive) opposition accordingly. The number of evoked storylines increased from period to period from 2018–19 (38), 2020–21 (49) and 2022–23 (58), which has led to the presence of a large variety of different problem, solution and repugnostic framings around the German mobility transition. Fig. 3 illustrates the overall evolution of the share of the three different framings throughout the three time periods and highlights that while the number of evoked solution-framing storylines remained relatively stable over time, the number of problem-framing storylines declined throughout and is surpassed by

Table 3

SNA measures and our interpretations of them in the analysis.

Network level measures	Interpretation	Node level measures	Interpretation
Network Density	Ideational congruence (Congruence networks)	Degree centrality	Influence of actors (Congruence networks) Level of support for a specific storyline (Actor-concept networks)
Louvain clustering algorithm	Identification of potential discourse coalitions (Congruence networks)	Average degree	Number of influential actors present in the network (Congruence networks)
Network Diameter+Average path length	Degree of polarisation in evoked storylines (Congruence networks)		
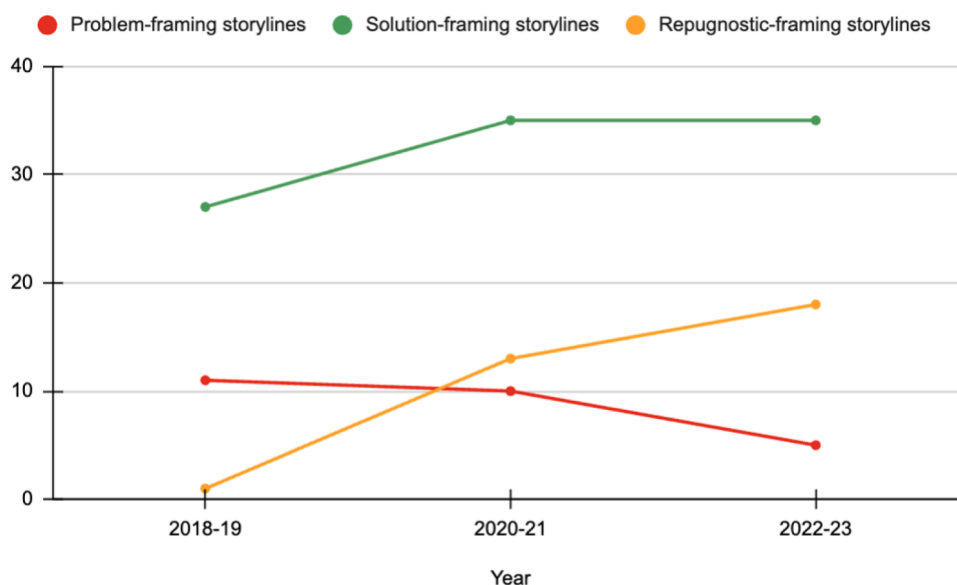
Fig. 3. Share of different framings throughout the three periods.

a rise in repugnostic-framing storylines.

Table 4 gives an overview of the condensed storylines. Where multiple similar storylines exist, aggregated themes are listed (text in italics), and the number of storylines for each theme is indicated in brackets.[8]

Comparing the discourse content and the prominent storylines across the three phases, the COVID-19 pandemic can clearly be identified as a pivotal event that influenced the evolution of the discourse and consequently, the meaning-making around the floating signifier *Verkehrswende* has become subject to change and contestation over time. For example, in the COVID-19 pandemic phase (2020–2021), the dominant storylines that legitimised the hegemonic status of the automobile were initially strengthened as cars represented a 'safe space'. *To avoid infection, people might think it is much safer to sit alone in their own car than to take a crowded subway – Knie, mobility researcher.* (Die Welt, 2020). Nonetheless, during this phase, the lockdowns also led to a redistribution of urban spaces, such as parking lots, in favour of, for example, distanced outdoor restaurant seatings and re-dedicating car lanes to active transport modalities such as pop-up cycling lanes. *It was a simple administrative act, implemented overnight; the bike paths were already planned. All it took was a little yellow paint and traffic cones – it might not look pretty; however, it is very low cost and can be actualised in no time. Berlin's cyclists finally have the space they deserve – Hermann, Green Party member* (Die Zeit, 2020). These developments gave rise to a broader debate around mobility sufficiency, avoiding unnecessary trips and reclaiming the spaces occupied by cars, catalysing an increase in storylines around a more fundamental transformation of the prevailing (auto)mobility regime in the following phase (2022-mid2023).

However, a range of other political, societal, and economic events that shaped the discourse around the *Verkehrswende* can also be identified. Fig. 4 shows an overview of these events derived through the initial content analysis of the newspaper articles.

The pre-COVID period (2018–2019) was marked by a significant focus on legislative and regulatory actions: The introduction of the "Federal Climate Change Act" and the "NOx Emission Regulation" of the European Union highlighted the need for stricter environmental standards, leading to the prominence of storylines that problematised local air pollution and the adverse effects of a car-centric mobility system on climate change. The diesel driving bans ("*Diesel-Urteil*") that restricted diesel vehicle usage in certain urban areas to

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[8] A full list of all problem, solution and repugnostic-framing storylines of this study with illustrative text examples can be found in Appendix II.

Table 4
Storyline overview.

Problem-framing storylines	Solution-framing storylines	Repugnostic-framing storylines
Required advancement of economic structures (3)	*Fuel source switch (7)*	No CO2 tax
Local air pollution is not a problem	Optimised vehicles and incremental improvements to ICE	*Cities should remain accessible to all cars (2)*
Traffic congestion	Optimise existing and build new car infrastructure	No ICE ban
Carbon emissions and climate change	Autonomous vehicles	No Speed Limits
Human health and safety	*Policy measures and initiatives to support EV deployment (53)*	*Economic concerns with EVs (3)*
Local air pollution	Clear political direction on the federal level	Transition should not be a war on cars
Noise pollution	EU ETS	Freedom of mobility must be sustained
Negative effects of the rising stock of passenger vehicles (45)	Electric vehicles (EVs)	Cars are the symbol of individuality & freedom
High attractiveness of passenger car ownership	*Low and zero-emission mobility modes (excluding EVs)(45)*	Do not build new car infrastructure
Need for a fair allocation of resources across mobility modes (3)	*Low and zero-emission mobility infrastructure (excluding EVs) (2)*	No E-fuels for cars
	Measures to encourage a modal shift (5)	Only subsidies for EV company cars
	Policy measures to support EV deployment (5)	CO2 price leads to justice problems
	Policy measures and initiatives to reduce car fleet size in cities (4)	CO2 price mechanism is not enough
	More sharing and less ownership	*Cutting tax privileges and incentives for cars (5)*
	Reduce car dependence	Fuel-source switch is no transition
	Speed Limits	*Resource and justice concerns of EVs (2)*
	Redistribute urban space	
	Low and zero-emission mobility modes (excluding EVs) (4)	
	Policy measures and initiatives to reduce car ownership (4)	
	Policy measures and initiatives to encourage & enable a modal shift (75)	
	Increased transport equity	
	Integrate private mobility service providers into public transport	
	Low-car and car-free cities	
	Strassenverkehrsordnung (German general traffic law) must change	

improve air quality highlighted the need for cleaner mobility alternatives. Concurrently, the founding of the National Platform Future of Mobility by the German government aimed to reduce transport emissions, and the increased production and marked availability of German EVs prompted the prominence of storylines advocating for a drivetrain transition in the form of EVs. However, the rise of the Fridays for Future movement further brought climate issues and the (auto)mobility regime to the forefront of the discourse and highlighted alternative storylines such as cycling and modal shifts. The latter was strengthened by micro-mobility developments in this period, such as the introduction of e-scooter-sharing services in German cities.

In the post-COVID phase (2022 until mid-2023), the discourse diversified with new storylines emerging from a change in government, which brought about new legislative actions, including phasing out EV subsidies and delaying the vote on banning ICE vehicles, which influenced the reduced emphasis on environmental and climate change related storylines. However, there was a notable rise in storylines opposing the building of new car infrastructure and advocating for low-car and car-free cities, driven by the success of urban mobility experiments, such as pop-up bike lanes and pedestrian zones, implemented during the pandemic phase (2020–2021). The geopolitical crisis caused by Russia's invasion of Ukraine further exposed the automobility regime's unsustainability, particularly concerning energy dependence. *Hundreds of millions of dollars are flowing to Putin for gasoline every day. This money directly finances a large part of his war – Reemtsma, climate activist* (Die Zeit, 2022). The introduction of a nationwide valid flat-rate public transport ticket, the 9€ ticket, as a response to hamper the socio-economic impact of the war and its successor, the 49€ ticket, propelled by debates around transport equity and the cost of mobility. Fig. 5 provides an overview of the most frequently coded storylines across these periods, showing changes in the deployed storylines across the investigated periods.

4.2. Actors, coalitions and discursive strategies in the mobility discourse

The analysis encompassed 181 discursive agents from diverse social backgrounds. To facilitate a better overview, individual actors were aggregated into an actor group, namely national (Federal) and state (*Länder*) governments, industry actors, actors from scientific institutions or think tanks, NGOs and industry associations and lobbies.[9] As seen in Fig. 6, the dynamic of the discourse around the German mobility transition has fluctuated across different actors and periods, with the federal and state governments, industry and science and think tanks representing the most active actor groups, while the participation of industry associations and lobbies and NGOs varied across the analysed periods.

Initially, the public debate was dominated by politicians at the national government level. However, this dynamic experienced a

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[9] A full list of all identified actors and corresponding groups can be found in Appendix III.

Federal Climate Change Act
The introduction of the federal Climate Change Act makes sectoral climate targets legally binding.

Diesel Driving Bans
"Diesel-Urteil" by the German higher court enables cities to enforce diesel car driving bans to improve local air quality.

Fridays for Future Movement
National Fridays for Future (FFF) strikes bring Climate Change related topics to the foreground.

Rise in EV Production
German automakers, including VW & Daimler, intensify EV production, with VW launching its first all-electric vehicle.

2018

2019

EU NOx Emission Regulation Legislation
The implementation of EU NOx emission regulation legislation reveals air quality issues in many German cities.

National Platform Future of Mobility
The German government launches an advisory panel to reduce transport emissions in line with national climate targets.

E-Scooter Legalization
In an attempt to broaden micro-mobility options and reduce reliance on traditional cars for short trips, Germany legalized e-scooters

New Ride-Sharing & Mobility Services
BMW & Daimler start mobility joint venture including car-sharing, ride ride-hailing and parking services.

Climate Action Programme launch
An amendment to the Climate Change Act is passed to tighten climate regulations in combination with an immediate action programme (incl. Cycling infrastructure expansion, Investments in railways, and Subsidies for Fast charging points).

Corona Restrictions
The Covid-19 pandemic has led to the introduction of mandatory face masks in public transport.

Pandemic Mobility Paradigm Change
Covid related lockdowns allow for the establishment of Pop-up bike lanes and urban mobility experiments.

2021

2020

Financial Aid for Automobility
Government financial aid supports automobility industry amid pandemic-related production halts and sales slump

Climate Legislation Deemed Inadequate
The German higher court rules Climate Change Act legislation insufficient to reach Paris agreement targets.

Introduction of "Local electric mobility" funding programme
Federal Ministry of Transport and Digital Infrastructure launches funding tender for the procurement of electric vehicles & charging infrastructure to electrify municipal fleets.

National Public Transport Ticket
The federal government, together with the provincial governments, introduces the "Deutschland Ticket", a nationwide public transport flat rate of 49€ a month.

Change of Goverment
A new federal government comes into power.

Cutting EV Support
The federal government passes a new bill to phase out all subsidies for EVs by 2025.

Changes to Climate Act
The federal government introduces a plan to loosen sectoral climate change goals.

2023

2022

(Auto)mobility Subsidizes Amid War Crisis
To hamper the socio-economic impact of Russia's invasion of Ukraine, the government launched Diesel fuel subsidies, and a public transport ticket allows passengers to travel within Germany for a fixed price of 9€.

ICE Phase-out Blockage
Germany delays the vote to ban the sales of new ICEVs in the EU past 2035.

Rise of Civil Disobedience
Nationwide protests of the "Die Letzte Generation" blocking roads while demanding speed limits & affordable public transport.
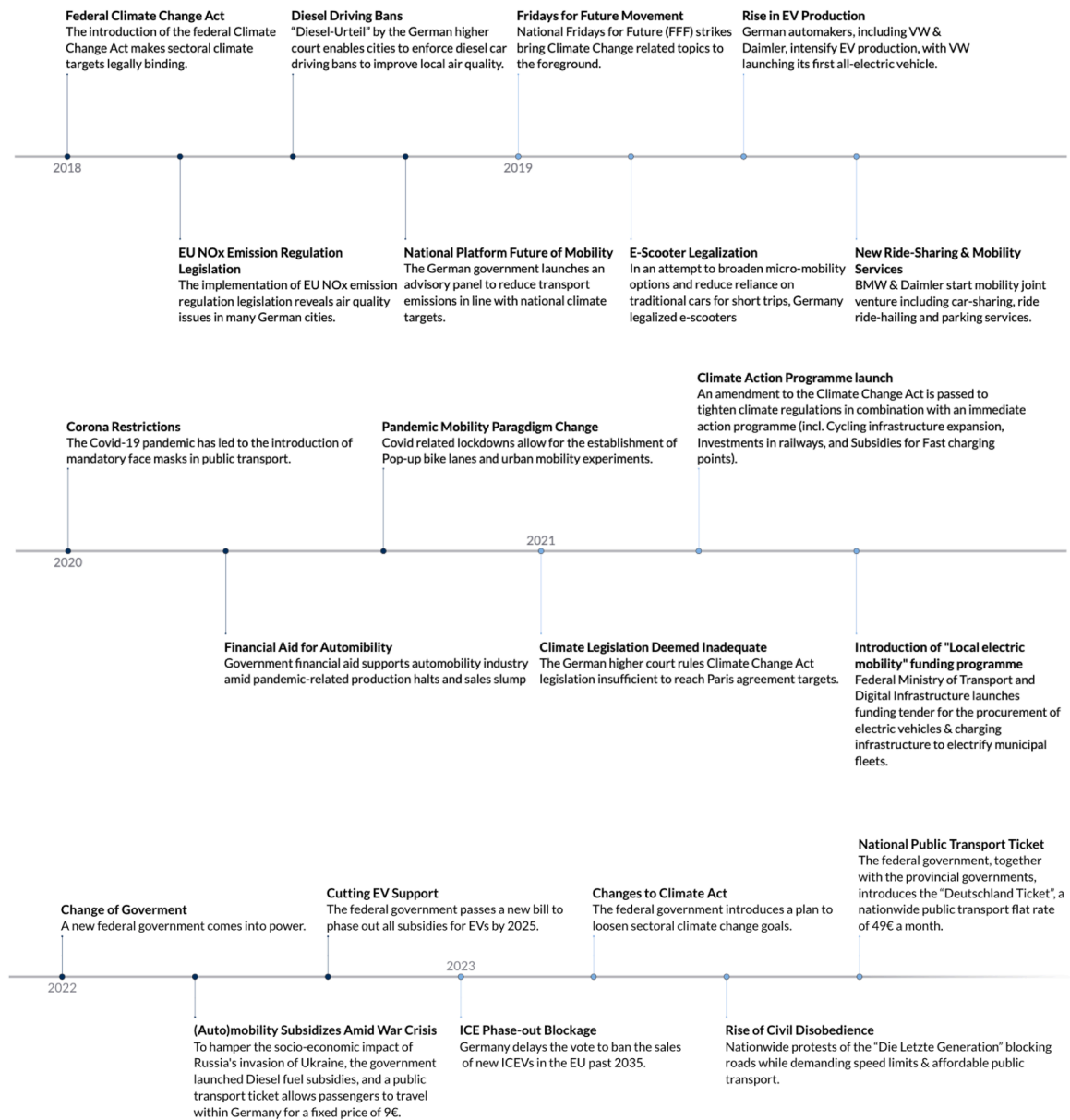
Fig. 4. Critical events in Germany that affected the transport sector from 2018–mid-2023.

shift in the subsequent period during the COVID-19 pandemic, with state politicians and industry actors increasing their discursive engagements. This shift likely reflects the decentralised nature of pandemic responses in Germany, where Länder governments took on greater responsibility for localised mobility measures and pandemic management. Simultaneously, actors representing industry associations and lobbies increase their engagement substantially. For instance, industry associations like the VDA intensified their efforts to secure financial support and policy commitments, framing the automotive sector as essential to economic recovery. During the most recent period, national politicians regained some of their initial prominence, while provincial politicians remained active in the discourse and industry actors were less engaged. After a phase of notably diminished participation, NGO actors experienced a resurgence in activity in the last period. Actors affiliated with scientific institutions or think tanks maintained a relatively steady level of engagement.

Fig. 7 shows the full actor congruence network graphs (all positive congruence) for all three periods. Different types of discursive agents (nodes) are depicted through different shapes and colours. The connections (edges) represent shared storylines, and the node size indicates an actor's influence level in the network based on degree centrality. The congruence networks reveal that the discourse around the *Verkehrswende* is not very stable over time, as the changing shapes of the graphs suggest (see Fig. 7). In addition, the number of actors and their positioning and the number of connections change dynamically from period to period. Further, across all three
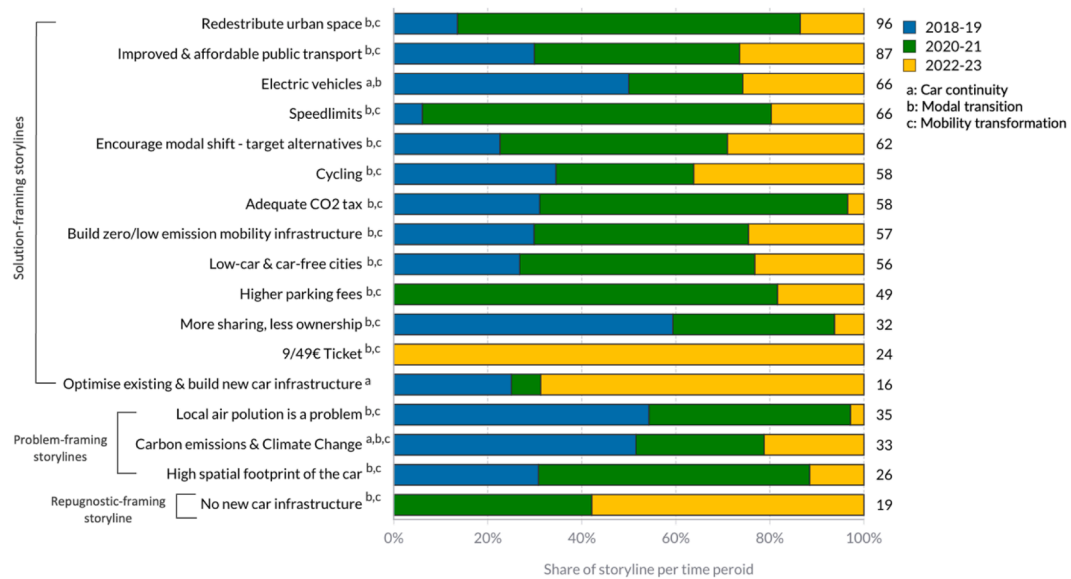
Fig. 5. Top-coded storylines across the three periods. The total coding frequency of each storyline can be seen next to the bar.
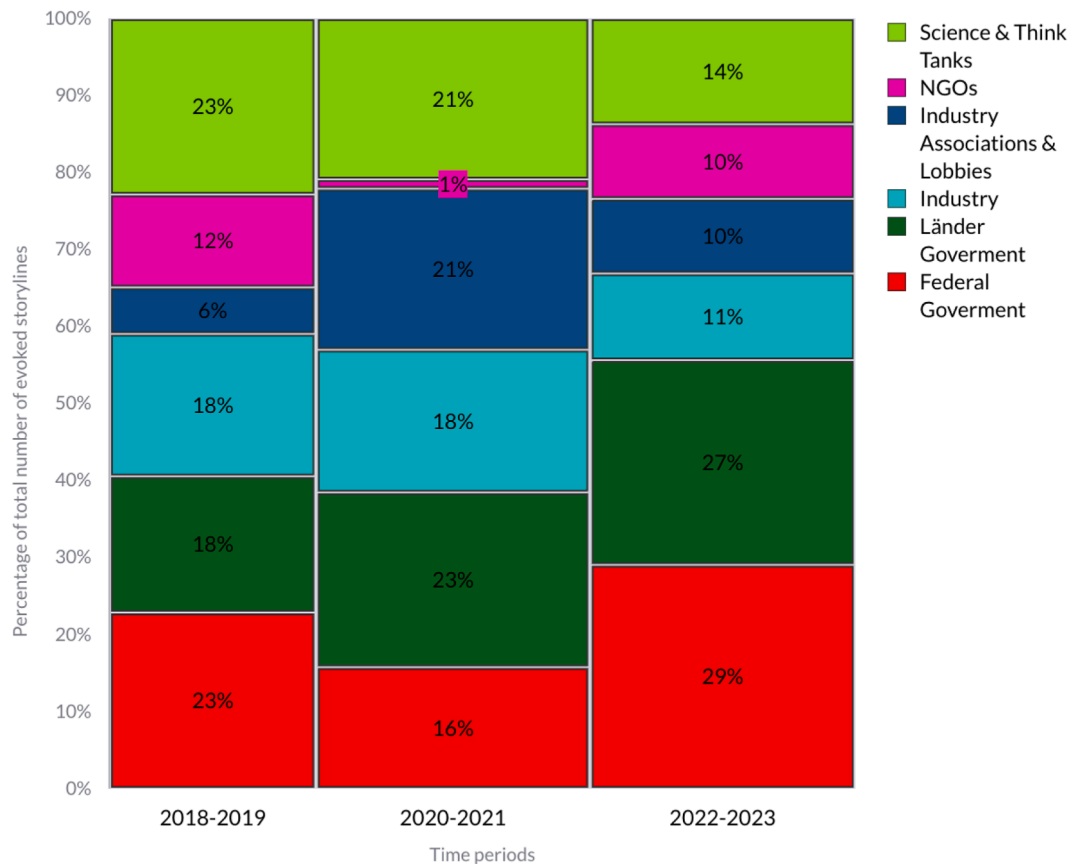
Fig. 6. Number of storylines evoked by shares of actors grouped across the three time periods.

periods, discursive agents of the same type, such as science & think tanks (light green), the federal government (red) and industry actors (blue), tend to form clusters of the same actor types as they are frequently drawing on the same storylines.

Next, for the analysis of potential discourse coalitions, actor congruence networks that focus only on structurally important ties
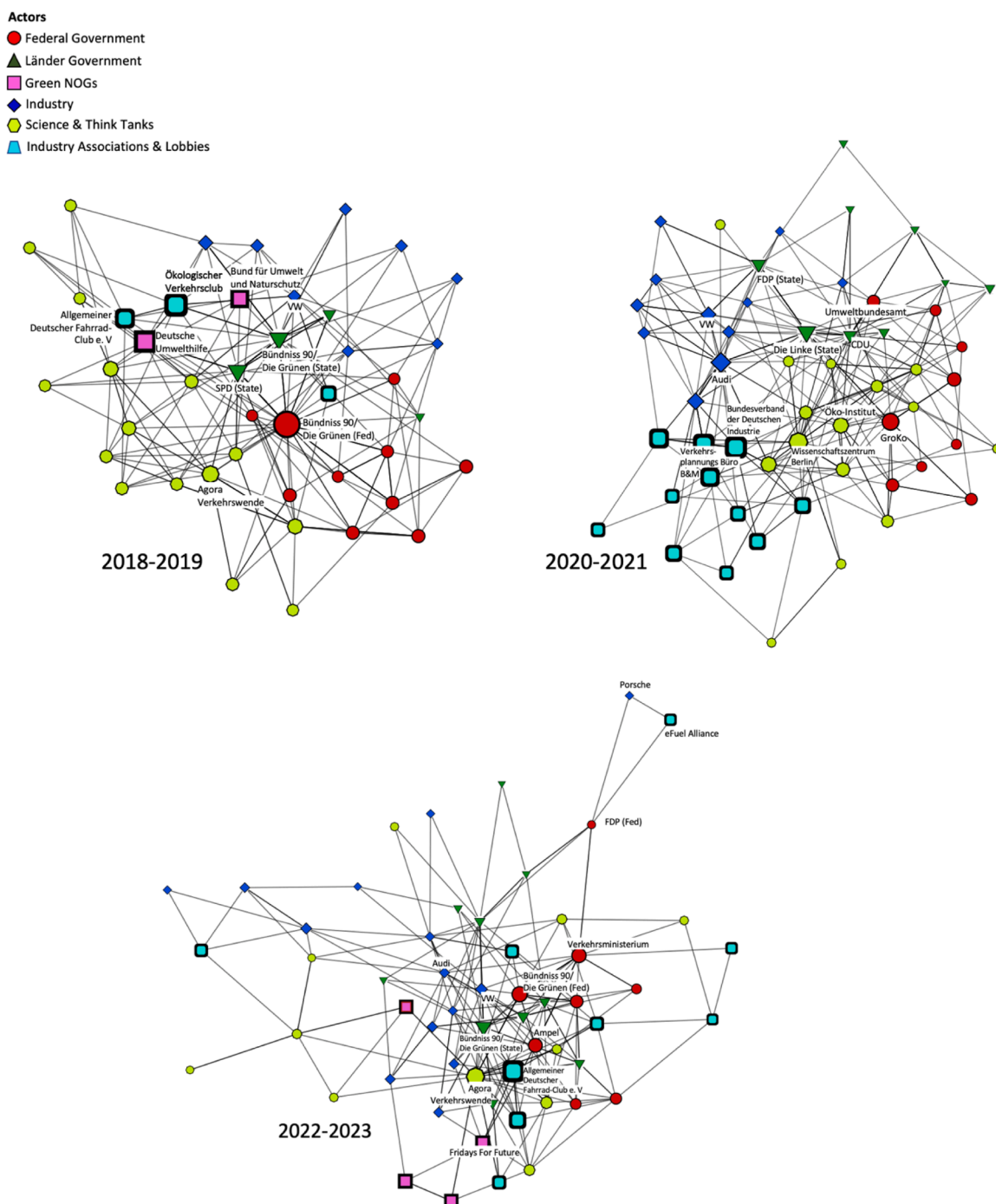
Fig. 7. Full actor congruence networks of 2018–2019, 2020–21 & 2022–2023. The size of the actor nodes is based on degree centrality.

were visualised for each time frame. Fig. 8 illustrates these networks organised by clusters for each period. Taking a closer look at the structural properties of these networks for 2018–2019, the graph displays four distinct discourse coalitions. However, the proximity of clusters and the substantial overlap between them imply that while distinct coalitions exist, there is considerable shared use of storylines within the discourse around the *Vekehrswende*. In 2021–2022, the network expands to five coalitions and exhibits significantly less overlap between coalitions. The network structure for this period reflects a shift from a broader alignment on problem and initial solution-framings in the earlier phase to more diversified and contentious discourse, as actors align with specific visions for a mobility transition while distancing themselves from competing storylines. Also, in the 2022–2023 network, five coalitions are observable. However, compared to previous periods, the separation between coalitions is more pronounced, and overlaps are further
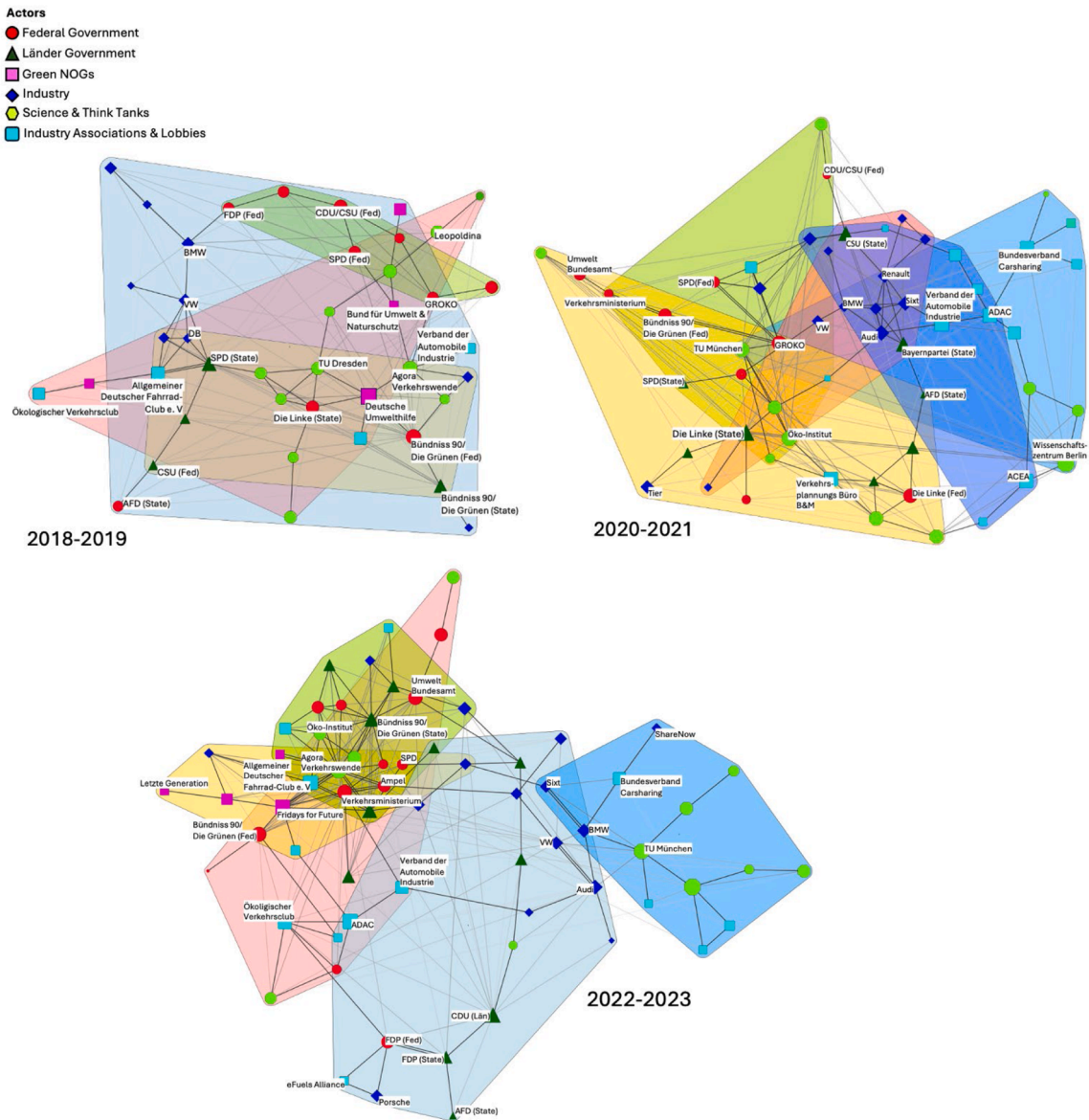
Fig. 8. Discourse coalition networks of 2018–2019, 2020–21 & 2022–2023. The size of the actor nodes is based on degree centrality. Shaded areas in different colours represent discourse coalitions, illustrating clusters of actors with strong internal congruence based on shared storyline use. The size and density of coalitions, along with the degree of overlap between them, provide insights into discourse structure. Overlapping shaded areas indicate shared use of specific storylines between coalitions, while greater distances between clusters reflect fragmentation and polarisation. Increased distances between nodes within a coalition suggest reduced discursive cohesion (i.e., limited use of the same storylines) among its actors.

reduced, thus indicating growing fragmentation. Especially, the two coalitions on the right (Blue & Light blue) are positioned more isolated from the rest of the network, and these actors in these coalitions are only loosely connected, indicating a weaker alignment around shared storylines. In contrast, the coalitions on the left (Red, Yellow and Green) exhibit tighter clustering of nodes within their boundaries, reflecting more frequent shared use of the same storylines.

To help understand these structural observations, Table 5 provides an overview of the characteristics of coalitions (in terms of used storylines) and their associated mobility futures (according to 2.2) across the three periods. For each period, at least one coalition aligns with a previously discussed mobility future, while overlaps between coalitions and shifts in actor alignment reveal evolving dynamics of the discourse around the *Verkehrswende*. In 2018–2019, coalitions were characterised by overlapping problem framings, such as the need to reduce emissions. However, the use of diverging solution-framing storylines (see Table 5) led to the formation of distinctive clusters. Additionally, the green cluster that included a high share of relevant political parties bridges the 'car continuity' coalition and 'modal transition' coalition by integrating storylines from both coalitions. In 2020–2021, coalition dynamics became more fragmented, with the 'car continuity' coalition splitting into two distinct clusters, largely made up of industry actors, associations

Table 5

A comparative overview of key storylines underlying the identified clusters and their associated mobility futures.

Period	Cluster color	Characteristics (in terms of top storylines used)	Associated mobility future
2018–19	Blue	CO2 & Climate Change; Traffic congestions; Electric vehicles (EVs); Subsidies for EVs & charging infrastructure; Need for new business models	Car continuity
	Red	CO2 & Climate Change; Cycling, Improved & affordable public transport; Encourage modal shift; High spatial footprint of the car; Redistribute urban space	Modal transition
	Yellow	CO2 & Climate Change; High spatial footprint of the car; Car-centric urban development; Cycling; Low car & car-free cities; Reduce car dependence	Mobility transformation
	Green	CO2 & Climate Change; Traffic congestions; Electric vehicles (EVs); Subsidies for EVs & charging infrastructure; Need for new business models; Encourage modal shift	Mixed alignment (Policy actor coalition)
2020–21	Light blue	Optimise existing & build new car infrastructure; Sharing solutions; Carsharing subsidies; Electric vehicles (EVs); Subsidies for EVs & charging infrastructure; No Speed limits	Car continuity
	Blue	Optimise existing & build new car infrastructure; High attractivity of passenger car ownership; Technological openness; No Speed limits; Subsidies for EVs & charging infrastructure;	Car continuity
	Red	Encourage modal shift; Redistribute urban space; Improved & affordable public transport; Build low/zero emission infrastructure; Cycling; Electric vehicles (EVs); Low-car & car-free cities	Modal transition
	Yellow	Redistribute urban space; Low-car & car-free cities; Improved & affordable public transport; Higher parking fees; Speed limits; Cycling; Build low/zero emission infrastructure	Mobility transformation
	Green	Build low/zero emission infrastructure; Subsidies for EVs & charging infrastructure; Encourage modal shift; Cycling; Technological openness	Mixed alignment (Policy actor coalition)
2022–23	Light blue	Sharing solutions; Carsharing subsidies; Need for new business models; Cities should remain accessible to cars; Electric Vehicles (EVs)	Car Continuity
	Blue	Optimize existing & build new car infrastructure; Electric Vehicles (EVs); No Speed limits; No ICE ban; Synthetic & E-fuels; Cities should remain accessible to cars	Car Continuity
	Red	Improved & affordable public transport; 9/49€ Ticket; Encourage modal shift; Cycling; Redistribute urban space; Speed limits	Modal Transition
	Yellow	Redistribute urban space; Encourage modal shift; Cycling; 9/49€ Ticket; Speed limits; Cut company car subsidies; Do not Build new car infrastructure	Mobility Transformation
	Green	Improved & affordable public transport; 9/49€ Ticket; Build low/zero emission infrastructure; Cycling; Electric Vehicles (EVs)	Policy mediation (Mixed alignment)

and lobby groups who emphasised diverging solution-framing storylines (see Table 5). The light blue cluster focused on shared mobility and electrification through business models like car-sharing, while the dark blue cluster emphasised traditional car ownership, opposing bans on internal combustion engines and promoting incremental changes such as e-fuels. Both clusters share the use of repugnostic-framing storylines, such as "No Speed limits," While the 'mobility transformation' coalition (Red cluster) still exhibits continuous overlap with both of these coalitions and thus sees increasing industry actor membership, the 'mobility transformation' coalition (Yellow cluster) started to separate itself more distinctly from the 'car continuity' coalitions and concurrently, saw increasing overlaps with the policy actor coalition (Green cluster).

By 2022–2023, both 'car continuity' coalitions are increasingly isolated within the discourse network, connected with each other through shared repugnostic storylines (see Table 5). However, the solution-framings further diverged, e.g., actors in the bottom-middle of the light blue cluster focused on promoting e-fuels as an alternative to electrification, while the connected actors on the top of the same cluster concentrated on electrification, also including shared mobility solutions. In contrast, actors within and across the 'modal transition' coalition and the 'mobility transformation' coalition became more densely connected, indicating a higher alignment around shared storylines. Additionally, both coalitions share a broad overlap with the policy actor coalition, while almost no overlap remains between this coalition and the 'car continuity' coalitions. Therefore, in terms of the success of the identified discourse coalitions, these findings suggest that the 'modal transition' and 'mobility transformation' coalitions have gained greater traction by achieving higher ideational congruence and attracting politically powerful actors. In contrast, the fragmentation and isolation of the 'car continuity' coalitions suggest that these coalitions are becoming more disconnected from mainstream policy discussions and are losing influence in shaping the dominant discourse around the floating signifier.

Additionally, to gain insights into the level of support for specific storylines by certain actors and changes in dominant discursive actors, actor-concept networks were visualised for each phase. In Fig. 9, actors are depicted as circles and according to the same colour classification as in the congruence networks above; storylines are depicted as squares and mapped according to their degree centrality (i.e., most central concepts are supported by the highest number of actors) while the line weight of the connections illustrates how often an actor draws on a specific storyline. Initially, from 2018 to 2019, the three most discursively active actors were *Bündniss 90/Die Grünen* (federal Green Party), their state-level counterparts, and the federal Social Democrats party (SPD). The most prominent storylines included electric vehicles, improved and affordable public transport, and cycling. Electric vehicles are strongly supported by the automotive manufacturer Volkswagen, the Ministry of Transport (*Transportministerium*), and the federal Green Party. Improved public transport was also advocated by the federal Green Party and the governing coalition of the time (*GroKo*). While cycling was promoted significantly by the federal Green Party, the Ministry of Transport, and the cycling lobby group Allgemeiner Deutscher Fahrrad-Club e. V.

During the COVID period (2020–2021), the top three discursive actors were the Left party (*Die Linke*) at the state level, the automotive manufacturer Audi, and the governing coalition (*GroKo*). The top three storylines were improved, as well as affordable public transport, cycling, and the need to redistribute urban space. Improved public transport was primarily supported by the Left
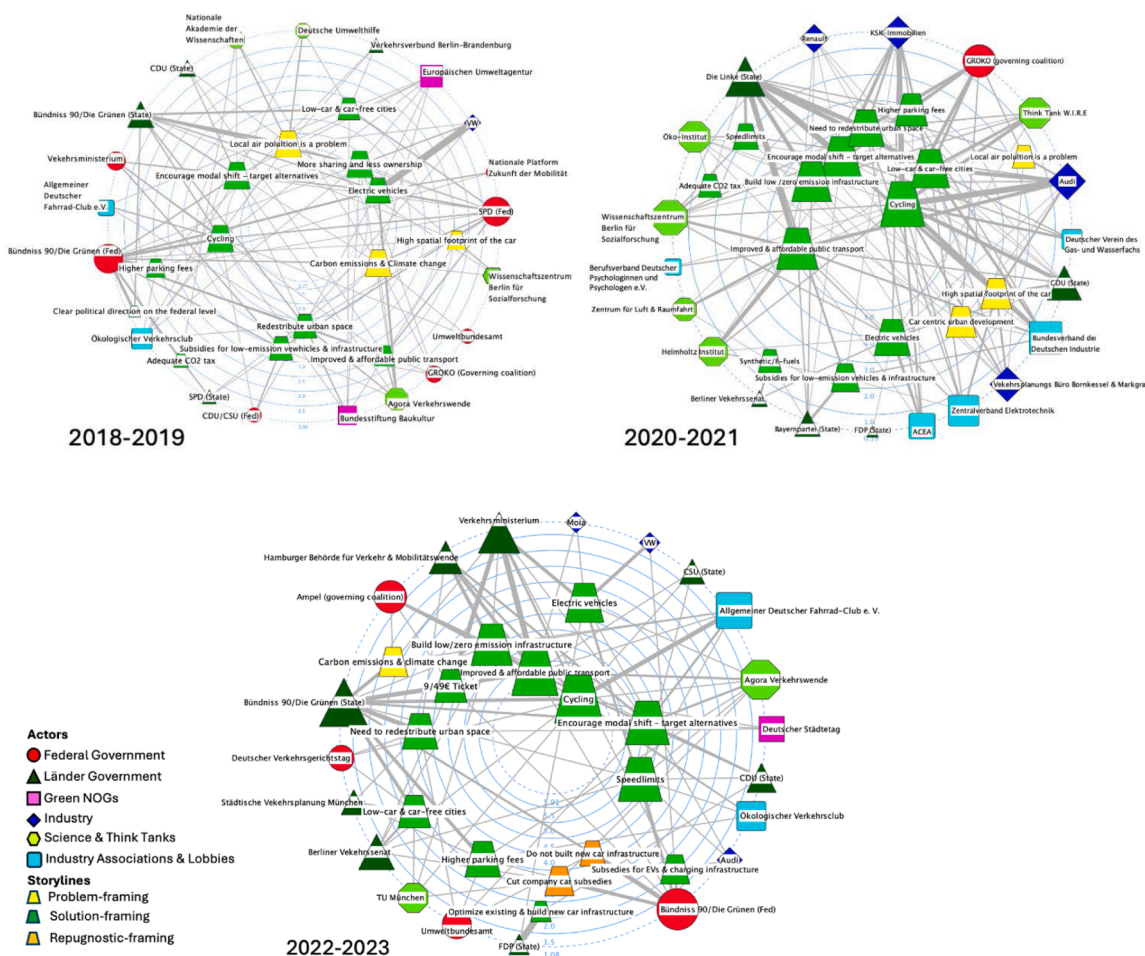
Fig. 9. Actor-concept networks of 2018–2019, 2020–21 & 2022–2023. Showing the top 15 storylines and top 20 actors.

party and actors affiliated with scientific institutions. Storylines in support of cycling were strongly promoted by the Left party and actors of scientific institutions, think tanks, and Audi. At the same time, the need to redistribute urban space was frequently advocated by the Left party and the governing coalition (*GroKo*).

During the post-COVID phase (2022 until mid-2023), the top three discursive actors were the Ministry of Transport, the federal Green Party and the new governing coalition (*Ampel*). The three most frequently drawn-up storylines included improved and affordable public transport, cycling, and electric vehicles. Improved public transport was strongly supported by the top three discursive actors. The cycling storylines received support from the federal Green Party and the cycling lobby group (*Allgemeiner Deutscher Fahrrad-Club e.* V.). While the electric vehicles storylines were most supported by VW, the Ministry of Transport, and the governing coalition.

Our analysis uncovered two important discursive strategies of actors: First, notwithstanding the shifts in discourse over the three phases, actors such as those belonging to liberal (FDP) and conservative (CDU/CSU) political parties both at the federal and state level and The German Association of the Automotive Industry (VDA) who initially heavily utilised storylines promoting 'car continuity' have exhibited persistent discursive involvement, and by drawing on repugnostic-framing storylines in the post-COVID phase attempt to polarise the discourse by deligimatising the solution-framing storylines of their discursive opponents. Here, discursive agents often perceive themselves as defenders of vital principles such as individual mobility freedom: *The car represents the freedom of individual mobility – the ability to get to any place anytime. We should not pit climate change mitigation against principles of freedom – Lindner, Liberal Party* (Die Welt, 2019) or technological openness: *Following the principle of technology openness, we must also allow sales of ICE vehicles after 2035 as long as they run on climate-neutral fuel sources – Wissing, Liberal Party & Transport Minister* (SZ, 2022a). Such discursive moves have led over the investigated periods to increased discursive push-back from actors, including the Green party, think tanks and activist groups that support less car-centric framings of the *Verkehrswende*. More specifically, a hardening of positions and seemingly unresolvable lines of conflict emerge around the following topics: (1) the potential ban on ICE vehicles, (2) the use of e-fuels or synthetic fuels for cars, (3) the expansion of car-centric infrastructure, (4) low-fare public transport, (5) a potential speed limit on German motorways and (6) the continued accessibility of cities for cars. See, for example, in the actor-concept network for 2022 until

mid-2023 (Fig. 8), *Bündnis 90/Die Grünen* frequently evoke storylines that call for no additional car infrastructure to be built while the FDP draws on storylines that support the optimisation of existing and the investments into new car infrastructure.

Second, other discursive proponents of storylines related to a 'car continuity' strategically switch sides and adapt their storylines to the shifting discourse that occurred over the analysed phases. Particularly, key industry actors, such as automobile manufacturers VW and Audi, co-opt the floating signifier to ostensibly support a broad shift away from the car-centric mobility regime. For example, Audi CEO Diesch stated: *Better mobility alternatives to the car must be developed quickly. It is definitely not the philosophy of my company to block up cities with cars* (SZ, 2022b). This is reflected in the actor-concept network for 20,219–2020, in which VW strongly promotes storylines related to electric vehicles, but by the last phase (2022 until mid-2023), Audi includes storylines such as low-car and car-free cities and cycling in their discursive repertoire (see Fig. 8). While this discursive support for cycling, low-car and car-free cities, as well as improved and affordable public transport, may signal an alignment with the mobility transformation discourse, it exists alongside sustained company investments in electric vehicles and ICE drivetrain technology. Such investments are further complemented by strong support for storylines advocating subsidies for adequate EV charging infrastructure to electrify all of Germany's ever-increasing car fleet. If implemented, this would likely reinforce the hegemonic status of the car for decades to come. The incorporation of such transformative storylines into their discursive repertoire thus can be viewed as an attempt by Audi to maintain their legitimacy and relevance in the shifting discourse around the Verkehrswende.

4.3. Discourse structuration and the evolution of dominant mobility futures

Analysing the congruence networks of the three phases (see Fig. 7) for indications of discourse structuration or even discursive closure reveals that the degree of separation between actors in the network due to using different storylines is relatively high from the beginning. In addition, the network diameter increases significantly in the last period (2022 until mid-2023), indicating a low ideational congruence amongst discursive agents and no structuration around a particular meaning of the floating signifier. Instead, an increasing separation between actors within the congruence networks over the three phases can be observed, as indicated by the consistent rise of the average path lengths in the networks. Furthermore, the normalised network density initially rises from 2018–19 to 2020–21 but then drops sharply for the post-COVID phase network. This significant decrease in density, in combination with the increased path length in the last period, suggests growing storyline polarisation among discursive agents.

During the pandemic phase, mobility restrictions, changes in transportation behaviour and opportunities for experiments likely shifted priorities and concerns within the discourse network. This might explain the temporary increase in network density for this phase, as actors coalesced around common immediate concerns. However, as the pandemic's immediate effects waned in the next phase, longer-term conflicts and differing visions for the future of mobility became more pronounced, leading to a sharp decrease in density. This development can be further attributed to intensified framing struggles and clearer lines of conflict during the post-COVID phase. This is marked by the emergence of repugnostic-framing storylines as certain actors align more strictly with distinct and opposing storylines and polarisation within the network increases. Overall, in the 2018–19 network, there might have been a broader consensus on the need for a mobility transition brought about by the "Federal Climate Change Act" and indicated by the higher number of problem-framing storylines. However, as the discursive focus shifts towards solution-framing storylines and specific policy measures, technologies and implementation strategies are debated, increasing separation between actors is observed, and the discourse becomes more fragmented. Table 6 summarises the above-described network measures for each phase.

Moreover, Fig. 10 zooms into these discursive framing struggles to gain a better understanding of whether certain meanings of the floating signifier have become more prominent than others despite the lack of discursive closure. Fig. 7 illustrates congruence networks in which actors are grouped based on their use of storylines related to one of the three possible mobility futures. Looking at the structural evolution of these networks, it becomes evident that while both the 'modal transition' and 'mobility transformation' future remain relatively stable over time, the 'car continuity' future is considerably less stable, as indicated by its change in structure. Similarly to the related discourse coalition above, the network for the 'car continuity' future across the three-phase shows discursive work predominantly from industry actors, industry associations and lobbies, as well as national and provincial policymakers from conservative as well as liberal parties and a few research institutes, while the 'modal transition' and 'mobility transformation' futures see a wide variety of different types of actor groups.

Fig. 10 further presents network and actor-level measures of the different mobility future congruence networks. In examining the number of actors participating in the discourse for each mobility future, an initial surge was followed by a more recent drastic decline for the 'car continuity' future. In contrast, the 'modal transition' and 'mobility transformation' futures have seen continuous growth in actor involvement, signifying sustained and expanding involvement of various discursive agents. The ideational congruence among actors based on shared storylines within the discourse nevertheless decreases across all three possible mobility futures (see Fig. 11). This decreasing normalised network density suggests a potential divergence in the utilised storylines among actors despite increasing actor participation. The average degree, which serves as a measure of the presence of influential actors (i.e., the number of highly

Table 6
Network measures of the full congruence networks depicted in Fig. 7.

Time phase	Network diameter	Average path length	Normalised network density
2018–19	4	2.05	2.8
2020–21	4	2.23	3.1
2022–mid23	6	2.54	1.6
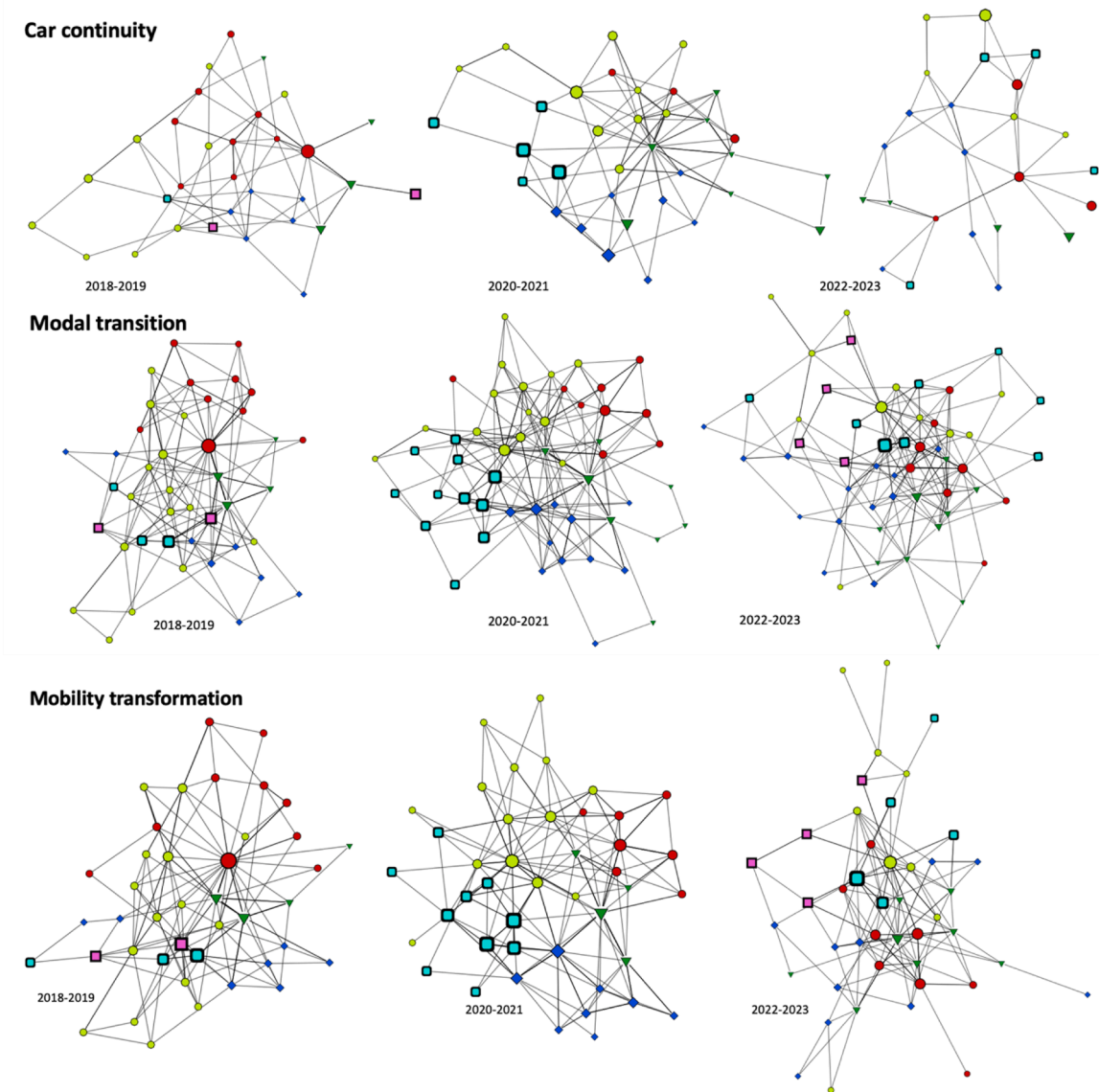
Fig. 10. Evolution of the actor congruence networks for the 'car continuity', 'modal transition' and 'mobility transformation' futures across the three time periods. The node size indicates an actor's influence level in the network based on degree centrality.

discursively active actors) within each of the mobility future congruence networks, initially increased for the 'car continuity' future but has faced a decline in the last period. The 'modal transition' future witnessed a steady rise before a slight decline; however, the 'mobility transformation' future remained on the rise.

Based on the most recent period, 2022–2023, it may be inferred that the discursive developments around the *Verkehrswende* are leaning towards a structuration around a 'modal transition' as exhibited by its relative stability over time and consistent growth in actor involvement. However, as also highlighted in the discourse coalition graphs (Fig. 8), it is worth noting that the 'mobility transformation' future gained more influential actors throughout each period.

5. Discussion

5.1. The significance of floating signifiers for transition processes

Studying the discursive framing struggles around the *Verkehrswende* through the concept of the floating signifier (Jørgensen and Philips, 2002) has offered novel insights into the evolving discourse on the German mobility transition. Understanding such terms as 'floating',(i.e., their meanings being constantly in flux) thus, provides an opportunity to investigate the making-possible of mobility
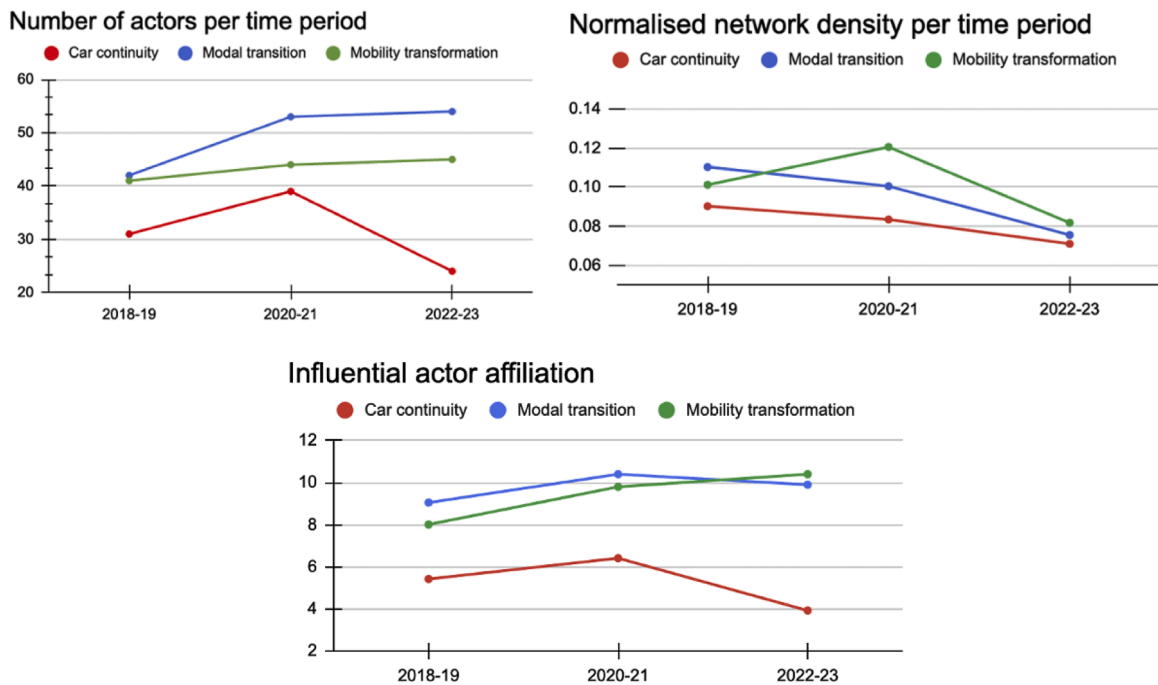
Fig. 11. Network and actor-level measures of the different possible mobility future congruence networks over the three time periods.

futures. The approach exemplifies how differing interpretations of transition-related terminologies shape socio-technical change. Beyond the case of the German mobility transition, our analysis has suggested that the flexibility of such terms generally warrants more analytical attention.

Our DNA results highlight the wide variety of societal actors who engage in discursive struggles to shape the meaning of the term to fit their visions of the future of mobility in Germany. In line with previous findings on floating signifiers, the lack of a strict definition allows discursive agents–often with fundamentally opposing perspectives, values, and ideologies–to commonly mobilize such terms (Rödle et al., 2022; Kögl and Kurze, 2013). The floating nature of such transition-related terms consequently can be considered an important underlying characteristic that allows to mediate interactions between different actor groups by providing a common signifier that each can adapt to their own understanding and agenda. Moreover, our findings indicate that the breadth of articulated meanings associated with the *Verkehrswende* became especially prominent during times of crises, such as the COVID-19 pandemic, in the sense that the more radical understandings of the mobility transition started to gain traction in the political discourse. During the phase 2020–2021, the discourse around the *Verkehrswende* experienced rapid re-articulation and a separation of discourse coalitions was observed as different discursive agents imposed their preferred interpretations of the changed conditions. The lack of fixed meaning of floating signifiers thus allows for more flexibility in defining the directionality of socio-technical change in times of crisis by sparking increased debates that can open the realm of possibilities. However, also less disruptive events, such as legislative changes, the rise of activist movements like Fridays for Future, and the introduction of new technologies like e-scooter sharing services, have also shaped the meaning-making process and contributed to the continuous re-articulation of the term's meaning. Therefore, unlike put forward in discourse theory (cf., Farkas and Schou, 2018), the contestation of meanings around a floating signifier was not confined to periods of crisis, but its ongoing meaning-making process was continuously influenced by a range of societal political, technological and economic developments.

Beyond the polysemous nature of the term *Vehrkerswende*, our analysis also revealed the discursive framing struggles and conflicts inherent to floating signifiers. Such conflicts amongst discursive agents, as they attempt to fix the meaning of a floating signifier, have been reported in previous discourse analyses on the circular economy (Niskanen et al., 2020) as well as the bioeconomy (Mijailoff and Burns, 2023) and can be considered a defining feature of floating signifiers (Jørgensen and Philips, 2002). However, despite the fact that our analysis of the different possible mobility futures and associated discourse coalitions indicates that the 'car continuity' future has lost discursive support throughout the three periods while the 'modal transition' and 'mobility transformation' have experienced growing support from key political actors, these struggles and intensified conflict have not (yet) resulted in discursive closure (i.e., no one meaning of the *Verkehrswende* becomes dominant, nullifying other forms of meaning). Instead, along with this evolution increasing discursive polarisation around the floating signifier's differing interpretations and the emergence of repugnostic-framing storylines coincide with ambiguous policy objectives and an absence of unifying strategies of how to achieve a sustainable mobility transition in Germany. These insights highlight that the ongoing discursive struggles around the floating signifier reflect a broader societal inde-cisiveness, which in turn affects the ability to foster coherent policy pathways. The terms *Verkehrswende* and *Mobilitätswende* are increasingly being pulled in diverse directions by various discursive agents, contributing to a more dispersed and fragmented discourse

over time, without a shared understanding emerging that could drive collective action. Furthermore, the decline in legitimacy for car-centric mobility discourse, while hopeful, alone seems like an insufficient condition to leverage action that signals a real departure away from the prevailing regime of automobility. The discourse related to a 'modal transition' and 'mobility transformation' future still lack the dominance or the strategic unity required to materialise in policy action. This suggests that although there is increasing discursive support for more transformative change, its scope is still contested (and fought against by powerful 'car continuity' proponents), which may at least provide a partial explanation for the lack of significant progress of the German mobility transition.

Both in 2022 and 2023 German transport sector missed all its national decarbonisation targets. Nevertheless, the transport ministry has developed no strategic action plan to close this emission reduction gap swiftly (Zeit, 2023a), resulting in the activist group Fridays for Future proposing their own strategic action plan while simultaneously requesting the resignation of the minster (*Die Zeit*, 2023b). Consequently, struggles around the meaning-making of floating signifiers may reinforce political paralysis as reflected in the lack of coherent policy interventions and the political reluctance to embrace more radical systemic changes of the mobility system. Unending disagreements on what precisely the problems are that should be addressed by precisely what kind of 'transition' can hinder policy-making processes. If such framing struggles and interpretative disputes over viable mobility futures persist, they may lead to discursive stalemates that could constrain the progress of socio-technical change. Additionally, this increasing polarization might also contribute to weakened public trust in governmental capabilities (e.g., see Statista, 2023), as the absence of an actionable strategy becomes increasingly evident. On the other hand, whilst an absolute consensus around the more radical mobility futures might appear highly challenging within the current political arrangements, more radical change is necessary to address the systemic injustices that are inherent to the car-based automobility regime (Sheller, 2018). Therefore, transitions research could benefit from critical investigations into the (im)possibilities of car continuity to consider the implications (and missed opportunity) of a mobility transition manifesting largely in the substitution of the drivetrain (Hawxwell et al. 2024).

Lastly, our analysis reaffirms that incumbent actors, such as actors from the automotive industry and lobby groups, can refer to more radical associations with the *Verkehrswende,* such as speaking up for "car-free cities" to appear supportive of more transformative mobility futures while still stabilising the prevailing car-centric arrangements both discursively and through their political influence and production practices. The discursive flexibility of floating signifiers, therefore, enables actors to present themselves as aligned with more radical changes than their activities might lead one to believe. The outcomes can be a greater dissonance between discourse and material change. This, in turn, can give the impression that significant progress is being made towards realising the promised 'transition', thereby potentially reducing the pressure on these actors to implement substantive action. These findings thus complement previous work that highlights the risk of strategic manipulation, co-optation and capture of floating signifiers (Tesfaye and Fougère, 2021) and their ability to enable an illusion of discursive commitment to an issue despite business-as-usual practices (Methmann, 2010; Blythe et al., 2018).

5.2. Limitations

While our study provides important insights into the discursive framing struggles around the German mobility transition from 2018 to mid-2023, a few methodological limitations and challenges bear mentioning.

First, solely relying on newspaper articles as a data source may not fully capture the spectrum of public discourse. Other sources of public discourse, like parliamentary debates or social media, could offer additional valuable perspectives (Leifeld, 2011). Similarly, relying on newspaper databases such as LexisNexis runs the risk of introducing biases due to the limitations of the search algorithms, which might restrict the scope of retrieved articles and potentially affect the comprehensiveness of the analysis. Second, focusing on storylines and discourse dynamics of a contemporary transition might overlook material aspects, such as the economic viability or technological feasibility of the proposed solutions (Markard et al., 2021). Any discourse analysis, therefore, may not fully reflect the intricacies of policy outcomes. Moreover, our results demonstrate that discursive support for more radical forms of socio-technical change can diverge from real-world actions. Thus, this highlights the need for a research design that integrates both discourse and empirical analysis of actions to mitigate the risk of overestimating rhetorical commitments and provide a more accurate assessment of the actual progress and challenges of transition processes.

Third, while the use of the Louvain clustering algorithm allowed us to identify discernible discourse coalitions, this approach has inherent limitations. As noted by Belova et al. (2023), any methods that simplify network structures, such as clustering algorithms, may risk misrepresenting the dynamics of discourse coalitions by artificially creating clusters. To mitigate this, we complemented the clustering algorithm with a qualitative analysis of the storylines within each cluster, ensuring that the identified coalitions were meaningfully interpreted. Furthermore, the identified coalitions were consistent with previously described mobility futures in the literature, which reinforces the validity and relevance of our findings. Nevertheless, caution must be applied to avoid overinterpreting the results. Lastly, the study's time frame, while spanning six years, inherently only captures the discourses in a specific temporal context. As discourses are dynamic and evolve, this temporal restriction may not fully represent their longitudinal development or potential future trajectories.

6. Concluding remarks

The aim of this study was to explore the contested nature of the German mobility transition through the discourse theoretical concept of the floating signifier. We applied discourse network analysis to 456 news articles from 2018 to mid-2023 to trace how problem- and solution-framings, actors' positions, discourse coalitions and the overall discourse structure evolved. In doing so, this paper makes three contributions to our understanding of the discursive dimensions of sustainability transitions: First, it demonstrates

how the polysemous nature of transition-related terms such as the *Verkehrswende* allows a variety of actors to engage in shaping the directionality of socio-technical change, therefore facilitating both consensus-building and framing-struggles. Second, it identifies how the term's ambiguity allows for rapid re-articulation during periods of crisis, but also reveals its risks of increasing polarisation and strategic co-optation. Especially the latter offers a direction for future research that critically examines the discursive underpinnings of transition-related terms—their various meanings, assumptions, interests, and power dynamics—to further our understanding under which circumstances such terms may be co-opted to mask the continuation of unsustainable practices under the guise of transition discourse. Third, this study has enabled a better understanding of how floating signifiers can contribute to the disconnect between discourse and real-world policy action. Our findings reveal that while there may be growing discursive support for more radical forms of socio-technical change (e.g., the 'mobility transformation' future), this does not necessarily translate into decisive policy measures. Instead, increased fluidity of these signifiers can amplify fragmentation and potentially prolong delays in achieving coherent action, especially when unresolved conflicts over their meaning persist. Future research could, therefore, investigate the relationship between discursive coalitions, institutional decision-making processes, and the material constraints that shape the implementation of more radical forms of socio-technical change. Such research could critically assess how power asymmetries among actors and coalitions impact the ability of transformative discourses to drive systemic change, as well as how and under what conditions fragmentation might be mitigated.

CRediT authorship contribution statement

Sophie-Marie Ertelt: Writing – review & editing, Writing – original draft, Visualization, Software, Resources, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Tom Hawxwell:** Writing – review & editing, Writing – original draft, Software, Resources, Project administration, Methodology, Formal analysis, Data curation, Conceptualization.

Declaration of competing 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.

Appendix I. Storyline classification

	Car continuity	Modal transition	Mobility transformation
Problem-framing storylines			
Required advancement of economic structures (3)	x	x	
Local air pollution is not a problem	x		
Traffic congestion	x	x	x
Carbon emissions and climate change	x	x	x
Human health and safety		x	x
Local air pollution		x	x
Noise pollution		x	x
Negative effects of the rising stock of passenger vehicles (45)		x	x
High attractivity of passenger car ownership		x	x
Need for a fair allocation of resources across mobility modes (3)		x	x
Solution-framing storylines			
Fuel source switch (7)	x		
Optimised vehicles and incremental improvements to ICE	x		
Optimise existing and build new car infrastructure	x		
Autonomous vehicles	x	x	
Policy measures and initiatives to support EV deployment (53)	x	x	
Clear political direction on the federal level	x	x	x
EU ETS	x	x	
Electric vehicles (EVs)	x	x	
Low and zero-emission mobility modes (excluding EVs) (45)		x	x
Low and zero-emission mobility infrastructure (excluding EVs) (2)		x	x
Measures to encourage a modal shift (5)		x	x
Policy measures to support EV deployment (5)	x	x	
Policy measures and initiatives to reduce car fleet size in cities (4)		x	x
More sharing and less ownership		x	x
Reduce car dependence		x	x
Speed Limits		x	x
Redistribute urban space		x	x
Low and zero-emission mobility modes (excluding EVs) (4)		x	x
Policy measures and initiatives to reduce car ownership (4)		x	x
Policy measures and initiatives to encourage & enable a modal shift (75)		x	x
Increased transport equity			x
Integrate private mobility service providers into public transport		x	

(*continued*)

	Car continuity	Modal transition	Mobility transformation
Low-car and car-free cities		x	x
Strassenverkehrsordnung (German general traffic law) must change		x	x
Repugnostic-framing storylines			
No CO2 tax	x		
Cities should remain accessible to all cars (2)	x		
No ICE ban	x		
No Speed Limits	x		
Economic concerns with EVs (3)	x		
Transition should not be a war on cars	x		
Freedom of mobility must be sustained	x		
Cars are the symbol of individuality & freedom	x		
Do not build new car infrastructure		x	x
No E-fuels for cars		x	
Only subsidies for EV company cars		x	
CO2 price leads to justice problems			x
CO2 price mechanism is not enough			x
Cutting tax privileges and incentives for cars (5)			x
Fuel-source switch is no transition		x	x
Resource and justice concerns of EVs (2)		x	x

Appendix II. Full list of storylines

Problem-framing storyline short	Storyline long
Local air pollution	The air quality in cities is severely impacted by vehicle exhaust emissions of carbon-fueled ICEs.
CO2 & Climate Change	CO2 emissions of the transport sector are continuously rising, and the sector thus has a direct negative impact on climate change.
High spatial footprint of the car	Cars and their related infrastructure are taking too much space away from other forms of mobility.
Car-centric urban development	Urban planning has for too long prioritised the private automobile as a primary transportation mode.
Human health & safety	Car-related emissions and accidents are a threat to human health and are costing society significant health damage costs.
Cars are getting bigger, heavier & faster	SUV-cation of the private automobile is exacerbating existing car-related problems (e.g., taking up more space, producing more emissions, causing more severe accidents)
Traffic congestions	Existing road network capacity is exceeded, leading to increased vehicle queuing.
Space scarcity	Urban space in cities is becoming increasingly scarce, and parking spaces for cars compete with living spaces for citizens.
Livability & atmosphere	Rising vehicle stock is impacting the livability and atmosphere of cities.
Overfinancing of automobility	Historically, the regime of automobility has received more financial benefits than other modes of transportation (e.g., more tax benefits for cars, more R&D funding for cars)
Need for new value creation & jobs	The German car industry is of great economic importance to the country, and new forms of value creation around sustainable mobility solutions are needed to ensure the job safety of current workers.
Need for a strong economy	The automotive industry is one of our most important economic sectors in the country, and, for many in our society, the car is a symbol of our engineering skills and will ensure Germany's economic success in the future.
Need for new business models	Instead, the carmakers and the federal government continue to rely on the business model, which has remained essentially unchanged since the early days of the car. It consists of three pillars: the fossil combustion engine, manual control and individual ownership, but this has to change now.
Noise pollution	Car traffic has become a major burden in many cities. In particular, noise pollution and nitrogen oxide emissions are responsible for massive negative externalities.
Rising stock of passenger vehicles	There are currently around 46 million passenger cars in Germany – and the trend is rising. This is becoming an issue that can no longer be ignored.
High attractivity of passenger car ownership	So far, we have made the car more and more attractive, with much political support, but it cannot go on like this.
Cemented landscapes	Every parking space is fought over as if the public space today just because the space in the city belonged forever to motorists and not to all road users. Cities are not parking lots but places to live.

Solution framing-storyline short	Storyline long
Electric vehicles EVs	Electric vehicles are the key to climate-friendly mobility.
Improved & affordable public transport	To make public transport attractive, the current offering must be extended and priced at an affordable price point.
Cycling	Changes in transport behaviour towards an increase in cycling play an important role in the sustainable mobility transition.
Sharing solutions	A mobility transition requires the development and promotion of shared mobility services that create alternatives to private cars, such as car sharing.
Adequate CO2 tax	An adequate CO2 tax based on the actual damage costs that fossil fuels cause is needed to accelerate the mobility transition.
Subsidies for low-emission vehicles (LEVs)	LEVs will become more attractive for consumers with the help of strategic subsidies for both the vehicles and their related infrastructure.

(*continued*)

Solution framing-storyline short	Storyline long
Low car & car-free cities	Removing/lowering the number of cars from urban areas would lower carbon emissions, air pollution, and road traffic accidents, as well as improve the overall livability of cities.
Modal shift	A mobility transition requires a shift from private vehicles to other transport modes like cycling or varying forms of public transport.
Redistribute Urban space	Citizens must claim back the space that cars take up in cities.
Clear political direction on the federal level	Politicians must make courageous decisions and create reliable regulatory frameworks that can guide the future of the German transport sector.
Public Transport	To reshape the mobility sector, a large increase in public transport users will be needed.
Fair allocation of resources across modes	These subsidies for cars alone have a volume of 30 billion euros a year nationwide. The money could be used to achieve much in the mobility transition, but in the mind of the state government, Bavaria is a pure "car country". The mobility industry, however, includes not only car manufacturers but also many other sectors, from rail to bicycle retail, that deserve subsidies.
Increased transport equity	Even outside cities, all citizens should be able to enjoy affordable and climate-friendly mobility suitable for everyday use.
Integrate private mobility service providers into public transport	We will develop a commercially viable business model for Moia to integrate the service into the HHV.
9/49€ Ticket	This also includes the low-priced 49-euro monthly ticket, which will come next year and be valid nationwide on local transport. This is according to the motto, "One ticket for everything, from the bus to the tram and subway to the S-Bahn and the regional train". The successor model for the summer nine-euro ticket is intended to help, for example, commuters who complain about high petrol and diesel prices and could then travel to work more cheaply.
Pop-up cycling lanes	It was a simple administrative act, implemented overnight; the bike paths were already planned. All it took was a little yellow paint and traffic cones - it might not look pretty; however, it is very low cost and can be actualised in no time. Berlin's cyclists finally have the space they deserve.
(Hybrid) Electric Trains	Battery-powered hybrid trains are an important bridging technology in transitioning towards a climate-neutral railways sector.
(E-)Cargo bikes	Cargo bikes can contribute to a sustainable mobility transition. Like some municipalities, the Bavarian state capital Munich, therefore, provides financial support for the purchase of cargo bikes for its citizens.
Intermodal Maas	At the heart of the new mobility is the idea of transporting people and goods multimodally: quickly, easily, safely, cheaply, CO2-neutrally and without unnecessary transfers. This requires overarching mobility platforms that can be used to plan, book and pay for trips.
Build zero/low-emission mobility infrastructure	We are now expanding the bicycle network again. In the past legislative period with Green participation, it was 30 to 40 kms a year, less than promised. I promise 60 to 80 kms a year and 100 kms as a long-term perspective. It's a process, as always, in politics.
E-scooters	E-scooters facilitate short-distance travelling, so we must take advantage of the current boom and integrate them into the transport network so that they contribute to a sustainable mobility transition.
Reducing car dependence	We need to shape the transport transition in such a way that more people do without their own cars because they simply don't need them anymore.
Strassenverkehrsordnung must change	Again and again, citizens ask us that a speed limit of 30 km/h should be introduced in their street or neighbourhood – and again and again, they are annoyed when we must explain to them that this is not possible at this specific point because of the road traffic regulations, this must be changed.
Changing car benefitting tax structures & incentives	In principle, it would make sense to change the tax structures: The green bonus for hybrid electric vehicles should be withdrawn, and the VAT rules for public transport and the electricity tax regulation for electric public transport should finally be changed.
Subsidies for e-bikes & cargo bikes	A transport policy geared to environmentally friendly modes of transport would also subsidise the purchase of pedelecs and electric bicycles.
Diesel driving bans in cities	We stand behind the driving bans for older diesels. It is supposed to go in quick succession; in February, it will catch the vehicles with the Euro standard four, and in October 2023, almost certainly also those with emission class five. More than 100,000 vehicles from Munich alone will no longer be allowed to drive into the city centre via the Ring and will no longer be allowed to drive on the Ring itself.
Congestion charge zones	Another political measure would be much better: a city toll. Every driver would have to pay this daily fee, regardless of whether they are driving a diesel or gasoline car in a city. This way, the so-called 'polluter pays' principle would be implemented.
Speed limits	I want a speed limit because I believe that the incentive to build big cars with huge engines will then be less. Besides, it would make a strong contribution to greater road safety.
Subsidies for zero-emission mobility & infrastructure	Despite our differing views on how quickly and how much car traffic must be reduced, we have agreed that a mobility transition is only possible when funding the expansion of public transport and cycle paths has priority and must also reach beyond the city's outskirts.
Increase bus/train personnel	Given the shortage of public transport drivers, concepts would be needed on how to attract staff through training and how to keep them, namely through better employment conditions.
Drastically improve public transport capacity	However, in the bus sector, there are huge gaps in the network coverage and frequency, especially in rural areas. Without increased capacity in rural areas, however, there is no mobility transition.
Autonomous vehicles	Road safety and sustainability will increase sharply in Hamburg due to the adoption of teledriving and autonomous driving.
Carsharing subsidies	Car sharing is an indispensable building block for the climate-neutral transport of the future and should be funded by the future federal government over the next four years in support totalling 500 million euros.
Subsidies for EVs & charging infra	Every euro of funding for charging infrastructure increases the attractiveness of the electric car, almost more than a purchase subsidy for the vehicle itself. We can only achieve the energy transition by joining forces. The charging infrastructure plays a key role in this.

(*continued*)

Solution framing-storyline short	Storyline long
Higher parking fees	Parking space in the city centre will be scarce and more expensive across the board; if you live within the S-Bahn ring, you should pay ten euros per day as a long-term parker, and short-term parkers at least five euros an hour.
ICE ban	That is why we are calling on politicians to ban the sale of new vehicles with combustion engines from 2025.
Smart parking management	Information about where a space is currently available could also be exchanged between vehicles. At the same time, it must also be possible to differentiate parking prices depending on the time of day. Traffic flows and volumes could be controlled in this way.
Climate-neutral fuel sources	Synthetic fuels, and those in green hydrogen and biogas, are a solution for climate-neutral mobility.
Hydrogen fuel cell vehicles	I also call for much more passion when it comes to hydrogen. Battery-powered electromobility will not be suitable for everyone. In the future, too, there will be people who prefer to refuel rather than charge, so hydrogen is needed.
Technology openness	All modes of transport and technologies are needed for climate neutrality - we must remain completely open.
Synthetic & E-fuels	That's why I'm also in favour of e-fuels, because they can be a solution to reduce emissions of the existing vehicle fleet.
Optimised vehicles & incremental improvements to ICE	Internal combustion engines should be further developed to exploit their full efficiency potential.
Optimize existing & build new car infrastructure	Even in ten or twenty years, there will still be cars. It makes sense to continue the construction and expansion of selected roads to close gaps around major traffic axes.
Plug-in Hybrids	We need the electrification of passenger cars through hybrid and electric drivetrains, as no other scalable technology is available to achieve the 2030 climate targets.
Lowered energy tax for EVs	We need a lower energy tax. This would lower the price of electricity and encourage more people to switch to more environmentally friendly EVs.
EU ETS	It is also important to take advantage of the beneficial effects of capitalism. There is currently a growing interest from companies to invest in CO_2 avoidance technologies. The EU emissions trading scheme plays an important role in this. Companies from industry and the energy sector in Europe are currently taking part. They are obliged to purchase a certificate for every tonne of CO_2 emitted.

Repugnostic-framing storyline short	Storyline long
Do not build new car infrastructure	We can still stop this madness. We are in exactly the right place to end this building sin and to streamline the motorway lanes into a smaller network. It is a question of political will.
Fuel-source switch is no transition	There is no mobility transition if we replace every combustion engine with an EV. The aim must be to "snatch" public spaces from the car.
No COVID support for ICEVs	Now, it is a matter of defending the ongoing mobility transition and preventing purchase premiums for new combustion engines. Just because the car lobby shouts the loudest doesn't mean you have to reward them.
E-SUVs not sustainable	E-SUVs are not eco-friendly cars and do not contribute to climate change mitigation.
EVs not affordable to the masses	Only 24 % of the population is considering buying an EV in the next few years, and 69 % of those surveyed still do not see battery models as an alternative to the combustion engine because the acquisition costs are simply too high.
No E-fuels for cars	Hydrogen and e-fuels are the champagnes of the energy transition. They belong in hard to decarbonising ships and planes, but not the car tank.
No CO_2 tax	We want to get to the root of the problem and demand the abolition of the CO_2 tax. This way, the fuel cost will decrease on its own.
Cut the commuter allowance	We need to make the commuter allowance more ecological and reduce it. Politicians must make it clear that all means of transport are on an equal footing when it comes to commuting.
Do not cut the car commuter allowance	If the price of gasoline increases by ten cents, the commuter allowance must be increased by one cent. The commuter allowance remains in place. This is a coalition demand of the CSU, from which we will not move away.
No ICE ban	Banning the internal combustion engine is completely unnecessary for a functioning climate or environmental protection.
No diesel driving bans in cities	I do not consider such far-reaching restrictions on diesel vehicles proportionate and would concentrate all efforts on avoiding driving bans through air pollution control plans.
No Speed limits	We are against a general speed limit on German motorways. That's not the real issue when it comes to CO_2 reduction. Over the decades, our cars and our product image have become a kind of seal of approval for German engineering.
Transition should not be a war on cars	A vocal and sometimes aggressive minority is waging a war against cars, motorists and the automotive industry. In the guise of apparent progressiveness, re-education is demanded. I observe a desire for the demise of a key industry instead of climate change mitigation.
Electric vehicles not resource & energy efficient	Because the production of large battery capacities is energy-intensive, the production of an electric car produces significantly more greenhouse gases than vehicles with conventional engines – on average, 1.5 times the amount. This is a major reason why the carbon footprint of EVs is even bigger than that of diesel cars.
Electrification should not lead to unemployment	If the competitive situation of the German industry in the field of electromobility does not improve in the coming years and the import demand for battery cells and electric vehicles continues to increase with the market ramp-up of electric vehicles in Germany, the impact on employment structures will be considerable.
Do not build new car infrastructure	I call for a paradigm change in the German transport policy and a moratorium on all motorway and federal road projects, including further construction of the A49.
CO_2 price leads to justice problems	It seems plausible to me that a higher CO_2 price helps to reduce CO_2 emissions, but there is a social issue associated with it. We cannot simply raise the prices of CO_2 and, for example, leave commuters with older cars, small wallets and oil heaters in the countryside to their own devices. These questions must then be answered in one breath.
CO_2 price mechanism is not enough	Subjectively, there has been little decline in traffic since the higher prices – regardless of new price records at the petrol station. For many commuters, price is not the decisive criterion in their choice of means of transport.

(*continued*)

Repugnostic-framing storyline short	Storyline long
Cut the Green tax bonus for EVs	Premiums for the purchase of electric cars must be abolished. Germany simply can no longer afford misguided subsidies.
No more company car tax privileges	The general public also uses taxpayers' money to excessively promote cars for top earners, who have luxury company cars at their disposal as an attractive salary extra. Germany must no longer incentivise the purchase and use of cars with high fuel consumption by companies.
Cut diesel owner tax privileges	Anyone who is serious about the mobility transition from an economic point of view and wants to keep costs as low as possible must first create equal opportunities among the drivetrains. As long as fossil fuels have an advantage, there is no need to discuss openness to technology. That is why we favour abolishing all state subsidies for petrol and diesel cars.
Free/affordable ÖPNV only benefits the urban population	If citizens in rural areas did not receive the same or similar offer as people in the city with the €49 ticket, then this is a blatant violation of the constitutional principle of the equivalence of living and working conditions in urban and rural areas.
Only subsidies for e-company cars	Passenger car emissions in Germany could be reduced by almost a third, and the national climate targets in the transport sector could be achieved if all company cars were electrified by 2030.
Not enough capacity for free/low public transport	Tariff measures alone are not enough. The most important thing is to expand the range of bus and train connections in the city and the rural district of Regensburg. Here, too, the long-term support through financing commitments is absolutely necessary.
EV subsidies must continue	Consumers will be left in the lurch, and the ramp-up of e-mobility will be slowed down without a continuation of the EV premiums.
Consumer preference for SUVs	In any case, for us, SUVs are the models that customers love and have the largest margins, and given the uncertainties surrounding the switch to electric mobility, it would be economically irresponsible to say that we are leaving this lucrative business to our competitors.
Charging/refueling infrastructure is lacking	To reach one million public charging points by 2030, around 2000 new charging points would be needed from now on – per week. That's ten times what it is today.
Cities should remain accessible to cars	Car-free inner cities are completely out of touch with reality. There are people on the road here who transport more than themselves, who can't ride a bike because they're older or frail, who work in delivery traffic, who can't cycle through the streets on a cargo bike as craftsmen. But I am very much in favour of focusing on clean drives, hydrogen, electric cars, e-fuels. Offers instead of bans – that should be our motto.

Appendix III. DNA Actor List

Actor name	Actor group
Ampel Regierung	Federal Government
Bundesministerium für Wirtschaft & Klimaschutz	Federal Government
Wirtschaftsministerium	Federal Government
Wirtschaftsweisen	Federal Government
Bundesumwelt Ministerium	Federal Government
Bundesministerium des Innern, für Bau und Heimat	Federal Government
GROKO Regierung	Federal Government
Bündniss 90/Die Grünen	Federal Government
Verkehrsministerium	Federal Government
Verbraucherzentrale Bundesverband	Federal Government
Umweltbundesamt	Federal Government
Klimaliste 2021	Federal Government
Die Linke	Federal Government
FDP	Federal Government
CDU	Federal Government
CSU	Federal Government
SPD	Federal Government
AFD	Federal Government
Deutscher Verkehrsgerichtstag	Federal Government
Deutscher Städtetag	Federal Government
Nationale Plattform Zukunft der Mobilitä	Federal Government
Städtischen Verkehrsbetriebe der Stadt Monheim	Federal Government
Nationalen Plattform Elektromobilität (NPE)	Federal Government
Münchner Stadtraat	Federal Government
Straßenamt Berlin	Federal Government
Hamburger Behörde für Verkehr & Mobilitätswende	Federal Government
Städtische Vekehrsplanung München	Federal Government
Landesregierung Bremen	Federal Government
Bayerische Staatsregierung	Federal Government
Hamburger Behörde für Stadtentwicklung und Wohnen	Federal Government
Berliner Vekehrssenat	Federal Government
Senat des Stadtstaats Bremen für Umwelt	Federal Government
FDP (Länder)	Federal Government
AFD (Länder)	Federal Government

(*continued*)

Actor name	Actor group
Bayernpartei	Federal Government
Die Linke (Länder)	Federal Government
CSU (Länder)	Federal Government
Bündniss 90/Die Grünen (Länder)	Federal Government
CDU (Länder)	Federal Government
SPD (Länder)	Federal Government
Ionity	Industry
Renault	Industry
Tier	Industry
Brose	Industry
Moia	Industry
Vay	Industry
Trumpf	Industry
L'Oréal	Industry
Sixt	Industry
Telefonica Deutschland	Industry
Argus	Industry
Hamburger Hochbahn	Industry
Kwiggle	Industry
Share Now	Industry
Verkehrsverbunds Berlin-Brandenburg (VBB)	Industry
Münchner Vekehrsgesellschaft (+)	Industry
Lime	Industry
Volvo	Industry
TomTom	Industry
Beratungsgesellschaft Aengevelt Immobilien	Industry
ECE	Industry
Autobahn GmbH	Industry
Porsche	Industry
e.GO Mobile	Industry
EnBW	Industry
Mercedes-Benz Group	Industry
FlixBus	Industry
Bosch	Industry
Sonnen	Industry
Deutsche Bahn	Industry
Buro Happold	Industry
DPD	Industry
BMW	Industry
Baron Cars	Industry
Apcoa Parking Group	Industry
VW	Industry
Audi	Industry
KSK-Immobilien	Industry
eFuel Alliance	Industry Associations & Lobbies
Bundesverband Deutscher Omnibusunternehmen	Industry Associations & Lobbies
Verband Deutscher Vehrkehrsunternehmen	Industry Associations & Lobbies
Handelsverband Deutschland	Industry Associations & Lobbies
Bundesverband der Deutschen Industrie	Industry Associations & Lobbies
Arbeiterwohlfahrt	Industry Associations & Lobbies
Radlogistikverband	Industry Associations & Lobbies
Verbunds Service und Fahrrad	Industry Associations & Lobbies
Autofahrerclub	Industry Associations & Lobbies
Bundesverband Carsharing	Industry Associations & Lobbies
Zentralverband Elektrotechnik- und Elektronikindustrie	Industry Associations & Lobbies
Arbeitgeberverband Gesamtmetall	Industry Associations & Lobbies
Zentralverband Deutsches Kraftfahrzeugsgewerbe	Industry Associations & Lobbies
IG Metal	Industry Associations & Lobbies
Verband der Immobilienverwalter Deutschland	Industry Associations & Lobbies
Verbande der Metall- und Elektroindustrie BW	Industry Associations & Lobbies
Deutscher Gewerkschaftsbund	Industry Associations & Lobbies
Cargo-Gesamtbetriebsrats	Industry Associations & Lobbies
Bundesverband Zukunft Fahrrad	Industry Associations & Lobbies
Ökologischer Verkehrsclub	Industry Associations & Lobbies
Bundesverband für Wohnen und Stadtentwicklung	Industry Associations & Lobbies
Deutscher Verein des Gas- und Wasserfachs	Industry Associations & Lobbies
Allgemeiner Deutscher Fahrrad-Club e. V.	Industry Associations & Lobbies
Verband der Automobilindustrie	Industry Associations & Lobbies
Bundesverband der Deutschen Industrie	Industry Associations & Lobbies
ADAC	Industry Associations & Lobbies

(*continued*)

Actor name	Actor group
Vehrkehrs Club Deutschland	Industry Associations & Lobbies
European Automobile Manufacturers Association	Industry Associations & Lobbies
Letzte Generation	NGO
Lebenswerte Städte	NGO
Deutsches Verkehrsforum	NGO
Naturschutzbund	NGO
Bundes Naturschutz	NGO
Runter vom Gas	NGO
Changing Cities E.V.	NGO
Extinction Rebellion	NGO
Greenpeace	NGO
Ökologischer Verkehrsclub Deutschland e.V.	NGO
Sand im Getriebe	NGO
Deutschen Städte- und Gemeindebunds	NGO
Fridays For Future	NGO
Domagkpark e.V.	NGO
Bund für Umwelt und Naturschutz Deutschland BUND e.V.	NGO
Deutsche Umwelthilfe	NGO
Institut für Umwelt Medizin	Science & Think Tanks
Universität Kassel	Science & Think Tanks
Deutschen Akademie für Städtebau & Landesplanung	Science & Think Tanks
Institut für Stadtbaukunst TU Dortmund	Science & Think Tanks
Acatech	Science & Think Tanks
Arbeitsmarkt-und Berufsforschung	Science & Think Tanks
TU Berlin	Science & Think Tanks
TU München	Science & Think Tanks
Mobility Institute Berlin	Science & Think Tanks
FU Berlin	Science & Think Tanks
Karlsruher Institut für Technologie	Science & Think Tanks
Future Mobility Lab Uni St. Gallen	Science & Think Tanks
Otto-von-Guericke-Universität	Science & Think Tanks
Kompetenzzentrums Öffentliche Wirtschaft, Infrastruktur	Science & Think Tanks
Deutsches Institut für Wirtschaftsforschung	Science & Think Tanks
Transport & Enviroment	Science & Think Tanks
Wuppertal Institute	Science & Think Tanks
Agora Energiewende	Science & Think Tanks
Helmholtz-Zentrum Hereon	Science & Think Tanks
Wissenschaftszentrum Umwelt der Universität Augsburg	Science & Think Tanks
Hochschule Rhein-Main	Science & Think Tanks
Frauenhofer-Institute	Science & Think Tanks
Vekehrsplanungs Büro Bornkessel & Markgraf	Science & Think Tanks
RWTH Aachen	Science & Think Tanks
Institut der deutschen Wirtschaft	Science & Think Tanks
Umwelt- und Prognose-Institut	Science & Think Tanks
Münchner Ifo-Institut	Science & Think Tanks
Center of Automotive Management	Science & Think Tanks
Center Automotive Research	Science & Think Tanks
Nationalen Akademie der Wissenschaften (Leopoldina)	Science & Think Tanks
Zentrum für Luft & Raumfahrt	Science & Think Tanks
Mercator Research Institute on Global Commons & Climate Change	Science & Think Tanks
Institut für Zukunftsstudien und Technologiebewertung	Science & Think Tanks
Alianz Pro Schiene	Science & Think Tanks
Bundesstiftung Baukultur	Science & Think Tanks
Deutsches Institut für Urbanistik	Science & Think Tanks
GEOMAR	Science & Think Tanks
Wissenschaftszentrum Berlin für Sozialforschung	Science & Think Tanks
Helmholtz Institut	Science & Think Tanks
Die Deutsche Rohstoffagentur DERA	Science & Think Tanks
Öko-Institut	Science & Think Tanks
Institut UPI	Science & Think Tanks
Hochschule Trier	Science & Think Tanks
Hochschule für Technik und Wirtschaft	Science & Think Tanks
Leibniz-Institut für Wirtschaftsforschung	Science & Think Tanks
TU Dresden	Science & Think Tanks
Deutsche Verkehrswissenschaftliche Gesellschaft.	Science & Think Tanks
Europäischen Umweltagentur	Science & Think Tanks
Agora Verkehrswende	Science & Think Tanks
TU Harburg	Science & Think Tanks
Think Tank W.I.R.E	Science & Think Tanks
IHS Market	Science & Think Tanks

(continued)

Actor name	Actor group
Zukunftsinstitut	Science & Think Tanks
Allianz pro Schiene	Science & Think Tanks
ICCT	Science & Think Tanks

Data availability

Data will be made available on request.

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