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Advances in Transport Policy and Planning

Transport and Energy Transition

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TRANSPORT POLICY AND PLANNING

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Transport and Energy Transition

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CHAPTER ONE

Introduction

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Abstract

This book examines the complex, "wicked" challenge of decarbonizing global transport systems, drawing on socio-technical, institutional, and political perspectives. It situates transport energy transition within the broader context of climate change mitigation, emphasizing the interplay between path dependency, large technological systems, and socio-technical imaginaries. The analysis integrates insights from the multi-level perspective on innovation, historical institutionalism, and policy paradigm shifts to explain why transport remains one of the most difficult sectors to decarbonize. Contributors explore the roles of state capacity, market governance, behavioural change, and equity considerations in shaping viable transitions. Case studies address organizational reform, policy mixes, rural mobility, and social movements, highlighting both successes and failures in advancing post-carbon transport. By critically assessing the limits of techno-optimism, the influence of modelling, and the embeddedness of mobility in cultural norms, this volume identifies pathways for disrupting entrenched systems and enabling just, sustainable futures for moving people and goods.

1. Introduction

This book explores the possibilities and pitfalls of an energy transition in transport, one that would shift the systems used to move people and goods around the world off of hydrocarbon-based fuels in order to mitigate climate change and produce associated benefits for public health and

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wellbeing. The goal of a post-carbon era in global transport is embedded within the paradox that energy transition becomes increasingly daunting at the same time that it appears ever more necessary. In the face of mounting evidence about the risks from, and costs of, climate change, most countries struggle *harder* with the challenge of shifting energy sources that power their mobility. From a detached, rational perspective, such a correlation between an intensifying climate crisis and growing resistance to address transport energy transition seems to make little sense. But societies do not develop only according to paths determined by rational calculations, but also deeply held norms, behavioral and cognitive habits, ideological blind spots and material interests. Thus, an eclectic perspective on understanding the transport and energy transition is called for, one that carefully considers evidence while also being open to the beliefs and interests that feed into policy and planning options to address the mounting problems of, and from, mobility. In the chapters that follow, we seek to shed some light on how energy transition in transport could advance beyond proposals and plans, and yield outcomes that sustain economic and social systems which appear increasingly vulnerable to the consequences of ongoing greenhouse gas emissions.

Since the Paris Agreement entered into force on 4 November 2016, mandating pursuit of the transition to a sustainable future climate, countries, regions and cities across the globe have been attempting to advance plans for decarbonization of their energy sectors. The Paris treaty represents "the first global accord on climate change that contains policy obligations for all countries" designed to prevent global mean temperatures rising by more than 2 degrees Celsius by 2050 (Dimitrov, 2016). The initial evidence from these efforts illustrates how transport has posed among the more challenging problems for countries attempting to meet the decarbonization levels that would be necessary to implement the Paris Agreement, with each transport subsector providing distinct barriers to transformation. International aviation and shipping, for example, demand cross-border agreement on transition measures that have proven difficult to achieve for economic and political reasons. Decarbonization of flying, in particular, would depend on technological breakthroughs that have yet to materialize.

Such a techno-social "tipping point" might be closer to arriving in the energy sources used to power private motor vehicles, where the sales of battery electric vehicles could outstrip sales of combustion engine vehicles by 2035, if governments around the world follow their officially stated

policies (IEA, 2024). However, in light of recent geopolitical uncertainty and cost increases throughout the EV supply chain, industry analysts have begun to slash their forecasts for EV uptake (Winton, 2024) Fossil fuels still account for 95 % of global transport energy usage in total (United Nations, 2021). Big question marks remain over the extent to which extraction of the raw materials needed for electric car production can be scaled up, and what the consequences for societies and natural environments would be (Michaux, 2021).

Global modelling studies illustrate the challenges facing the transport sector as a whole. In the synthesis for the sixth Assessment Report by the IPCC, for example, the following graph is used to show that the transport sector is among the sectors estimated to be most difficult to decarbonize: (Fig. 1).

However, daunting as these numbers are, quantifications do not suffice to grasp the full challenge of global transport decarbonization. If the history and possible futures of transport are considered through numbers only, they risk presenting us with a deterministic narrative of sociotechnical change in which human agency is both obscured and underestimated. Critical researchers have cautioned that the popularization of the "tipping point"

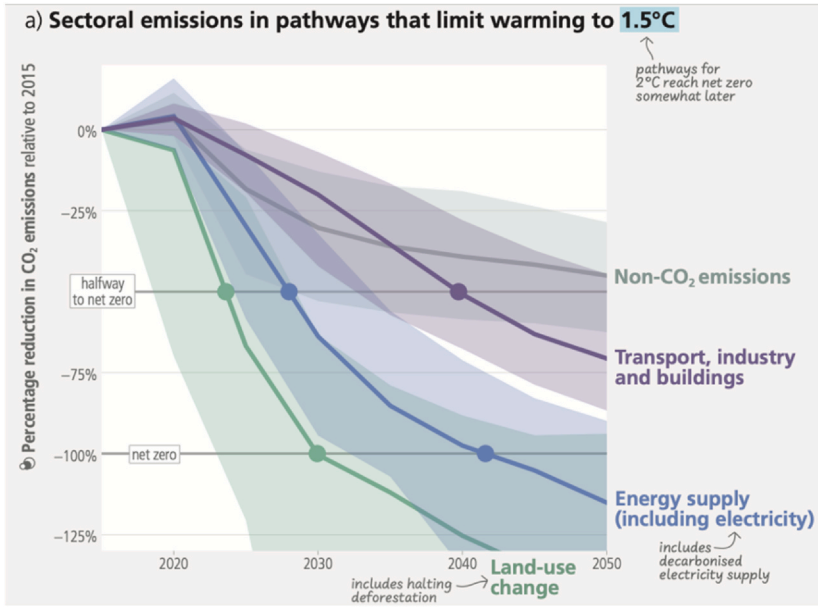

Fig. 1 Sectoral emissions in model pathways that limit global warming to 1.5 °C (IPCC, 2023, p. 94).

concept, now used to describe everything from ecological systems to behavioral change and EV uptake, reinforces precisely such deterministic narratives. They argue that the hope for positive, "social tipping points" that could allow the steep decarbonization pathways required for the 1.5 degree global warming target to appear feasible, lack a basis in scientific evidence and fail to account for complex social dynamics (Milkoreit, 2023). Computer modelling, while necessary to evaluate interactions between social, technological and biophysical spheres, carries with it a risk of presenting political choices as matters of predetermined, and thus inevitable, development trajectories (Hulme, 2023).

What sociologist Theodore Porter (1996) has termed a "mechanical objectivity" residing in scientific calculations holds the power to convince, but also to transform subjective assumptions – about the factors and forces that drive technological change, for example, or what values should inform environmental regulation – into objective facts when they are in fact neither objective, nor facts. Accepting such "facts" as objective can then create arbitrary constraints on subsequent action. Knowledge of historical transport changes is crucial to inform political choices for the future, but transport policymakers and planners must also be careful not to reify historical development patterns. Policies and planning for transport decarbonization must grapple with the necessity of decisively breaking away from established trajectories that are generating increasingly unsustainable outcomes. Being adequately reflexive about the relation between history and the future is one of the central challenges for today's transport planners, in that they must remain acutely aware of how historical interpretations risk being "black-boxed" as tacit assumptions about causal relationships in computer models. The contributors to this volume seek to unpack the black box by interpreting real evidence from actual attempts at major change in transportation plans and technology that were both successful and unsuccessful.

One key lesson from the previous centuries of technological and economic development in general, and mobility transformation in particular, is that barriers to societal change rarely, if ever, pose immutable limits to systemic change. They can be shifted, or sometimes even removed, by technological and political disruption. Just as often, however, they can be reified by a lack of technological or political imagination combined with the increasing returns to particular interest groups who benefit from maintaining the status quo. The challenge for people and institutions working for transport system decarbonization is gauging the extent to

which the known barriers of today represent entrenched limits to what can be achieved, versus the degree to which they can be deconstructed through political intervention that enables technological and social adjustment.

This judgement is complicated by the fact that transport decarbonization is typically premised on an unspecified form and extent of disruption across technological, political, economic, and cultural sectors. Technological breakthroughs, in themselves dependent on innovative thinking about industrial policy, may well be necessary, but they are rarely sufficient to fundamentally alter transport patterns. Actual change often requires both regulatory and behavioral change that enables new technology to become widely used. At the base of every transport system is a physical infrastructure in which enormous sums of capital have been sunk, and around which human spaces, traditions, cultures, memories and habits have been built. This physical legacy of past mobility patterns and techniques must usually be radically altered or replaced by new infrastructure in order to shift mobility to a new reality.

The challenges associated with fundamental disruption of a complex system embodies the concept of "wicked problem" as elaborated on by Horst Rittel and Melvin Webber in their seminal research paper on planning challenges from 1973. A wicked planning problem, argued the authors, offers no definitive solution or even commonly accepted definition, as every framing of a problem can and will be challenged by different stakeholder groups with recourse to their own knowledge and resources for arguing for their preferred option and against competing alternatives. The vantage point from which objectively true knowledge statements can be declared and defended disappears from view, and instead planning becomes – for better or worse – a contest over alternative futures informed and shaped by politics. Political scientist Easton (1955) famously described politics as the authoritative "allocation of values". It is a fitting description for the work of transport planners ahead, as they are tasked with navigating change through the value conflicts that are triggered when a more sustainable transport infrastructure is being considered to take the place of an unsustainable one.

For planners and policy makers, implementing decarbonization as a wicked problem calls for integrating an understanding of: the knowledge about transport as complex systems of technologies and infrastructures; the discursive and ideological dimension of visions for decarbonized transport systems, and; the social, cultural and political nature of the institutions that shape the organization of transport systems. This volume will examine key

dimensions of the social and political challenges that face contemporary transport officials, planners and users. In the following pages, we will establish the empirical and conceptual parameters for better understanding efforts and options to advance alternatives despite the "wickedness" inherent in attempts to transition toward postcarbon energy sources that can power mobility.

1.1 Transport as socio-technical systems – the challenge of path dependency

Transportation offers a prime example of what Thomas Hughes (1983, 1987) described as large technological systems (LTS): these are global in scope and structure (but embodying national and regional characteristics) and constituted by a number of subsystems, making them extensive and substantial enough to significantly influence the path of societal and technical development.

Scope is determined by spatial extent, and with transport, that extent is considerable. Transport systems extend across the globe, connecting localities through interurban, interregional, and global transport. Even local transport modes such as bicycles are supported through global supply chains that can influence the amount and character of mobility – e.g., the growth of e-bikes in local travel. Structure, on the other hand, connotes a multidimensional process of interactions across societal levels. An LTS has the effect of structuring the way societies organize themselves and even contributing to shape their collective imaginaries. Organizations and institutions are developed to regulate the social activities enabled by an emerging LTS: so, for instance, countries across the globe have built up state agencies and laws regulating the flow of traffic according to similar principles. On a deeper level, the proliferation of cars for personal mobility and aircraft for intercity and intercontinental travel have had considerable effects on the ability of individuals to imagine themselves as free to move over an unlimited space.

The causal influence of mobility on human imagination can work in the other direction as well, and the development of new technologies – some with the potential to grow into components of an emerging LTS – is affected by the existing socio-technical landscape. The spatial extension of new infrastructures tends to follow pre-existing systems, such as when French railroads were established along existing roads that themselves followed earlier transport routes along the major rivers; the poles of telegraph lines that followed the railroads were, in turn, later used for the first

inter-urban telephone system (Gökalp, 1992). Likewise, emerging technologies are not formed in a vacuum but are modelled to improve upon the function of existing ones.

From this brief overview of the LTS perspective on mobility development, we can already discern the multifaceted challenge for transport system decarbonization that arises from *path-dependency*. Path dependency takes many forms, and in its widest sense could mean anything from acting upon historical experience to the reliance on existing material infrastructures (Van Assche et al., 2022). The experiences examined in this volume highlight the dynamics by which technological innovation, societal unrest or some combination of them can generate sufficient disruption and reach a large enough scope to challenge the fossil fuel transport LTSes that proliferated over the previous century, and whether policymakers and planners will be able to collectively imagine and empower a break with the past and establish institutional structures necessary to bring a decarbonized transport LTS into the mainstream.

For Hughes (1983, 1987), large technological systems are seen to develop through phases, from an early development stage, through expansion to consolidation, with subsequent theoretical developments extending analysis to consider LTS stagnation or decline (Kaijser, 1994; Magnusson, 2012). The momentum phase through which an LTS expanded, according to Hughes, involved the creation of synergistic and reinforcing connections between both technological and social subsystems, thus rendering the technological system resistant to change because it had become embedded in the beliefs, interests and imaginations of a society. However, as decarbonization is widely considered to require disrupting such path-dependencies, LTS researchers have been closely examining the different institutional levels and processes through which new technologies can emerge and establish themselves.

The multi-level perspective (MLP), a concept first used by Rip and Kemp (1998) and further developed by Geels (2004) explains technological disruption through an analytical framework that portrays change as occurring at different institutional levels. The *landscape* provides the macro context of multilateral regulations (e.g., trade pacts), politics and infrastructure systems, and is the level most prone to inertia through path-dependencies. The *regime* shapes the meso level of national politics and planning goals, whereas the *niche* constitutes the level where technological innovation actually occurs among firms and related organizations.

Since the niche is the level offering the greatest opportunity for actor intervention in a democratic and capitalist society, most studies using the MLP framework and similar ones – such as Strategic Niche Management (Hommels et al., 2007; Raven, 2022) and Technological Innovation Systems (Dewald & Truffer, 2011) – have focused on micro level actions and the experiences of niche actors to advance change (Sengers et al., 2019). Others, however, stress the dependence of niche level activities, and especially the potential for technological up scaling and social diffusion, on supportive regime and landscape levels (Kivimaa & Kern, 2016).

Many clean techs that hold promise for transport decarbonization still exist only at the niche level, but a systemic technological realignment is premised on changes that also occur at the regime and landscape levels (Krahé, 2022). The Paris Agreement could represent one such multilateral landscape change. As economist Mariana Mazzucato (2015, 2018) has shown, most if not all technological developments that western societies have reaped past benefits from are derived from massive state investments in basic research. Such programs, often driven or motivated by geopolitical conflict, have resulted in diffusion of jet aircraft, intercity motorways such as the Autobahn in Germany and the Interstate Highway network in the US, rockets capable of launching intercontinental nuclear weapons, space travel, satellites and the internet, to name but a few. Existential threat does seem to spur technological innovation and diffusion, but if history is any guide, strong state capacities must be developed and leveraged to translate such development into systemic adaptation of the kind needed to mitigate climate change.

Public policy researchers have identified a rhythm of continuity and change that animates many domains of government and administration. Baumgartner et al. (2018) have developed Punctuated Equilibrium Theory (PET) to explain why policy instruments and government programs tend to stick in established configurations for extended periods of time but then slip into rapid and transformative episodes of change rather suddenly. PET looks to a combination of political realignment (e.g., change in government), international regime change (e.g., reconfiguration of alliances and rivalries), and economic crisis to destabilize and delegitimate the landscapes and regimes that constitute the meso and macro levels of the LTS. The more that policy actors lose faith in the established organizations and techniques that are associated with a particular technology, the more open they will be to embracing alternatives that have been under development within niches of the LTS. Thus, examination of the energy transition in transport needs to consider these factors and forces of punctuation as they do, or could, emerge.

These theoretical perspectives remind us that technological change is intricately connected to sociopolitical processes and dependent on conducive institutional structures. The extent to which changes in these institutional dynamics can be accurately captured by computer assisted modelling is at the center of a debate about the role that computer models have in informing transport planning. In transport planning, there is a longstanding debate about how scenario modelling and other planning tools should be used when it comes to transformative planning. With the growing presence and capability of Artificial Intelligence in computer assisted analysis and (re)design, the nature of agency in advancing change is starting to extend beyond human activity. We turn to the potential of such change agents in the following section.

1.2 Transport as socio-technical imaginaries – envisioning disruption

In his analysis of how financial models work, sociologist Donald MacKenzie (2008) argued that modelling should not be regarded as an act of accurately representing reality but instead viewed as intervening in and actively shaping the practices that the models purportedly reflect. This is also the central proposition around which the debate about advanced computer modelling in the field of climate policy has turned in recent decades. What is contested is the issue of computer model performativity – that is the influence models have on the real world – but also responsibility for how scientific results derived from models should be communicated to policymakers and the public.

Most computer models that consider scenarios for transport decarbonization are designed to calculate cost-efficient pathways to achieving climate targets based on neoclassical economic assumptions. Because neoclassical economics typically treat the economy as an equilibrium system striving towards optimum, such models have a certain conservatism built into them (Kaya et al., 2017). Critics of such climate models have therefore argued that they are ill-equipped to effectively capture and explain the dynamics of real-world economic transitions of the kind that would accompany and enable systemic change in energy use (Pindyck, 2013). Others have ventured even further and claimed that these least-cost pathway models are detrimental to such decarbonization efforts, since they assign too much value to existing and unsustainable transport patterns (Witzell, 2021).

The critique points to a precarious balance that modelers must attempt between recognizing current reality and the likely transition path that will depend upon some form of systemic disruption. By extrapolating from existing transport patterns into the future as a base case scenario, conventional forecasts risk perpetuating the unsustainable status quo. However, if they are perceived to deviate too much from the present, the models may be discounted and criticized as blue-sky thinking. Continuous attempts to increase the precision and scope of models by adding complexity and more decarbonization options, including behavioral changes, can also create epistemological confusion, if models are interchangeably presented as realistic representations of the world and heuristic devices for exploration of different futures (Haikola et al., 2019; Low, 2021).

The contradictory status and role of models used in energy transitions have led to calls for better and more transparent communication from the scientific community that emphasizes the models' exploratory role (Ellenbeck and Lilliestam, 2019). These debates open up the precarious issue of politics in representation of future mobility patterns. While scientific representations of the future often figure discursively as objective assessments of potential developments, they can also be construed as competing visions that are socially constructed, and therefore liable to inherit the institutionalized epistemic cultures in which they are created (Heymann and Dahan Dalmedico, 2019). Efforts to break epistemological ground by introducing new methods for envisioning and advancing a decarbonized future are therefore likely to encounter institutional resistance (Witzell, 2020). It also emphasizes the human agency involved in the visionary act of evaluating development trajectories. Here, the advent of AI enters to further complicate the question of where the power to alter mobility patterns is located. Not only does AI potentially shift responsibility from human actors in the visionary planning stage, but it also enters into mobility discourse as yet another technological promise around which mobility futures might be constructed (Van Wynsberghe and Guimarães Pereira, 2022). Debates about the role and scientific status of various tools for evaluating the future trajectory for the energy transition are therefore unlikely to subside.

Modelers and other planners involved in establishing pathways for the energy transition in transport are understandably reluctant to acknowledge that their representations of the future could in any way limit the range of possible actions and outputs. At the same time, such representations would have little value if they did not identify possible pathways of change and

thereby contributed to shaping the future. Paul Edwards, who has written about the history of global climate models, argued as early as 1996, that debates over how to obtain realism in global climate models missed the point. Their function, argued Edwards, was not to accurately represent real-world dynamics but to be rallying points for scientists, policymakers and publics around the world seeking to break with business as usual. While they may or may not be "true" in any objective sense of the word, they had the potential to form an "epistemological community" that fostered a global understanding of climate warming, and hence enabled climate action possibilities on a global scale (Edwards, 1996).

From that perspective, envisioning decarbonization paths appears as an activity with two sides: on the one hand a neutral assessment of possible futures, on the other hand an intervention in policymaking that contributes to shaping the future. The significant role projected for technological solutions in the energy transition can then say something about the collective imaginations that permeate the industrial societies of the West, where it seems the future has become impossible to consider without a conscious strategy for changing technology (Andersson, 2020). The technological mode of imagining the future of transport goes beyond a reliance on the "technological fix", i.e. the reliance on some kind of technological breakthrough to facilitate the energy transition. Technology is now the medium through which the future will be both envisioned and assessed. Scenarios that describe a future transport system without fossil fuels are elaborated through technological models, and other models will be used to verify or question their feasibility, a point made also by Edwards in the aforementioned paper. Attention must therefore be paid to the assumptions that are built into models and other visioning tools.

Origins of these debates stretch back to the mid 20th century when philosophers of technology like Lewis Mumford (2010) and Jacques Ellul (1964) claimed that modern technology had acquired a new role in society. Being more than material tools expected to perform specified functions, they argued, technological society made technology a state of mind. This idea is evoked in more recent scholarly attempts to theorize how technology and discourse interact to create institutionalized modes of envisioning the future. "Socio-technical imaginary" is used as a concept to describe "collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology" (Jasanoff, 2015: 4). The concept

highlights that path dependency resides not only in infrastructure and formal institutions, but also in the discursive realm of fantasy, albeit manifested in sophisticated, technocratic jargon.

Furthermore, this perspective highlights that socio-technical imaginaries are not only constructed by state actors but rooted in deeply held cultural norms (Richter et al., 2023). This adds ethical complexity to the wicked problem of transport decarbonization, probed in the scholarship on transition justice, since cultural norms of car dependency are inextricably linked to "material" issues of economic insecurity, availability of alternative transport modes, etcetera (Portinson Hylander et al., 2024; Wågsæther et al., 2022). Navigating this politicized terrain is the challenge facing transport planners, who must therefore be mindful of path-dependencies that are both external and internal to the institutions they operate within. We turn to the challenges of developing such a strategy below.

1.3 Transport as socio-technical evolution – planning for disruption

It is apparent from the LTS perspective that planning institutions often accommodate, and at times reinforce, the current equilibrium between the global transport systems and contemporary economic and social structures. Most obviously, they explicitly govern multiple aspects of transport function – from the physical movement of goods and people to the threshold values set for release of chemical substances into the environment – through formal rules. Less obviously, but equally important, transport planning and policy institutions promote certain norms and behaviors in society by disseminating informal rules through their practices, which are themselves are imbued by such unwritten rules in their organizations (Kingston and Caballero, 2009). Thus, planning institutions contribute to the path dependencies that entrench unsustainable transport patterns. Just as importantly, they are necessary sites of leverage for effective decarbonization efforts.

When considered through the lenses of institutional economics and historical institutionalism, the problem of institutional maladjustment has long been central for scholars interested in why and how institutions evolve to manage complex societal and environmental processes. Within the former, evolutionary perspectives have treated institutional development as a Darwinian process by which societies adjust their institutions over time through mechanisms that are equivalent to natural selection (Hayek, 2022; Veblen, 2017). Collective-choice theories have focused instead on the

deliberate or non-deliberate choices by rational agents and regarded institutional development as the result of the deliberations between agents under certain constraints (Ostrom, 2009).

Regardless of their merits, these two schools of thought within the field of institutional economics appear ill suited for addressing the wicked problem of transport decarbonization. First, since decarbonization requires immediate action the longer that business as usual continues, the greater the risks of "natural selection" are likely to be. Second, neither evolutionary nor collective choice economic theories are well equipped to probe the complexities of relations between technical, cognitive and institutional spheres. Change in energy systems cannot be reduced to purely evolutionary perspectives. Reliance on metaphors or models that draw heavily upon ecology and natural science to explain processes of path-dependency and path-disruption in techno-social transition are therefore problematic (Markard et al., 2012; Olsson et al., 2015).

Crucially, both evolutionary and collective-choice perspectives struggle to provide substantive analyses of why societies, as collectives, embark upon flawed pathways. The term "bounded rationality" (Williamson, 2000) has been used to explain the fact that humans – individually and collectively – always act upon imperfect information and are therefore prone to mistakes, particularly those arising from the unintended consequences of any action. The transport path dependencies created around fossil fuels could certainly be regarded as a result of such bounded rationality, but that observation in itself does little to help us understand the power dynamics involved when certain technologies and institutional configurations establish hegemony, nor why certain societies develop institutional capacities that prove conducive to adopting technological change or adaptation of specific innovations.

The concept of bounded rationality, while meant to cope with "irrationality" as an important factor in societal change, in fact reveals a philosophical assumption that can be detrimental to analysis of wicked planning problems. Even if the boundedness of actors' rationality is assumed as a rule rather than an exception, it still implies that rationality operates as the general principle against which deviations may be measured. Institutional change is regarded as determined by a form of natural or rational selection mechanism. That perspective means that informal rules – such as norms and tacit assumptions – are treated as an exogenous constraint that impedes the optimal selection at a given time or over a given period.

Historical institutionalism is better equipped to reveal the cultural dimensions of institutional (re)development. It treats "irrationality" not as a deviation from a norm but rather holds as a premise that institutions bear no objective relationship to rationality. Instead, institutions are defined as fundamentally cultural entities. As Frank Dobbin (1994) showed in his famous work on the industrial policies that established the first railroads in Britain, France, and the US, the policy routes chosen by each state should neither be construed as optimal, nor in any way irrational, but rather the result of nationally specific institutional cultures. Swedish historian Lundin (2008) has similarly highlighted the thoroughly ideological character of the transport planning regulations that were developed in the postwar decades, which put the petrol fueled private motor car at the center of the modern Swedish urban landscape (Anshelm, 2005). Other studies have identified how the Swedish Transport Administration has inherited this legacy and developed a path-dependency that provides cognitive and structural barriers to planning for a decarbonized transport system (Jacobsson and Sundström 2017; Witzell, 2020).

Since institutions are thus acknowledged to include both formal legal frameworks and the habits and thoughts that inform the life-worlds of professional transport planners, researchers of institutional change have paid special attention to the importance of ideas as barriers to, or enablers of, change. If decarbonization is assumed to entail fundamental changes to transport, a mere reformation of certain regulations will not suffice. A more structural shift of the ideas that permeate transport planning is needed, but the direction of causality is difficult to ascertain in complex societal transformations. A key question to explore is whether planning institutions must embrace a whole new way of thinking, or whether a change in the type of formal rules that are more susceptible to immediate change, what Roland (2004) calls "fast-moving" institutions, comes first and can be followed by ideational shifts later.

In something of a parallel to the heuristic model of nested levels in sociotechnical change described previously (niche, regime, and landscape) political scientist Hall (1993) has distinguished between three orders of institutional change that accompany the kind of social learning that can lead to a policy paradigm shift. Through first order change, the "settings" of basic policy instruments are changed, but the instruments are left untouched. An example would be a modification of an existing carbon tax on transport fuels. Second order change entails the change of the instruments themselves, for example the creation of a new regulation stipulating that a

minimum level of biofuels must make up the gasoline and diesel mixes sold at petrol stations. Third order change are fundamental changes to the underlying ideas that inform policymaking, what Hall also calls *policy paradigm* change with reference to Thomas Kuhn's theory of scientific paradigms.

The key change driver in Hall's model is the delegitimization of an established policy paradigm as technocrats first try, and then fail, to address growing problems by tinkering with instruments, and then changing instruments, in the face of disruption and policy failure. Mounting levels of policy failure yield to more overtly political debates over alternative paradigms, and these are contested in the public domain, rather than by experts in epistemic communities. When a new paradigm gets ratified by mass politics – e.g., Monetarism replacing Keynesianism on the wings of the Thatcher/Reagan political ascendency, then many other policies will eventually shift to align with the new paradigm.

From this perspective, transport decarbonization appears to pose two challenges. First, change makers must embrace an alternative policy paradigm under which the effective institutions for such transformation could be developed. And second, based on past policy paradigm shifts, those pursuing a transition will also need to find ways to delegitimize the established policy paradigm that continues to block needed change. Insights in where to find solutions can be gleaned from the historical institutionalist literature that has drawn attention to the consequential role of the state in enabling social and technological change. In reaction to what they perceived as a tendency to disregard state powers and disproportionally emphasize the role of interest groups in explanations of societal change, Theda Skocpol and other researchers provided comparative analyses of how central state bureaucracies had been during policy change in multiple historical and national contexts. They argued that to understand structural change in the modern world, emerging from industrial policy programs and comprehensive welfare programs, one must look to the state as an autonomous actor with unique capacities to both define/construct societal problems, and to develop policy responses that encompass the whole of society horizontally and vertically (Skocpol, 2014).

The "state autonomy" perspective developed by Skocpol and others suggests a path to transport decarbonization requires developing state capacities for regulation and industrial policy, rather than acting within the existing barriers that have been created by the current LTS. If a state finds it difficult to impose taxes on shipping, for example, or to restrict the sale of

ICEs, this is not to be seen as a result of market forces but rather a limitation of the state's capacity to regulate. In the end, the state alone would have the authority to re-establish that capacity, and this would be a political act that requires autonomy from advocates and interests of the existing LTS.

The analytical question that should be posed is under what circumstances states are willing and able to mobilize their regulatory capacities and how does the pivot toward such authoritative activity occur? The struggle to regulate global aviation, for example, shows that industrial resistance to states' regulatory efforts are often successful. Nevertheless, the few instances of where states have been able to withstand industry pushback, such as the Dutch state's ambition to limit traffic to Schiphol airport and the French decision to forbid domestic flights that duplicate established rail routes, could be taken as signs that a more proactive regulatory stance is possible (Bounds and Georgiades, 2023).

By highlighting the socially constructed nature of regulatory powers, the state autonomy perspective is congenial to post-Keynesian analyses of decarbonization based on energy transition. As opposed to mainstream, neoclassical economics, post-Keynesians stress the unique ability of the state to mobilize and create financial capital for industrial policy. Money, in this perspective, is always endogenous to the economic system and its value is guaranteed, ultimately, by the state. Accordingly, economic (as opposed to physical) limits upon the state to advance industrial projects for energy transition in transport are always, in the final instance, self-imposed rather than external (Mason, 2022). When state actors reify such limits by trumpeting the merits of private over public investments, the wicked problem of transport decarbonization becomes even more difficult to address, since that makes the state dependent on the willingness of market actors to phase out fossil fuels which entails absorbing large financial costs for stranded assets (Mooney, 2023).

In the subsequent chapters, our contributors provide both conceptual and empirical guidance on the alternatives and options that have emerged when governments engage with the factors and forces that can enable changing energy sources and energy efficiency in the transport sector. The examples of change that has worked to reshape the LTS of mobility, alongside examples of what has not worked to advance such change can provide lessons to those who will need to accomplish future transitions that enable society to better navigate the coming climate and socio-economic disruptions. We offer an overview of these contributions to conclude this introduction.

1.4 Chapter overview

In Chapter 2, Karolina Isaksson, Jean Ryan, Kristina Trygg explore "Path dependency and transformative capacity in planning organizations". They consider how the role envisioned for planning and planning organizations in transport decarbonization can differ depending on what perspective is adopted regarding market versus state steering. Just like infrastructure planning in general has been greatly affected by the macropolitical trends towards market liberalism after the 1970s, transport planning has been subjected to greater market orientation and associated focus on cost-efficiency. While an emphasis on resource efficiency is not unique to market liberalism, it takes a certain form under the market liberal planning paradigm of the late 20th century (Gunder, 2010). A typical feature of market liberal transport planning is the assumption that resource efficiency is best achieved through private solutions, and while there are national differences, this tends to involve both privatization of planning activity and a priority given to carbon pricing over more directive regulatory measures (Sager, 2011).

Studies that adopt a market centered perspective show results that indicate a limited potential for state steering towards pre-set targets. Modelling can reveal counterproductive effects from policy efforts to induce mode shifting or electrification, for example (Börjesson, 2020; Wardman et al., 2018). Such results are then used to support a decarbonization approach of minimal intervention into the existing market structure, with a carbon tax being the most favored policy mechanism (Pietzcker et al., 2014). However, critics of a market-led transition strategy have argued that it fails to countenance the form of systemic shifts that may be required for extensive transport decarbonization (Rosenbloom et al., 2020). While a carbon tax may appear to be most cost-efficient measure in a computer model, it has yet to deliver rapid decarbonization in practice, speaking to the overall ineffectiveness of decades of climate change mitigation plans (Eskander and Fankhauser, 2020; Pretis, 2022). Evaluations of relative policy success have highlighted that a permanent decoupling of carbon emissions from transport, still elusive in the majority of the world, is dependent on structural changes in infrastructure, technology and society (Foster et al., 2021; Loo and Bannister, 2016). Transport policies will therefore be needed that enable major change across sectors, with clearly stipulated policy targets and regulatory oversight and enforcement (Tsoi et al., 2021). A more holistic approach would engage both planners and

policymakers in the decarbonization process. Planners would be required to acknowledge the political effects of infrastructure planning, and policymakers would need to recognize that the action space of planning agencies is considerably influenced by political decisions (Isaksson and Eriksson, 2021).

Most policy evaluations have a technical orientation, and transport policy analysis is still often conducted by engineers. As a result, assessments of the efficacy of policies that account for behavioral changes remain methodologically undeveloped (Krause et al., 2020). This limitation affects not only policy developments for consumers and users of transport. It extends as well to the behavioral dynamics within planning organizations themselves, e.g., the institutional attitudes toward change and risk. The effects of path dependency within organizations will be a factor in debates about needed planning reforms in the coming years. Some researchers have stressed that planning organizations must be able scrutinize their own limits and capacities through critical self-reflection (Howe and Langdon, 2002). Openness to a greater diversity of perspectives - on accessibility, equity and gender, for example – will contribute to such reflexivity and could introduce new ideas that facilitate energy transition (Innes and Booher, 2015).

However, organizational reform must also be attentive to the fact that inclusivity and perspectival pluralism were the guiding principles for the participatory turn in planning, which has subsequently been argued to accommodate a neoliberal "roll-out" of market led policymaking (Davoudi, 2017). Arguably, participatory planning, when viewed as a planning paradigm, has failed to live up to its democratic promises or to significantly change the course of transport planning in a sustainable direction (Allmendinger, 2016; Metzger et al., 2014). A growing emphasis on market forces have resulted in a hollowing out of institutional capacity within state planning organizations. Therefore, organizational reform should consider both fostering democratic participation and to equipping state planners with the resources they need to enforce national sustainability targets. The challenges facing such a transformation are illuminated in Chapter 2.

In Chapter 3, Margaret Taylor and Sydny Fujita present findings on "Behavioral dimensions of technological diversification in the light-duty vehicle fleet." The degree and nature of people's attachment to different forms of mobility, and their associated energy demands, has received considerable attention among researchers focused on sustainability in

transportation. Bamberg et al. (2011) identify behavioural change as a necessary component of any significant shift in the energy used for mobility. While technological substitution can produce efficiencies that are comparable to those attained through behavioural change, there is a growing awareness that "radical demand and supply strategies" (Brand et al., 2019: 187) such as those needed to meet Paris Accord and COP 28 targets to decarbonise energy use by 2050 will require *both* the introduction of new technologies and the adoption of different behaviours in order to achieve accepted goals. Sovacool et al. (2022: 1) highlight that "… global consumers will need to reduce their [emissions] footprint by a factor of 30 to stay in line with the Paris agreements." Meeting this existential challenge will thus require as much behavioural adaptation, if not more, as it does technological innovation. Furthermore, behavioural change can be viewed as a necessary precursor to adopting new technology since it would take the pressure off governments to mandate new technical standards that increase user costs, and thus contribute to a "decarbonization divide" in which only some can afford the new mobility option(s) (Sovacool, et al., 2022: 328). In a scenario analysis of the necessary transport energy transition in Scotland, Brand et al. (2019: 200) found that:

> *Lifestyle change alone (without an EV transition) has a similar effect on total transport energy demand to a transition to EVs with no lifestyle change. This has important implications for climate mitigation policy. A scenario that involves lifestyle change will place much less pressure on policy to require rapid (and potentially disruptive) technical change, including technologies at the point of use.*

Since changing behaviour will be an essential part of any energy transition in transport, understanding how to accomplish it belongs high on the research agenda. Two conceptual frameworks from applied psychology have been used to assess the dynamics of how people make choices about mobility and its energy consumption. The Theory of Planned Behaviour identifies a variable mix of personal attitude, group or societal norms, and perceived efficacy as the determinants of personal choice, while the Norm Activation Model emphasizes personal norms based on internal values as a predominant behavioural influence, particularly when it comes to changing behaviour (Aini et al., 2013). Both frameworks identify norms as a key influence on behaviour. Entrenched norms need to be distinguished from aspirational norms to reveal the potential of systemic change.

Stephenson et al. (2015: 119) suggest that:

> *… we have found it helpful to differentiate between norms that are reflected in a subject's current practices and material culture, and those that are considered desirable by the subject but have not yet been realised. We use 'expectations' to refer to the first, and 'aspirations' to refer to the second situation. Aspirations are particularly interesting as they may indicate a level of dissatisfaction with current practices or material culture, and may act as the springboard for change if the right set of circumstances exists.*

The power of aspirations to drive change can be tapped into by designing policy with more ambitious objectives and then highlighting these ambitions as a rallying point for support. When challenging new goals are set, these have been found to exert a stronger motivating effect on people than policies with less ambitious goals. A summary of psychological research into motivation concluded that:

> *…people with specific, challenging goals reliably outperform those with do-your best goals because the latter type of goal is interpreted too subjectively. Moreover, the degree of goal challenge or difficulty is linearly related to performance, given sufficient skill or ability. (Locke and Latham, 2019: 97)*

Thus, bold goals for change can stimulate more ambitious behaviour, perhaps by allowing people to concentrate on their aspirations more than existing constraints.

Gender can also mediate the reaction to norms, with males found to be less likely to embrace social norms of conservation such as eco-driving (Sovacool and Griffiths, 2020) and more likely to prefer new technology to changing behaviour in the use of existing technology (Aini et al., 2013). The potential for success in any energy transition strategy will thus depend on integrating behavioural approaches with technical possibilities, as examined in Chapter 3.

In Chapter 4, Jamil Khan and Bengt Johansson consider the "Policy mix for decarbonization of the transport sector" with Sweden as a case study. As an early adopter of climate action goals, Sweden's ebb and flow of energy transition initiatives can illuminate the challenges that come with pursuing ambitious change that needs to extend over a long time horizon in order to attain identified goals and targets.

In the wake of the Covid pandemic and subsequent geopolitical conflicts, the market liberal governance paradigm that dominated previous decades has become questioned in calls for a "return of the state" to catalyse systemic change (Garrard, 2022). Preceding this recent turmoil, similar

analyses argued that a "green state" was required to effectively decarbonize society. The central question, often answered in the negative, raised by studies on green industrial policy is whether a hands-off approach to state governance is viable given the scale and scope of the transition that is required (Hildingsson et al., 2019; Patt, 2015; Rodrik, 2014).

The principal division between the market and state centered perspectives concerns where to locate the center of governance in capitalistic societies. That raises the issue of co-ordination. In the market-liberal view, co-ordination between market actors is best achieved through the price discovery mechanism, since markets have a natural tendency towards equilibrium. Therefore, state involvement is often considered to be price distorting and should only be recommended to correct for market failure. In the state-centered paradigm, on the other hand, the market-liberal view is based on a fundamental misconception about market forces. There is no natural tendency towards equilibrium, but rather a heterogeneous set of market actors with myopic views on the future that try as best they can to maximize their gains under conditions of deep uncertainty. There is therefore no self-correcting mechanism, which is why the state must be looked to for co-ordination of societal change (Krahé, 2022).

There is now a broad literature on the green state, with more or less explicit connections to Keynesian economics. The green state literature can be seen as a development of ecological modernization studies, and partly a response to what is widely considered to have been not only a research paradigm but also a political project that over time became increasingly associated with market liberal governance (Christoff, 2005; Lundqvist, 2004). The green state literature, as well, is being challenged by a more radical environmentalist perspective that argues there is a need for a research agenda, and a politics, that breaks radically with the capitalist system and embraces "post-growth" (De Blas et al., 2020; Laurent, 2021).

In the vocabulary of socio-technical transition studies, green industrial policy is a matter of finding ways to stimulate and govern effective interactions between niche, landscape and regime levels of the economic system, and assigning proper roles to state and market actors (Köhler et al., 2019). While neoclassical economics is still strong as a research paradigm, evidenced by the fact that many studies still focus on finding cost-optimal solutions through rational distribution of resources, a view assigning a more proactive role for the state is in the ascendancy. That constitutes a course change from previously when technological and market-based mitigation strategies dominated transport decarbonization studies (Schwanen et al., 2011).

No doubt, such developments in research agendas co-evolve with changing priorities on the macropolitical front, with the EU (Bloomfield and Steward, 2020) embracing industrial policy in an explicit departure from economic theories that have dominated over previous decades (Brower et al., 2023). No doubt, these are recent phenomena for which the institutional implications are still highly uncertain. Even if they signal genuine attempts at fundamental institutional reform for the purpose of transport decarbonization, institutional inertia and political blowback may well force a halt to or roll-back of such reform.

Chapters 5 and 6 both focus on the roles that equity seeking objectives and initiatives can play in overcoming the institutional constraints embedded within, and inertia generated by, the LTS that deliver mobility. In Chapter 5, Fabio Schojan and Céline Schmidt-Hamburger consider the potential of community based and participatory research to co-create mobility transitions that meet the needs of rural communities. These locations, and the people who live in them often resist energy transition options that appear designed by and for urban elites, and threaten the viability of rural life. In "Power and Discourse in Rural Mobility Transformation", policy options that address rural equity are shown to have the potential to manage conflict over coming energy transitions. And in Chapter 6, J.S. van der Craats & D.S. van Lierop look into "How crises and social movements can build momentum for alternative mobility visions" to explain a previous juncture in which Amsterdam's urban transportation policy shifted from privileging the automobile to making considerable room for human scale and human powered mobility that has set that city on a different path and paradigm that could facilitate further energy transitions.

While the social challenges of motorized mobility have been clearly recognised since the first global energy crisis of the 1970s, relatively modest attention has been paid to the equity impacts of exponential increases in human mobility over the subsequent half century. The social theorist Ivan Illich developed an extensive critique of the inequity generated by modern trends in energy and technology as they are applied to mobility. He wrote that:

> *… equity and energy can grow concurrently only to a point. Below a threshold of per capita wattage, motors improve the conditions for social progress. Above this threshold, energy grows at the expense of equity. Further energy affluence then means decreased distribution of control over that energy…. if ecologists are right to assert that nonmetabolic power pollutes, it is in fact just as inevitable that, be-yond a certain threshold, mechanical power corrupts. (Illich, 1974: 4).*

Illich was emphatic regarding the inverse relationship between speed and distance travelled, on the one hand and social equity, on the other. He claimed:

> *From the moment its machines could put more than a certain horsepower behind any one passenger, this industry has reduced equality among men, restricted their mobility to a system of industrially defined routes, and created time scarcity of unprecedented severity.*
>
> *Extremes of privilege are created at the cost of universal enslavement. An elite packs unlimited distance into a lifetime of pampered travel, while the majority spend a bigger slice of their existence on unwanted trips. The few mount their magic carpets to travel between distant points that their ephemeral presence renders both scarce and seductive, while the many are compelled to trip farther and faster and to spend more time preparing for and recovering from their trips. (Ibid: 9)*

Although research on transport disadvantage has grown since Illich's critique (Delbosc and Currie, 2011; Dodson et al., 2006; Lucas et al., 2016) the social challenges of decarbonizing mobility remain under-examined in relation to the magnitude of impacts that are starting to emerge from efforts to transition away from carbon-based energy. One large scale investigation of decarbonisation initiatives (in electric vehicles, electric power generation and smart energy metering) found that a significant subset of expert stakeholders across sectors reported that they saw no risk of injustice in decarbonisation plans and programs. This led the authors to "… emphasize the apparent invisibility of many of the injustices that were identified by other participants" as a challenge that would need to be addressed if energy transitions were to attain more just outcomes (Sovacool et al., 2019: 590).

Energy transitions would thus need to find ways to build principles of justice into policies and plans, and to ensure that outcomes are meeting those goals. Four dimensions of equity have been highlighted as necessary principles to advance a just transition. The first of these, *distributive justice* identifies creating an equitable distribution of burdens and benefits as a core goal in energy transitions. For example, shifting energy sources and propulsion technology in order to mitigate climate change will create costs for those who were associated with "business as usual" e.g., petrochemical producers and their workforce while simultaneously producing benefits for renewable energy adopters and workers.

Recent findings have highlighted that policies designed to accelerate such a transition to renewable energy tend to favour affluent population segments and entrench gender imbalance in the energy sector workforce.

Research revealed that California's electric vehicle rebate scheme, which was intended to accelerate the adoption of EVs, also increased inequity. When the geographic distribution of rebates was analysed across the state it became apparent that "… the bottom 75 % census tracts receive only 38 % of total PEV subsidies" (Israel et al., 2024: 666). And when it came to labour market analysis of the growing employment associated with the energy transition, Carley and Konisky (2020; 572) noted that "… [renewable and clean] energy jobs are infrequently held by women and people of colour." These findings show a need for additional measures to prevent the inequitable distribution of burdens and benefits in transport's future energy transition. Examples of such compensatory thinking do exist and will need to be built upon going forward. Carley and Konisky pointed out "California's mandate that 35 % of all Volkswagen settlement funds for electric vehicles go toward a Community Car Share programme that serves low-income residents" (*Ibid*: 573) as an example of a transition policy that embraced distributive justice.

A second dimension of equity that needs to be considered in energy transitions is *procedural justice*, which seeks to enable the mechanisms of planning and policy development to better advance social equity. More open, inclusive, and egalitarian processes are seen to lead to more equitable outcomes, not only because a representative range of interests and values will get incorporated into policy, but also because communities are more likely to embrace transition initiatives for which they feel a have been arrived at fairly. Dawkins, et al. (2023: 15) thus conclude that a "… key determinant of just low-carbon transitions is the recognition and participation of affected groups in consultation and policy design processes." Carley and Konisky (2020: 574) state "… studies have found that programmes are perceived as more successful when they are led by local stakeholders and are bottom-up, rather than state or national initiatives." Sovacool et al. (2022: 334) suggest that policy making which is informed and improved by procedural justice promises to "… reduce the level of future social backlash by validating proposals and co-designing interventions with representative cross-sections of society."

The third perspective on equity that should become part of energy transitions is *recognition justice*, which seeks to acknowledge the capabilities, needs, values, and understandings impacting equity that have emerged and become entrenched during centuries of energy extraction and use. Such recognition begins with appreciating the harsh legacy of industrial

development in energy systems where: "The evidence is clear that the first financial supports for the economic systems that produced global climate change have come from practices and policies that involved social injustice and institutional violence, including colonialism, chattel enslavement, and the reinforcement of generally brutal, low-wage workplace conditions across national economies" (Kime et al., 2023: 2). One consequence of these past injustices is that vulnerabilities to future adaptation need to be addressed in transition plans and programs. Places and peoples that have had energy extracted from under them often suffer from economic deprivation and political marginalization.

In examining equity challenges arising from energy transition Garvey et al. (2022: 7) identified that:

> *Rural communities were seen as both more vulnerable and less able to benefit from some of the opportunities arising in the course of the [low carbon transition]. For instance, rural regions are typically more susceptible to energy poverty due to limited access to energy services …. Similarly, rural areas are seen as less able to benefit from the transition to EVs and policy incentives to support this.*

A fourth dimension of equity in energy transition considers cosmopolitan justice and recognizes that "… all human beings have equal moral worth regardless of ethnicity, gender, or social status. They also have a collective morality and responsibility for others that goes beyond borders" (Sovacool et al., 2019: 589). And when looking beyond borders, it becomes apparent that resource inputs required to advance electric mobility would require considerable amounts of minerals that include:

> *… cobalt, copper, lithium, and nickel. The in-use stocks of these four metals in energy transition-related technologies may take up between 20 % and 30 % of the ultimately available resources of these metals in the continental Earth's crust. Even with an 80 % end-of-life recycling rate, the increase in the annual use of primary resources is estimated to be 9 % for copper, 29 % for nickel, 52 % for cobalt, and 86 % for lithium, compared to the estimated annual use of these metals without an energy transition (Henckens, 2022: 1).*

The social effects of extracting these minerals, and the environmental impacts of such extraction, could be expected to exacerbate inequality and pollution in regions of the world where mining and refining are likely to occur. If past injustices from colonial resource extraction are not to be reproduced, or magnified, then cosmopolitan justice will need to inform mechanisms to mitigate the risks and damages to people and places that have key inputs to the energy transition.

1.5 The dilemma of planning for energy transition in transport

The LTS concept that we have overlaid on the challenge of energy transition in transport highlights the social and cultural embeddedness of technology and the institutions that govern its development and deployment. An LTS develops with, and integrates into, the broader macroeconomic and political institutions of its time, both influencing and being influenced by the societal context that envelops it (Gökalp, 1992). At the same time, however, if we accept the notion put forward by Thorstein Veblen about institutional inertia, there is an inevitable temporal lag in institutional development. Veblen claimed that "the habits of thought" that constitute institutions "can never catch up with the progressively changing situation in which the community finds itself at any given time" (Veblen, 2017, p. 88). This cognitive dimension of path-dependence could explain a particular challenge for transport planners today.

When Rittel and Webber (1973) advanced their wicked problem concept, modern planning institutions were shown to fall short in managing the increasingly complex challenges that confront societies. Whereas planners once could define a societal problem and its solution in a linear fashion that treated the problem space as a closed system, without thinking too much about the opinions of the people their planning decisions would affect, planners facing wicked problems have been forced to recognize that there is no singular best practice, and no societal optimum against which to measure their results. In relation to Veblen's perspective on institutional inertia, the identification of a changing problem landscape facing planners in the 1970s could be seen as symptomatic of broader societal trends towards pluralism, identity politics, environmentalism, neoliberalism and postmodernism, which planners have been struggling to cope with ever since.

The planning response put forward to guide practice in the 21st century has been oriented toward broadened participatory planning processes, including a significant role for the private sector and a more circumscribed role for the state (Healey, 2020; Purcell, 2009). However, as this ideal has become institutionalized, the previous two decades have also seen increasing calls for a new shift towards transformative planning (Mazzucato, 2018; Schot and Steinmueller, 2018). Such transformative planning is envisioned to include holistic thinking and active industrial policy necessary to realize broad societal goals, like transport decarbonization, adopted by governments seeking to meet their commitments to the Paris Agreement.

The challenge facing transport planners today is thus that demands raised by transformative planning, such as cross-sectoral planning and daring to embrace societal disruption, are counteracted by the historical legacy of market-oriented planning practices that have undermined the institutional capacity of governments at different levels to pursue state led transformation (Strömberg and Elander, 2001). The question is whether a return to the centralized, top-down steering of the postwar decades is needed, or whether transformative planning requires something completely new (Feygin and Gilman, 2023). The answer may depend on how the problem of path-dependencies in transport is to be addressed.

Experts debate whether decarbonization requires a fundamental reordering of the global geography of transport, as the technological leaps that form the basis for most net zero scenarios used by the IPCC are bound to run into natural resource limits (Marx, 2022; Michaux, 2021). Others argue that assumptions of strong resource constraints are overly pessimistic (Breyer et al., 2022), and that a wholesale technological shift that leaves much of the current system infrastructure intact, for example by shifting road transport from ICEs to EVs, could be manageable, with skillful planning. It could be seen as a case of *technical renewal* observed in previous studies of LTS saturation (e.g. Magnusson, 2012), whereby a system manages to avoid stagnation or decline under competing technological or institutional pressures. Alternatively, it could be seen as a new technological system replacing the old one by acquiring some of its main characteristics, such as high-speed trains evolving to resemble airline travel for distances up to 1000 km (Gökalp, 1992).

Yet even the most optimistic scenarios for technological development would necessitate a mobilization of investment capital and regulations on a scale difficult to imagine occurring in the current political climate (Beattie, 2023). Ultimately, transport decarbonization will require breaking path-dependencies, whether they be of a technological, cognitive or institutional kind. The research syntheses that follow will explore different perspectives on these dimensions, with insights offered on contemporary challenges and opportunities.

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CHAPTER TWO

Path dependence and transformative capacity in planning organizations

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Abstract

This chapter reports the findings of a study on factors influencing the capacity of planning organizations to break prevailing path dependencies and pave the way for more energy efficient and sustainable transport futures. Empirically, the chapter builds on a qualitative exploration of contemporary land use and transport planning. The planning case in focus illustrates some well-known challenges to establishing sustainable transport and land use development pathways, with specific attention being paid to the dynamics between planning organizations with different roles and mandates, operating at different administrative levels. In the chapter, theories of path dependence are used to discuss ways in which unsustainable and energy-intensive policy pathways are perpetuated, while theories of transformative capacity are used as a framework for exploring what it would take to establish more sustainable transport trajectories. The analysis has led to insights into different types of changes that would enhance the transformative capacity of contemporary land use and transport governance, with a focus on roles, resources and abilities within and across planning organizations, and with attention paid to the wider governance and policy levels. Ultimately however, the chapter concludes that enhanced transformative capacity within and among planning organizations is not enough. What is required is also an active political leadership with a capacity and willingness to engage in the value conflicts that permeate initiatives for sustainable land use and transport transformations.

1. Introduction

1.1 Background

Gaining in-depth insights into barriers and facilitators for change among public planning institutions should be, we believe, of high priority in policy and planning research. We are now in a situation where global warming, together with other social and environmental problems, constitutes a deep civilizational crisis and a threat to human existence (Boström and Lidskog, 2024). In order to break unsustainable trends and embark on sustainable development paths, deep systemic change is needed from all sectors of society (Boström and Lidskog, 2024; IPCC, 2023).

Climate change is directly affected by the transportation system, which accounts for a significant share of greenhouse gas emissions globally. In 2019, approximately 15 % (8.7 GtCO2-eq) of net global greenhouse gas emissions came from the transport sector, with its rate of growth having stayed constant at approximately 2 % per year during the decade to 2019 (IPCC, 2023, p. 44). Recent research shows that if international climate and sustainability goals are to be achieved, there is a need for extensive

changes of today's mobility practices, especially in affluent countries where motorized travel per capita is at a high level (Berg Mårtensson et al., 2023; Brand et al., 2025; Pathak et al., 2022).

In this chapter, we focus on *transport and land use planning* as a collaborative practice that has a significant role to play in either (1) reinforcing path dependence, and so, perpetuating unsustainable trends of energy intensive policy pathways, or (2) opening up other development trajectories more in line with the kind of deep and sweeping systemic transformation that has long been called for. The focus on transport and land use planning is motivated by the fact that while technological developments in vehicles and construction alongside the substitution of energy carriers are important, these will not be sufficient for transitioning to sustainable pathways (Berg Mårtensson et al., 2023; Pathak et al., 2022).

Transport and land use planning has a profound influence on the ways in which society functions, and the energy use associated with the ways in which we as people live our lives. Hence, while research indicates the need to reduce the magnitude of the use (in terms of person- or vehicle-kilometers travelled) of the most emitting and energy-demanding modes of transport (i.e. car and air travel), it is also clear that this is a complex and politically sensitive issue. To enable a shift to sustainable transport, many types of interventions are needed. Some changes are needed in the built environment, including transport infrastructure and its intersection with land use planning. Other adjustments will be needed in terms of policy instruments such as taxation, fees and charges for parking and congestion, while others concern the ways in which everyday life is organized and the overall activity level in society. For all these examples, public institutions and organizations have a critical role to play. At a time when the need for deep systemic change is becoming increasingly clear, it is important to understand the structure and function of these organizations to work towards more transformation-oriented development trajectories.

1.2 Studies on implementation and organizational challenges of transport transitions

A large body of research has drawn attention to different implementation issues and resistance with respect to the transition to more sustainable and energy efficient transport systems. Several studies have approached this as a classic implementation problem, discussing the importance of identifying and formulating clearer targets for transport planning, and emphasizing the need for improved monitoring of performance with respect to such targets

(e.g. Finnveden and Åkerman, 2014). Others have considered the importance of relevant planning support tools (e.g. Curtis and Scheurer, 2010). Other studies have investigated the lack of sincere consideration of goals related to climate change and sustainable development in land use and transport planning, and explained this in terms of vested interests and power dynamics (Eriksson et al. 2024, Falkemark, 2006; Flyvbjerg, 1998; Legacy et al., 2017).

Previous works have also drawn attention to the political-economic factors that make it difficult for society to move away from the prevailing car-dominated and high-carbon transport system. Examples include the existence of automotive industry and lobbying, which can be linked to other aligned industries related to real estate developments and urban sprawl (Mattioli et al., 2020), and the creation of social, physical and cultural environments that serve to reproduce social norms that favor continued car mobility and car dependency (Saeidizand et al., 2025; Walker and te Brömmelstroet, 2025). Several studies have examined discursive power dynamics and the shaping of meanings, norms and ideas that serve to maintain conventional norms and perspectives and ways of working in local, regional and national transport and land use planning (Hrelja, 2019; Imran and Pearce, 2015; Isaksson, 2023; Isaksson and Eriksson, 2021; Pettersson, 2013; Tennøy, 2010; Witzell, 2020).

A closely related body of literature focuses on institutional and organizational aspects that influence transport planning. Studies with such a focus are often based on an explicit complexity and critical understanding of how transport policy is formed and implemented in practice (Marsden and Reardon, 2017). Such studies reflect the insights from previous critical policy studies where, for example, Howlett and Rayner (2013) have launched the concept of policy-patching as a way to conceptualize how processes of policy making are often influenced by situational logics and the specific governance settings at hand. On a similar note, previous research on institutional barriers for sustainable transport highlights how governance systems that are characterized by distributed, somewhat diffuse and split roles and responsibilities (both horizontally and vertically) comprise particular challenges for integrating goals and targets for sustainable mobility (e.g. Curtis and Low, 2012). In other words: the integration of goals related to climate mitigation and sustainability is far from straightforward when each organization has its specific mandate, its own internal logic(s) that influence how the organization (and its professionals) interprets and operationalizes knowledge and the meanings of specific goals and policy

directions (e.g. Flyvbjerg, 1998; Tennøy et al., 2016). A theme that frequently arises in the literature involves the challenges inherent in the integration of transport and land use planning, often as a result of differences in knowledge perspectives and professional approaches, legal and regulatory frameworks, methods and ways of working (Geerlings and Stead, 2003; Hrelja, 2015). These differences are associated with different kinds of planning (different sectors and/or different administrative levels) building on partly incompatible sets of assumptions on, and approaches to, what kind of planning is possible (or desirable) to strive for.

1.3 Aim

This chapter aims to identify and discuss factors and forces that shape the capacity of planning organizations to develop land use and transport planning in ways that can break path dependencies and pave the way for more energy efficient and sustainable transport futures. We will discuss what this could mean for policy and planning contexts that are characterized by distributed roles and mandates across different administrative and political levels. We draw on empirical research into the conditions for collaborative planning for sustainable land use and transport in the Swedish context, namely, a qualitative case study from the city of Umeå in northern Sweden (discussed in detail below).

This chapter is structured as follows: in the next section, we introduce the Swedish transport and land use policy context. This is followed by a section where the central theoretical concepts are presented: path dependence and transformative capacity in and among public organizations. Thereafter, we present the research design including a brief introduction to the empirical case with which we are concerned. This is followed by a section where we present the results of the case study analysis. The chapter ends with a concluding discussion.

2. An overview of the Swedish transport and land use policy context

2.1 Policy goals and strategies

Goals related to sustainable development have been part of Swedish national transport policy since the 1990s. Since 2009, the overarching transport policy goal is "to ensure an economically efficient and long-term sustainable supply of transportation for citizens and industry across

the country" (Swedish government, 2009, p. 14). There are two additional goals, namely, the *accessibility goal* (the functionality of the transport system) and the *impact goal* (referring to goals for the environment, health and traffic safety). The accessibility goal sets out that "the design, function and use of the transport system should contribute to providing everyone with basic accessibility with good quality and usability and contribute to development throughout the country", and stresses the importance of gender-equality (Swedish government, 2025). The impact goal clarifies that "the design, function and use of the transport system should be adapted to ensure that no one is killed or seriously injured, contribute to achieving the overall generational goal for the environment and environmental quality goals, and contribute to improved health" (ibid.) whilst pursuing the functionality and overarching goal. This goal also includes working towards increased energy efficiency and breaking the dependence on fossil fuels (Swedish government, 2009, p. 52). Since 2017, the impact goal has been adjusted to include an explicit target to reduce greenhouse gas emissions from the transport sector by 70 % by 2030, compared with 2010.

The Swedish national climate policy framework, which includes a Climate Law, was established in 2017. According to the Climate Law, the government is obliged to develop a climate action plan every four years, to set out a clear direction for how to reach the milestones for climate emissions reduction until 2030 and 2040, respectively, and eventually net-zero emissions by 2045 (SFS, 2017). According to the current national climate action plan, the overall strategy for reducing the emissions from transport is to focus on electrification but also increase the proportion of fossil-free fuels and to increase the overall transport efficiency of the transport system (Swedish government, 2023, p. 139). Transport efficiency means that accessibility is achieved without increasing the number of vehicle kilometers travelled. According to the Climate Action Plan, this can be accomplished in several ways, for example by means of longer vehicles for freight transport, increased vehicle occupancy, route optimization, digitalization, and spatial planning that shortens distances and improves the conditions for people and businesses to get access to what they need with less mobility (fewer vehicle-kilometers travelled). The intention is to make transportation "as efficient as possible from an energy, environmental and financial perspective to achieve accessibility, sustainability and competitiveness in the whole country" (ibid., p. 161).

2.2 Roles and responsibilities

In Sweden, the mandate and responsibility to implement national transport policy in practice lies with public organizations at the national, regional and local levels. The national level has significant power for how the transport sector develops as it decides the overall policy direction and makes long-term plans and investment decisions regarding national transport infrastructure. The formal power lies with the national government and parliament, but significant parts of the strategic and operative work are delegated to public organizations (i.e. the civil service). The Swedish Transport Administration (STA) is responsible for the long-term infrastructure planning for road traffic, rail traffic, shipping and aviation as well as for the construction and operation of state roads and railways (SFS, 2010:185). Ultimately, the STA's task is to realize the overarching transport policy goal as well as the additional transport policy accessibility and impact goals (presented above). The STA is also instructed to support the realization of Sweden's goals for the environment and the national environmental quality objectives.[1] In the governments' instruction it is stated that the STA shall base its work on a broad societal planning perspective (a more holistic perspective than transport planning alone) and build on cooperation with other actors to achieve the transport policy goals (SFS, 2010:185).

The regional level is responsible for regional public transport planning and provision, and for developing plans for regional transport infrastructure. The regional infrastructure plans are intended to contribute to fulfilling the transport policy goals (SFS, 1997:263). The implementation of these plans is normally dependent on funding from the national level, and the work to develop these plans is carried out with some collaboration between each of the 21 regions in Sweden and the STA. Ultimately, the STA has significant influence on which regional projects are prioritized. When it comes to regional spatial planning, this is a rather limited activity in the Swedish context. In recent years, a formal regional land use planning function has been adopted in the Stockholm region and in two other regions which comprise some of the most densely populated areas of the country. However, the other regions have not formally begun to work with this function.

[1] There are 16 Swedish environmental quality objectives, covering a variety of environmental issues such as reduced climate impact, clean air, lakes free from eutrophication and acidification, sustainable forests and farmland ecosystems and a good built environment, which includes specifications related to land use and transport infrastructure and energy efficiency (Swedish Environmental Protection Agency, 2025).

In Sweden, the municipalities manage land use planning at the local level, including local roads and streets. The local mandate is often referred to as the "municipal planning monopoly", which means that each of the 290 municipalities makes its own decisions about land use. There is national planning legislation that states that the municipalities shall use and develop the land in ways that will lead to equal and good living conditions and a long-term sustainable living environment for people today and for future generations (SFS, 2010:900). The Planning and Building Act, which governs the Swedish planning system, encompasses the regional plan, the comprehensive plan (direction of the municipality), the area regulations (indicating national interests), and the detailed development plan (which is legally binding). Sweden has no cross-sector planning at the national level, instead the state provides frameworks for the municipal and regional levels, which means that national transportation infrastructure planning also affects the conditions for municipal and regional land use and transport planning.

3. Conceptual framework

In order to provide insights into obstacles and opportunities for change in contemporary land use and transport planning, this study takes as its starting point two overarching theoretical concepts and perspectives. One relates to *path dependencies as a form of inertia*, and the other comprises *transformative capacity,* the *capacity to challenge such path dependencies* and bring about and realize transformation (see Borrás et al., 2024; Hölscher et al., 2019; Wolfram et al., 2019).

3.1 Path dependence in policy and planning

Path dependence adopts a longitudinal and retrospective stance on the actions and inactions that have led many nations to the institutional constraints which they face today (see Kvåle, 2024 for a discussion). Path dependence can be described as influenced by, and in turn influencing, inertia in planning and policymaking. It can itself comprise and reinforce resistance to change for broader transformation, and indeed the kind of transformation required to ensure that we embark on sustainable development paths, as referred to above.

The concept of path dependence has its roots in neo-institutionalism as a strand of political science which has grown since the 1990s (see North, 1990; Pierson, 2000; Scott, 2014). The term "institution" is commonly

understood as "the formal or informal procedures, routines, norms and conventions embedded in the organizational structure of the polity or political economy" (Hall and Taylor, 1996, p. 938). Neo-institutional theory considers the combination of formal (i.e. laws, written rules and regulations) and the informal (i.e. norms, mindsets, adopted frameworks, established but unwritten ways of working, etc.) aspects of institutional life, as key features of exploring inertia as well as dynamics of change.

The conceptualization of path dependence has strong links to neo-institutional theory. Low et al. (2005) present a framework for understanding and analyzing the path dependence of institutions, having identified three interdependent strands: technical, institutional, and discursive path dependence. The first strand (technical) involves the momentum that is brought about by initial investment in infrastructure and what can be referred to as "systems of knowledge". The second (institutional) encompasses the rules, protocols and routines that exist and prevail in organizations. The third (discursive) relates to the assumptions and beliefs surrounding the structure of problems that need to be solved, i.e. the kinds of ideologies and forms of knowledge upon which operations and decision-making at the organization lie (ibid., p. 392, see also Næss et al. (2013) for a discussion concerning the knowledge engaged in transport planning more specifically).

3.2 Transformative capacity for public sector organizations

The inertia that constrains the sustainable transition of the transport (and land use) system is not unique, but can be found in several policy areas where ambitions to reduce emissions, to increase energy efficiency, and to more explicitly account for social and environmental sustainability are intended to be integrated into existing operations. These recurring implementation challenges have generated empirical research and theoretical developments focusing on how systemic transformation can be brought about in practice, and proposing different ways for societal actors to accelerate and develop transformative capacity, in industry as well as within public governance contexts. One example is research on sustainability transitions where theories on socio-technical systems are combined with influences from innovation theory and organizational and governance theory, often with an urban focus (see Geels, 2010, 2012).

Research on sustainability transitions has time and again shown that public organizations and institutions have had crucial roles in societal transformation processes (e.g. Geels, 2012). Despite these findings, few attempts have been made to develop theories with a specific focus on the

transformative capacity of public organizations (Borràs et al., 2023, p.5). However, during the last decade, such a theoretical development has begun to take hold (see Castán Broto et al., 2019; Hölscher et al., 2019; Wolfram, 2016; Wolfram et al., 2019). This theoretical development forms the basis for the conceptual framework applied in the analysis of our empirical case.

Transformative capacity has been defined as "the collective ability of the stakeholders involved in urban development to conceive of, prepare for, initiate and perform path-deviant change towards sustainability within and across multiple complex systems that constitute the cities they relate to" (Wolfram, 2016, p. 126). Capacity can be understood in different ways. One way involves the capacity of the governance system, i.e. the range of organizations that are connected through their roles and mandates linked to a specific sector or geography to work together to achieve something. Borrás et al. (2023, 2024) discuss this as capacity at the *governance level*. But capacity can also refer to the *policy level*, i.e. the institutional set-up which includes overall frameworks, policy goals and policy instruments, and the *organizational level*, which concerns the individual capacity of different organizations to engage in issues of transformation, for instance by "purposefully performing specific roles exercising change agency, and by deploying and developing its dynamic skills when mobilizing the internal and external resources at its disposal" (Borrás et al., 2023, p. 21). Altogether, the capacity of the governance system is thus dependent on both intra- and interorganizational dimensions.

Borrás et al. (2023) discuss the concept of transformative capacity, with a particular focus on public sector organizations, and pinpoint three dimensions that have been highlighted as particularly significant in previous research:

- *Roles*, which concerns the "specific purposeful tasks that an organization performs enacting institutional work in processes of sustainability transitions" (ibid. p. 14);
- *Resources*, which is understood as "the set of material or immaterial assets that are explicitly available (and perceived to be available) […], either internally or externally to the organization" (ibid. p. 16);
- *Abilities*, which means "the set of dynamic (cap)abilities or competences, in the form of practices and processes, inside the organization" (ibid. p. 17).

The authors conceptualize transformative capacity as developing in the dynamic interplay between these three components. In addition, Borrás et al. (2023, 2024) stress that transformative capacity should not be thought of as static, but instead something that develops over time, through "the continuous interaction between the roles, resources, and abilities as three constitutive elements" (Borrás et al., 2024, p. 10). They discuss the need for further research on the *interplay* between these elements, to see how this may play out in practice, and on ways for public sector organizations to overcome different types of barriers to the development of transformative agency. They stress that transformation processes are neither linear nor conflict-free and emphasize the importance of understanding capacity-building "as a process of gradual expansion of its constitutive elements; and […] a process related to public leadership" (Borrás et al., 2024, p. 12). It is important to note here that they differentiate between *public* leadership and *political* leadership, where public leadership is related to the role of the civil service, not the least managers in public sector organizations (Borrás et al., 2024).

3.3 Operationalization of the concepts of path dependence and transformative capacity

In our study, the concepts of path dependence and transformative capacity function as counterweights, with the dynamics between the two disentangled through empirical analysis. We draw on the course of events in specific planning processes in the city of Umeå, situated in the north of Sweden (see next section for a detailed description). These events are examined to shed light on a planning process that was intended to enhance goals of sustainable urban development including energy-efficient urban mobility. How these transformative ambitions met and interacted with different types of path dependencies related to land use and transport infrastructure planning will also be explored. In concrete terms, we investigate this by focusing on key events in the planning process, where existing infrastructure, planning frameworks and discourses have posed obstacles for the transformative ambitions. We also analyze how the planning organizations navigate and reflect upon roles, resources and abilities. We focus specifically on the dynamics between these three key features of transformation, not only within the individual planning organizations but also in the collaborative efforts among and between planning organizations at the wider governance level.

4. The empirical case

4.1 Umeå: A city with progressive ambitions and complicated implementation conditions

This chapter is empirically based on a single case study of land use and transport planning in the Swedish context. We build on the reasoning about case study research that has been developed by the Danish planning researcher Bent Flyvbjerg, who argues that single cases, if they are rich and illustrative, and if they are analyzed thoroughly, can provide a type of context-dependent knowledge which is of high value for in-depth knowledge development (Flyvbjerg, 2006).

Umeå is located near the northeastern coast at the Gulf of Bothnia, located beside the Umeå river and the intersections between European road routes 4 and 12, which makes it an important junction along the national road network. Umeå is a growing city with around 134,000 inhabitants (in 2024), of whom around 95,000 live in the denser parts. Umeå is known as a progressive city with ambitious targets for sustainable urban development and climate and energy transitions. In the city's Comprehensive Plan from 2011, which was updated in 2018, it is stated that there is a need for a "paradigm shift towards sustainable movement, which means goal-oriented development and transformation of the transport system" (Umeå municipality, 2011).

The city has adopted a strategy called *the five-kilometer city*, according to which the growth of the city shall, in as far as possible, take place within a five-kilometer radius from the city center or university campus area (ibid.). The overall intention is to stimulate a type of urban development that favors public transport use, walking and cycling, and facilitates a high level of accessibility without becoming too (motorized) traffic-intensive (ibid.). Umeå has also signed a *climate contract*, which is a mutual agreement between a selection of Swedish cities, national authorities and the national strategic innovation program Viable Cities. This form of contract is intended to increase the pace of climate transformation and accomplish a transformative system change "based on a mission for Climate-neutral cities 2030 with a good life for all within the boundaries of the planet" (Viable Cities, 2025).

The overall climate goal for Umeå is that the denser parts of Umeå municipality shall become climate neutral by 2030 and the entire municipality (i.e. the whole geographical area that constitutes the municipality), by 2040 (Umeå municipality, 2022a, 2022b). There are also policies that

clarify that the share of sustainable transport (i.e. public transport, bicycling and walking) shall be at least 65 % of all trips generated by residents within the city by 2025. This is also known as the *65-percent target* (Umeå municipality, 2022a). The Energy Program for Umeå confirms the intention to become climate neutral in the whole municipality by 2040 (Umeå municipality, 2024). In the program, transport in and around Umeå is highlighted as a considerable source of greenhouse gas emissions within the current energy system. Approximately 84 % of Umeå's use of fossil fuels are directly linked to the transport sector (ibid.).

The city has thus made several commitments to promoting more sustainable and energy-efficient land use and transport planning. But at the same time, the possibilities to accomplish these ambitions are somewhat limited by competing policy priorities. As a growing city, Umeå has an ambition to accommodate 200,000 inhabitants by the year 2050. This figure is based on the municipality's population projections which, in turn, warrant the development of additional new housing. Thus, even though the five-kilometer city constitutes the overall strategy for the development of Umeå, and many initiatives are focused on the denser parts of the city, new housing areas are also planned to be built in areas on the outskirts of the city, where larger contiguous areas of land are available.

The ongoing urban development in question is also shaped by a large ring road project that has been a work in progress since the 1990s. The original ambition was to direct traffic out of the city's central parts to the outer areas, to improve air quality and traffic safety, and to enable new development in central locations. But the areas that seemed further out 30 years ago are today areas where new housing is being planned. The combination of large new residential areas and proximity to major roads risks making car travel an attractive option for the residents in the new housing areas.

4.2 Efforts to plan for more sustainable land use and transport: The case of Tomtebo Strand

The planning case in focus for this study is a case that illustrates some well-known challenges at the interface between local and national land use and transport planning. It concerns the planning of a new mixed-use area, Tomtebo Strand, on the outskirts of Umeå, near the eastern part of the ring road, known as the Eastern link, which is part of European route 4, which forms part of the transnational TEN-T network. This road is as such defined as a national interest ("riksintresse"), which means that special

requirements are placed on its functionality, i.e. that users should be guaranteed a high, even and continuous level of service, comfort and safety. Several kinds of changes in and around this type of road are highlighted as running a risk of damaging the functionality, for instance, development that leads to regular or recurring excessive volumes of traffic that affect the traversability of the road (see further STA, 2022).

In the 1990s, an area for the development of companies linked to the university was proposed in this part of Umeå. The current focus on a mixed-use development comprising a combination of e.g. housing, administrative, retail and commercial uses became part of the city's comprehensive plan in 2011. The work to develop a more specific plan for the area gained momentum 5–6 years later, and eventually a detailed development plan was approved in 2023. The first housing construction is expected to start in 2027 and the whole area is intended to be completed sometime around 2045.

The intention of the municipality has been to develop Tomtebo Strand into an area with a clear and ambitious sustainability profile, with a mix of housing and workplaces, and a mix of rental and privately owned (owner-occupied) dwellings. The main share of the new dwellings will be apartments, complemented with a smaller number of single-dwelling terraced houses. The area's location in the eastern outer areas of Umeå, approximately 4–5 kilometers from the city centre makes it somewhat challenging in terms of sustainable mobility. At the same time, the location close to the university campus and the large hospital area (1–2 kilometers away) mean that there are several workplaces within convenient walking and cycling distance.

Still, however, the area is directly adjacent to the Eastern link/European route 4, which is not only the main road for traffic bypassing the city in a north-south direction along the Swedish coast, and a road of national interest, but also the main road for those who come by car to the hospital and the university campus. The proximity to high-capacity road infrastructure has led to extensive discussions between the municipality and the STA throughout the whole process of preparing the detailed development plan, which will be outlined in more detail below. Eventually, the process ended in a decision to significantly expand the large road interchange closest to the location of the new housing area, to accommodate the expected increase in motorized traffic. This road infrastructure expansion is, in turn, expected to lead to a further growth in car use.

In many ways, the case illustrates a quite "typical" planning situation where means of achieving goals for sustainable land use and transport prove

difficult to implement, and where the perspectives, roles and mandates of local and national planning actors are difficult to align. It illustrates several types of path dependencies that constrain the accomplishment of transformation-oriented planning initiatives in practice, and is of particular interest since it illustrates a different type of context than the one that has often been the focus of previous studies on sustainable transport transitions. Umeå is a large city in its specific geographical context in the northern parts of Sweden, but a small city (or perhaps even classed as a "town") by many international standards. In this type of geographical context, which is characterized by low density and long distances between districts, the transport and energy transition is even more challenging, especially when it comes to measures that affect average travel speed, which in turn affects the time taken to traverse long distances. Insights into what hinders and supports the development of transformation-oriented land use and transport planning practices in these types of environments are of critical importance beyond this specific context.

4.3 Collection and analysis of empirical material

This chapter is based upon work in a larger research project that explores the conditions for working with transformation-oriented approaches among Swedish land use and transport planning organizations at different governance levels. The research project is funded by the STA and involves collaboration with two regional divisions of the STA as well as local and regional planning organizations responsible for land use and transport planning in two urban areas of Sweden. For this chapter, we draw on parts of the empirical material from the case study in Umeå.

The chapter draws on ten qualitative interviews carried out between August 2024 and April 2025. Four of these were interviews with planners working at the northern division of the STA, one interview was carried out with an external consultant with insight into the planning process, while the remaining five interviews were carried out with planners working with traffic planning, land use planning and strategic issues related to land use and infrastructure at the municipality of Umeå. Four interviews were conducted in person and the rest were held online. Each interview lasted around 60–90 min and was recorded and transcribed in full.

The interview material was complemented by written documents from the planning process for Tomtebo Strand. As background information and supporting material, we also draw on the insights from two preliminary studies carried out with Umeå as a case study. Furthermore, as part of the

research project, we have held a number of project meetings and workshops with the relevant planning organizations. These meetings gave further background and supporting information that contributed to improving our understanding of the case.

The analysis of the empirical material involved reading and re-reading the transcripts from the interviews. This was then complemented by material in the form of insights from the other research project-related activities mentioned above, including continual informal communication with the planning actors. The research team convened and reconvened to discuss the themes arising from the empirical material. The analysis involved an abductive approach of movement between empirical evidence and conceptual frameworks, where the thematic analysis comprised a combination of (1) the identification of themes in the material, and (2) iterative referral to the literature and relevant theoretical and conceptual frameworks. This iterative process resulted in the final conceptual framework used to categorize and analyze the material (presented above) which ultimately constituted a combination of theories on path dependence and transformative capacity.

5. Results

5.1 Transformative ambitions and path dependencies in the process

5.1.1 Local visions for transformative transport futures

As mentioned above, ideas to develop the area around Tomtebo have been discussed by the municipality since the early 1990s. The starting point for the development that is today known as Tomtebo Strand can be traced back to 2013, when the municipality presented an in-depth study intended to guide the further development of the parts of Umeå that are close to the university campus area. Already at that point in time, the intention was to develop this part of the urban area in line with the overall policy direction for sustainable transport, thus with a clear prioritization of public transport, walking and cycling. The city's stated ambitions were to counteract the tendency for the car to remain/become the most attractive mode of transport in the outer areas, and to create a neighborhood with a high sustainability profile (Umeå municipality, 2013). These initial ideas were taken further in the preparations for the detailed development plan, that gained momentum during the 2016–2017 period. In the sustainability

program for Tomtebo Strand, which is a strategic document that is intended to guide the overall development of the area, it was stated that Tomtebo Strand should be a leading example for sustainable urban development, and an area where "sustainable modes of transport […] become the natural choice for travel within and to and from the area." (Umeå municipality, 2020, p. 30).

The strategies to accomplish this have included plans for public transport (establishing a bus line through the area), high-quality infrastructure for walking and cycling all year round, good parking facilities for bicycles (sheltered and with secure locking facilities), car pools and local service hubs with service points for deliveries of mail and packages as well as opportunities to borrow and share goods such as leisure items, tools, cars and cargo bikes (ibid., c.f. Umeå municipality, 2023). The plan is to ensure that different types of local services are available in the area, including leisure activities, preschools and schools, to reduce the need for motorized travel (ibid.). When it comes to car-parking, the plan includes car parks, but with fewer spaces than is the standard in relation to the number of apartments. Car parking facilities are to be located on the outskirts of the area, within "acceptable" walking distance but not too close to the residential buildings.

5.1.2 Existing road infrastructure and standardized forecasts

The municipality's ambitions for the new area gave rise to extensive discussions between the municipality and the STA regarding the way traffic volumes were expected to grow according to traffic forecasts. The STA had questions regarding the municipality's plan to create two separate entrances/exits that connected the area with the Eastern Link/European route 4, which would make Tomtebo Strand easily accessible by car. Several traffic studies were conducted during the process surrounding the detailed development plan. Some of these were conducted by the municipality, and one was conducted jointly. A recurring question was how the city considered STA's traffic forecasts, which are, very simply put, based on assumptions drawing on historical relationships between parameters such as population composition and growth, land use, trip generation and traffic growth, and which also take into account the existing and planned supply of road and other transport infrastructure. This approach can in some ways be compared to traditional predict-and-provide logics that conventionally characterize transport planning, as discussed in Khan and Johansson's chapter in this volume.

According to the STA, the planned developments would most likely lead to significant traffic growth, and a risk for congestion and reduced traversability on the Eastern link. It was considered that this issue needed to be tackled, for instance by means of increased capacity in the road network. The municipality confirmed that the new area was expected to generate an increase in car traffic, but according to their estimates the increase would probably be less than shown in the STA's forecasts, because they would also work on other initiatives linked to the overall ambitions for sustainable transport, which included having a clear strategy for how to prioritize sustainable mobility in the area, and make it accessible with measures for walking, biking and public transport. The municipality's approach, as stated in interviews, was to tolerate some additional congestion on surrounding roads, rather than increasing the road capacity in the first place.

In hindsight, the municipal planners recounted the experience that no matter how they calculated and described different possible scenarios and ways to mitigate the expected traffic growth, the STA was not satisfied with their analyses and suggested strategies. Planners from the STA instead reflect on a lack of clarity regarding how the municipality intended to handle a potentially problematic traffic situation. The planning organizations do not have equal power in these types of situations. The STA is a larger organization with substantially larger financial resources. Moreover, their methods and analyses have a higher formal status in the way these are intended to guide the prioritization of investments in transport infrastructure that concern national, and in part also regional transport infrastructure. Their methods guide not only the allocation of investments but also the assessment and selection of measures. In interviews, planners from both organizations reflected on the somewhat unbalanced power relation between the STA's established forecasts and the analyses developed by the municipality and noted that there is a lack of established working methods and tools for analysis that could help them develop joint approaches.

5.1.3 A new concept for national urban road infrastructure?

The tensions that evolved between the different perspectives of the municipality and the STA are not unique to the case of Tomtebo Strand. Similar issues have occurred in other planning situations where the national road network meets with densely built-up parts (or developing parts) of growing cities. At the central strategic departments of the STA, this has led to discussions and investigations related to possibilities to develop new

concepts for national road infrastructure in urban areas (Swedish Transport Administration, 2019, 2020). Such discussions have also arisen in the case of Tomtebo Strand. In interviews, planners from the STA refer to discussions evolving within the STA from 2019 and onwards, aiming to explore the possibilities to use the Eastern link as a pilot project for exploring a new type of road design that aims to create an enhanced urban feel, but also only allow for lower speeds than is commonly the case on high-capacity national road infrastructure of national interest. The planners from the municipality also recall that such discussions were taking place. In hindsight, it can be noted that these discussions took different paths over the years 2019–2022. In the spring 2022, the municipality and the STA worked on an application to the national research funder Vinnova (as part of the Viable Cities initiative), in which they applied for funding for a pilot project for trying out a new road design to try to bridge national and local perspectives on accessibility.

These types of discussions and initiatives were still ongoing when the municipality eventually took the final steps to complete the process for the detailed development plan, in order to be able to move on with the development of the area. At this point, several parallel processes related to Tomtebo Strand and the traffic developments were going on, not only in relation to the detailed development plan but also related to the possible pilot mentioned above, as well as other projects and initiatives aimed at attracting national funding for high-capacity public transport and bicycle infrastructure in the area. In retrospect, interviewees describe the planning process as characterized by a high degree of complexity, where only a few people had a good overview of the different processes and initiatives that were going on in parallel.

When it became clear to the STA that the municipality's detailed development planning process progressed without a clear solution to the problem with the expected traffic increase at the Eastern link/European route 4, it turned into a problematic situation. From the STA's perspective, an expansion of the nearby traffic intersection was now the only remaining way forward for them if they wanted to avoid appealing the municipality's detailed development plan, due to the remaining uncertainties about the consequences in terms of expected traffic increase and the risk of not being able to safeguard the functionality (interpreted and implemented as traversability for motorized traffic) of this part of the national and European road network. From their perspective, there was a considerable risk that traffic on the European route 4 would become blocked by congestion

caused by the developments in Tomtebo Strand. Against this background, the STA and the municipality made an agreement to significantly expand the capacity of the nearby traffic intersection.

5.1.4 Different mandates, goals and interpretations guiding the planning process

In hindsight, issues related to goals and mandates had a considerable impact on the course of events. This concerned not only which goals were given a more or less prominent place in the process, but also their specific interpretations. The municipal planners often refer to the overall goals and strategies for sustainable land use and transport planning, illustrated by mentions of the 65%-target (i.e. the ambition to increase the share of public transport, bicycling and walking) and the five-kilometer city. They refer to these goals and strategies as central and critical for the way the developments in Umeå are supposed to take place. At the same time, however, they reflect upon the goals as somewhat vague, and that it is not always clear what the goals mean in practice or how they are to be achieved. They also highlight the occurrence of goal conflicts, for example between plans for housing developments and objectives for sustainable travel and conclude that it is not always clear how such goal conflicts shall be resolved.

Planners from the STA have expressed that they in many ways support the municipality's ambitions for sustainable travel and reduced car use. At the same time, however, they are limited by their existing mandate and instructions to ensure the functionality of the national road network. From the interviews it is clear that the formal status of the Eastern link/European route 4 as a road of national interest limits their opportunities to draw on and interpret material in other ways. In concrete terms, this means that the function of the road is given priority over other goals and interests.

In general, the STA planners state that they have both the accessibility goal and the impact goal to focus on in their operations, but they also note that the main emphasis, internally within their organization, tends to be placed on the functional goal, which is operationalized by ensuring a certain level of traversability and to minimize congestion to ensure the accessibility of destinations. The STA planners express a lack of guidance regarding how to handle goal conflicts between the functional goal and the impact goal. In interviews, they repeatedly express uncertainty regarding what their role to apply a broader community planning perspective (which is part of their task as a national authority) actually means. In relation to this, it shall be noted that it is clearly stated in the national transport policy

that the functional goal and the impact goals should be given equal weight in policy development and implementation. On some occasions, the national government has even emphasized that the functional goal of accessibility should be achieved within the limits of the impact goal (Swedish government, 2020, p. 11). However, according to the planners, it is often the accessibility goal that gets prioritized in practice, and this has been referred to as a contributing factor to the decision to expand the road interchange in this case.

5.2 Planners' reflections on obstacles and possibilities for change

5.2.1 On goals, roles and responsibilities

In interviews, the planning professionals from both organizations reflected on what would have been needed to achieve a result more in line with sustainable transport transitions in the planning process for Tomtebo Strand, and – more generally – what they think would be needed to improve the conditions to plan for development trajectories more in line with systemic transformation. They all express a sense of uncertainty regarding their mandate in this respect. The municipal planners reflect on the overall goals of sustainable urban development and sustainable transport and note that even though these goals are clearly stated in strategic documents and plans, they easily get watered down in concrete planning situations, especially in situations when conflicts arise with other goals that the municipality also has set out to accomplish. Linked to this, they discuss the need for clearer operational strategies to provide guidance in situations where conflicting municipal goals (i.e. urban growth and housing expansion in outer areas, in comparison to goals for sustainable mobility) might pull in different directions.

Several of the municipal planners also mention the need for internal clarifications as different parts of the organization interpret the overall goals and strategies differently and are steered by alternative operational tasks, which, in turn, has consequences for the choices and priorities made in practice. This was seen in the Tomtebo Strand case, and in the tension between explicit quantitative targets for new housing compared to the more vaguely formulated goals for sustainable transport. A couple of the municipal planners mention that leading politicians are often good at formulating ambitious goals on paper, but do not always realize what these goals mean in practice. They reflect on their possibilities, as planners, to feed back the recurring goal conflicts to the leading politicians and to ask

for a clearer political mandate, but also express a sense of uncertainty regarding their actual possibility to do so and what that might lead to.

The officials at the STA, in turn, state that the overall formulations regarding sustainable development and climate mitigation targets (that are part of the STA's instructions and the transport policy goals) have not yet been sufficiently incorporated into the organization's operations. Interpretations differ among the interviewees when it comes to whether the STA has a clear mission to work for sustainable transport and climate mitigation and, if so, how this should be operationalized in practice. The view is that it is not entirely clear whether climate mitigation is an explicit priority and, if so, how they as an organization should prioritize climate and sustainability goals if these are perceived to be in conflict with the authority's mandate to provide accessibility for people and businesses throughout the country. As mentioned previously, the prevailing understanding among the planners from the STA is that the functional goal of accessibility (which in practice is interpreted in terms of travel time reduction for motorized traffic) weighs heavier than the impact goal (i.e the goal related to environment, health and traffic safety) within their organization. In order to plan for more transformative development paths, they would need internal clarifications regarding which goals and principles should carry the most weight, and get more internal support for how to navigate goal conflicts.

5.2.2 Resources for strategic and collaborative work

Issues related to human resources were also brought up in the interviews. This concerned, for instance, which competences are available while working with different kinds of plans and projects. Planners from both organizations stress the need to strengthen the competence to work with urban transport issues from a wider systems' perspective, which includes a more integrated approach between land use and transport planning, but also a slightly wider geographical scale than is often applied at the municipal level. From both the municipality's and the STA's perspectives, it is apparent that a project-by-project approach is often adopted, where the issues for each individual project are managed as they arise. This piecemeal approach can in turn mean that a system perspective is lost, or at least blurred. The planners stress the need for more resources and competences that can work on the consistency in transport planning on the system level, and can take on issues concerning transport and land use from a functional urban region-perspective.

The planners also stress the need to synchronize different time perspectives, and that a middle layer is needed between the long-term, strategic perspective (that which is intended to be realized in 25–50 years) and the decisions and plans being carried out today (or in the next few years). This is partly linked to access to personnel resources, but also to the capacity and preconditions to develop and activate these resources at the right time. Time is also emphasized as a scarce resource, and the planners reflect a working situation where they seldom have the possibility to sit down, analyze and discuss the ongoing planning cases, and to tackle them on a holistic basis.

Planners also mention issues related to funding as a recurring problem, which they perceive as constraining their possibilities to work across organizational boundaries towards common goals. They report that discussions between organizations are often characterized by 'who should pay for what'. Both organizations raise the need to find alternative models for how costs should be distributed between them.

Resources can also relate to the availability and use of different types of analyses and materials that inform decision-making. STA's traffic forecasts are one such type of material that is repeatedly raised as problematic. The conventional traffic forecasts are perceived as providing (and reinforcing) a narrow way of thinking about the future. This is, in turn, considered to limit the possibilities to conduct more open and exploratory discussions on conceivable paths forward for the sustainable development of the transport and land use system, for the city's development, and ultimately, for those who will live and work there in the future. Several interviewees emphasize the need to develop and apply alternative methods and decision-making materials, e.g. foresighting, scenario-building, etc. that could potentially help to identify, imagine and elaborate alternative pathways. These could in turn allow for the planning actors to adjust their perspectives and identify other courses of action, which deviate from the trajectories on which they are currently operating. The *joint use* (used and applied by all planning actors) of new or alternative methods is emphasized as being of utmost importance. During the last few years, the organizations have therefore worked on the development of a common traffic model that is based on the STA's forecasting model, where the municipality's goals and plans are taken into consideration.

5.2.3 Arenas and processes to collaborate around conceivable futures

Another issue raised by the planners is the preconditions to be able to work together towards a transformation, emphasizing that today, there is a lack of

arenas and processes for collaboration on strategic and complex planning issues. There is no real lack of meeting contexts – both organizations mention meeting series where the municipality and the STA convene on different levels to discuss ongoing issues. However, these meetings are often in the form of check-ins on a fairly general level, to keep each other informed about relevant activities, and to sometimes clarify ambiguities. Interviewees express a need for a collaborative arena which could, to a greater extent, allow the planning organizations to proactively discuss and define common visions and goals, and raise strategic (more long-term) issues. This would allow for the more challenging issues to be recognized, so that potential goal conflicts could be identified, discussed and dealt with at an earlier stage, alongside potential trade-offs and prioritizations.

One specific challenge that was raised from the STA was that their organization is characterized by more classical, technical and engineering perspectives, with a focus on physical infrastructure. This is considered to correspond to a lack, in many parts of the organization, of a developed capability to work in a more collaborative fashion, to understand procedural qualities and characteristics, and navigate issues that are more complex and multifaceted. From the municipality's perspective, it is considered that even if more formal collaborative arenas between organizations were to be established, and even if this might make a difference, the municipality is ultimately a politically governed organization, where one, as a civil servant, can rarely make binding commitments regarding how long-term strategic issues should be solved. In the end, they point out, it comes down to which political party/parties have the majority and can make decisions regarding the city's development.

A specific ability that is more indirectly apparent is related to the extent to which there is room to imagine and explore alternative, conceivable development paths, i.e. other than those which they are currently operating within and along. Several of the interviewees express how they perceive it to be unclear and unresolved within their respective organizations, what goals pertaining to sustainable development, sustainable energy use, and reduced climate impact actually mean, and what the systemic transformation required to achieve them actually implies. How this should be operationalized in the kinds of planning organizations they work within is also unclear and unresolved. This lack of clarity – and also lack of explicit discussion on these matters – becomes even more apparent for a spatial location like Tomtebo Strand, that is, locations on the outskirts of the city, which are today characterized by long distances and easy access to high-

capacity road infrastructure. None of the interviewees give an indication of their organization having a clear idea or position regarding whether the goals and principles which steer their work (at least on paper) will be sufficient. In this way, the interviews illustrate the need for a strengthened reflexive capacity within the organizations, which would include the capacity to assess to what extent today's decisions and plans have the potential to lead to goal achievement, but also highlight, describe and address some of the fundamental – and today unresolved – issues inherent to a sustainable energy and environmental transition.

6. Discussion and conclusions

This chapter aimed to identify aspects and attributes of the capacity of planning organizations to develop land use and transport planning in ways that can break path dependencies and pave the way for more energy efficient and sustainable transport futures. In this final section, we will use the conceptual framework of path dependence and transformative capacity to discuss and reflect on our main findings.

6.1 Path dependencies

Altogether, the study illustrates several types of path dependencies that served to perpetuate unsustainable trends of energy-intensive policy pathways. Already in the early stage of planning, the transformative visions outlined in the strategic planning documents were counteracted by a type of technical path dependence, which is rooted in how the city of Umeå has developed historically. The existing infrastructure and sparse urban structure involve significant risks that car travel will remain the most attractive option, even though many initiatives are planned to be taken to enhance more sustainable mobility. In line with previous research that has discussed the role of assessment frameworks and ways of working (Eriksson et al., 2024; Lyons and Marsden, 2019; Witzell, 2020), the analytical methods applied in the planning process had a path-reinforcing impact. As illustrated above, the established forecasting methods and perceptions of the most likely traffic development made it difficult to imagine and plan for other possible development paths.

The case also illustrates institutional path dependencies in the form of silo structures both within and between organizations, which counteracted a more proactive and collaborative management of the tensions and goal

conflicts that evolved in the process. Institutional path dependencies also concern existing rules and protocols that influence the positions of the various organizations. In this case this was illustrated, for instance, by the way in which the STA ultimately felt that there were no other options left than to pursue a significant expansion of the road interchange, when the municipality proceeded with the detailed development plan. The process was also characterized by a lack of joint strategic discussions regarding which goals should guide the development, how these could and should be interpreted and which concrete priorities would thus need to be made.

From the perspective of discursive path dependence, different types of implicit assumptions regarding urban and transport development influenced the process. This related, for instance, to the implicit assumption about the city's continued growth in less central locations, and assumptions that problems associated with this could easily be overcome. Another example is related to the definitions and interpretations of the overall policy goals and strategies for sustainable transport developments, such as the 65%-target. As noted above, this was repeatedly referred to as the central strategy for the municipality's transformation to a sustainable transport system. However, this goal only regulates *the proportion of* walking, cycling and public transport, not *how much* (motorized) transport there is room for overall, nor the need to economize with energy, land or material for vehicles and infrastructure.

Also, when it comes to the national transport policy goals, there is an unaddressed question of how much traffic can be accommodated in a transport system that is to achieve long-term goals regarding climate, sustainability and sustainable energy use. Existing policy goals produce vague ideas and meanings regarding what sustainable mobility is about, and direct the focus away from fundamental questions regarding how much motorized transport can be considered sustainable. In line with what has been discussed in previous studies of discursive framings of sustainable mobility in the Swedish transport policy context, we see how the prevalent meaning making of general policy frameworks serves to maintain a conventional view of urban growth and traffic growth, where traffic volumes and energy use are not questioned (c.f. Isaksson and Eriksson, 2021; Isaksson, 2023).

6.2 Transformative capacities

This study also illustrates the importance of roles, resources and abilities, if planning organizations at different governance levels shall be able to develop their capacities to open up and plan for alternative, more

sustainable, development trajectories. When it comes to *roles*, we noted a tangible uncertainty among the planning organizations, regarding their mandate to plan for transformative pathways. These uncertainties relate to what achieving existing goals concerning climate change and sustainability actually entails, their weight in relation to other goals, as well as how and by whom value and goal conflicts should be resolved.

The planners also expressed the need for *reinforced resources and strengthened competence* to work with strategic issues related to climate and sustainability within their organizations. A recurring example was the need to enhance the functional urban-regional perspective for transport and land use. This is linked to the possibility to move away from the management of transport and land use issues on a project-for-project, piecemeal basis, and focus more on the larger functional connections whilst maintaining a focus on the long-term development path. To a certain degree, this competence already exists within the organizations, but is not always activated in the right way and at the right time. Further resource issues were related to the time to sit down and analyze ongoing plans and development projects from a holistic perspective, and the need for methods to be developed so that they give a clearer representation of the goals that are to be achieved, and make visible the choices and priorities that need to be handled here and now in order to reach them.

When it comes to *abilities*, the interviews reflected a need to establish more collaborative arenas and ways of working, as a way to strengthen the conditions for the planning organizations to raise more systemic issues, to identify conflicts and tensions, and to develop more suitable decision environments for dealing with different kinds of conflicts that are likely to continue to arise in land use and transportation planning. Our interpretation is that there is also a need for a strengthened capacity for critical reflection and conflict prevention, management and resolution. This could be linked to the progress achieved towards reaching climate and sustainability goals, and an ability to react to indications of being on a trajectory that would lead to a failure to achieve such goals, as well as issues that are not dealt with. Included in this is the interplay between politics and public administration, in that a component of the fundamental goal and value conflicts needs to be dealt with by politicians.

6.3 Conclusions

Altogether, the study has led to insights into changes that would enhance the transformative capacity of current land use and transport planning. In

similar ways to what is presented by Borrás et al. (2023, 2024), we conclude that a strengthened transformative capacity requires the development and definition of roles, resources and abilities, as well as a reinforced interplay between these three components. The need for reinforcement is not just on the level of each organization, but also at the wider governance level, which refers to the organizations' common governance context. There is also a need for adjustments at the policy level, which pertains to planning frameworks, policy goals and policy instruments, that together constitute the basic institutional framework for collaboration.

What is ultimately unresolved however, and for which the reinforcement of roles, resources and abilities would not provide a solution, is what kind of transport and land use system the planning organizations, and ultimately, broader society, are striving to establish in the future. From our interview material, study of policy and planning documents, as well as ongoing contact with the planners, there are no clear answers to this question. This issue is likely to remain unresolved, owing in part to different forms of path dependencies. This, in turn, poses a barrier for collaborative efforts towards more sustainable futures. If there is no consensus about what kind of future is aimed for, it is even more difficult to determine how to get there, and indeed, how to collaborate in order to get there, wherever that may be.

The planning actors find themselves working within structures that reinforce these path dependencies. It is clear that a potential way forward is not purely about building transformative capacity within existing institutions. Changes need to be made to the structures in which the organizations work. Increased transformative capacity will not be enough if the basic issues regarding values are not addressed on a political level. The planning organizations could take a more active role in clarifying goal conflicts and the need for political priorities, but cannot make a change on their own. In relation to this, we note the tangible uncertainty within the planning organizations we are working with in this case, regarding the status of the strategies to accomplish climate and sustainable development goals, and how to navigate value conflicts. There is currently a lack of political discussion about different conceivable futures that we could plan for, and where the real choices (that have a real influence) should be made. To an extent, political leadership is missing, evident in the decentralization of many of the recurring and not insignificant challenges illustrated by this case.

Three promising developments are worth mentioning here. The first is that the planning organizations involved in the case of Tomtebo Strand

have organized themselves to start an investigation into tackling many of the transport planning and land use challenges mentioned above. The second is that there are signs of the STA as an organization taking these concerns seriously. The fact that they have funded the research carried out within this research project speaks to the STA's awareness of these problems, and hopefully to its intention to deal with some of the issues raised, to the extent to which it as an organization can. The third is the active engagement of the research participants in the research project itself. All actors have shown a considerable willingness to share and reflect on their experiences with the aim of contributing to strengthening their organization's capacity – on its own and in collaboration with others – to achieve climate and sustainability goals.

Climate change is directly affected by our current land use and transportation system. Research has shown that if international climate and sustainability goals are to be achieved, there is a need for extensive changes to today's energy intensive mobility practices (Berg Mårtensson et al., 2023; Brand et al., 2025; Pathak et al., 2022). Transport and land use planning as a collaborative practice has a significant role in influencing the transport and land use system and ultimately mobility practices in city-regions, which will, in turn have an influence on the energy required to reach places and to participate in society. This study has presented insights into barriers and facilitators of transformative efforts in planning organizations' work, and is intended to function as a way of highlighting and illustrating these issues, as well as pointing to positive developments and potential ways forward.

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CHAPTER THREE

Behavioral dimensions of technological diversification in the U.S. light-duty vehicle fleet

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Contents

Abstract

As new vehicle technologies and mobility services reshape the transportation sector, understanding consumer acceptance is essential for evaluating their implications for energy use and associated outcomes. This chapter examines the behavioral dimensions of technology acceptance, focusing on plug-in electric vehicles (PEVs) and the challenges they introduce for consumers in navigating purchase and refueling decisions. It begins by situating PEVs within the broader U.S. LDV technology and infrastructure landscape, which is dominated by internal combustion engine-only vehicles but includes a growing share of alternative fuel options. It then highlights key elements of the vehicle purchase process that shape the LDV technologies seen on U.S. roads today. This section reviews a well-established model of the consumer purchase decision-making process centered around five stages –problem recognition, search, alternative evaluation, purchase, and post-purchase behavior – and describes key influences on this process, including consumer characteristics and external factors. Building on this foundation, the chapter then introduces the 4-A Framework of Technology Acceptance, which is the cumulative result of many individual consumers progressing through four key stages: being Aware of a new technology; having Access to the technology; Approving of the technology as suitable to their needs and

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wants; and Adopting the technology through purchase and use. The 4-A framework is then used to structure a brief review of recent U.S. research on PEV acceptance, with attention to enablers and obstacles at each stage. While PEVs are the primary focus of this chapter, the frameworks developed here apply broadly to other emerging technologies.

1. Introduction: Behavioral perspectives on light duty vehicle technology adoption

As the technological complexity of the U.S. light-duty vehicle (LDV) fleet increases – with uncertain implications for energy consumption and its impacts – so too does the complexity of the issues consumers face, particularly around vehicle purchase and use. For example, mobility service business models[1] can lead people to make very different vehicle purchase decisions than they would traditionally, depending to what extent they see themselves as a consumer of mobility services or as a potential provider. The collective impact of these individual decisions could have large impacts for transportation-related energy use.

At the same time, the features of new vehicles are changing, often in ways that differ in their visibility to consumers. Under-the-hood innovations, ranging from new battery chemistries and structures to improved gasoline particulate filters, are enhancing vehicle attributes like performance and fuel economy. Many of these improvements introduce new information burdens to both vehicle buyers and the workforce that supports vehicle purchase and maintenance. Meanwhile, the features that comprise Advanced Driver Assistance Systems (i.e., ADAS)[2] are rapidly diffusing across new LDVs. These features offer the potential to improve individual vehicle efficiency as well as reduce crashes, thereby alleviating congestion and related system-wide energy waste (e.g., Gruyer et al., 2021). Realizing the full potential public benefits of these features, however, depends on how widespread they become in the LDV fleet and on whether consumers use them more or less effectively.

[1] Mobility service examples include ride-hailing, which connects travelers to destinations via third-party vehicle drivers, and delivery platforms which connect consumers with desired goods (e.g., takeout, groceries, packages).

[2] Examples include automatic emergency braking, forward collision warning, lane departure warning, lane-keeping assist, driver attention monitoring, traffic sign recognition, blind spot monitoring, rear cross-traffic alert, adaptive cruise control, traffic jam assist, lane centering/high-way assist systems, and even hands-free driving in certain systems and conditions.

Finally, vehicles with tailpipe emissions – a category that includes internal combustion engine-only (ICE-only) vehicles, hybrid electric vehicles (HEVs), and, to a lesser extent, plug-in hybrid electric vehicles (PHEVs) – dominate the U.S. fleet and primarily refuel using the U.S. gas station network. Alternative-fuel vehicles are gaining ground, however. Vehicles with zero tailpipe emissions that rely on non-gasoline refueling infrastructure – a category that includes battery-electric vehicles (BEVs), hydrogen fuel cell vehicles (FCEVs), and, again to a lesser extent, PHEVs – now represent a growing share of new LDV sales and introduce consumers to distinct infrastructure demands that reshape refueling routines. Charging locations for BEVs and PHEVs, in particular, are more diverse than traditional fueling stations, spanning homes, workplaces, public parking areas, and commercial destinations like retail stores and office buildings.

Together, these overlapping developments are reshaping not only the design of vehicles available in the LDV market, but also associated refueling infrastructure, patterns of energy use, and related impacts. Furthermore, these developments affect consumer behavior and preferences throughout the process of vehicle purchase and use, including how consumers learn about, assess, adopt, and use these new vehicle technologies. This underscores the need for analytical frameworks that integrate behavioral, contextual, and systemic influences.

This chapter examines the behavioral dimensions of light-duty vehicle technology adoption, with a focus on "plug-in electric vehicles" (PEVs) – a category that includes both BEVs and PHEVs. We center our analysis on PEVs because they represent the largest market share among alternative-fuel vehicles in the U.S. as of 2025, and because they introduce especially novel and widespread challenges for consumers navigating purchase and refueling decisions. These challenges differ in scope and visibility from those associated with mobility service business models, under-the-hood innovations, and emerging semi-autonomous vehicle features.

The next section of this chapter (Section 2) begins by setting the context for PEV adoption within the LDV technology and refueling infrastructure landscape of the U.S., which is dominated by gasoline-powered internal combustion engine-only vehicles. The following section (Section 3) similarly sets the context for vehicle adoption by highlighting key elements of the vehicle purchase process that consumers operate in and which has resulted in the LDV technologies seen on U.S. roads today. This section is structured around a well-established five-stage model of the purchase decision-making process and emphasizes some of the main

influences on that process, including (internal) characteristics of the consumer and external factors about the purchase which impact the consumer's decisions. Informed by this context, the next section of the chapter (Section 4) reviews the current literature on U.S. consumer acceptance of PEVs. This review is structured using a recently introduced conceptual model known as the 4-A framework, in which acceptance is the cumulative result of many individual consumers progressing through four key stages: being *aware* of the technology; having *access* to the technology; *approving* of the technology as suitable to their needs and wants; and *adopting* the technology through purchase and use. Section 4 begins by introducing the 4-A framework –with its distinct stages of Awareness, Access, Approval, and Adoption – and situating it within two important contexts: the broader landscape of conceptual models that have shaped research and policy on technology transitions, and the consumer vehicle purchase decision-making process described in Section 3. The section then presents a concise review of the current state of PEV acceptance in the United States since 2016, as developed in the peer-reviewed literature and organized by each stage of the 4-A framework. The chapter concludes with several overarching reflections.

2. Technology and infrastructure landscape for LDVs

Light-duty vehicles (LDVs) – including cars, light trucks, and motorcycles – account for over half (53 %) of the energy used to move people and goods in the U.S.; this represents 27 % of total national energy consumption (U.S. Energy Information Administration, 2023). Historically, the LDV fleet has been dominated by gasoline-powered internal combustion engine-only vehicles, but over time it has diversified to include a growing number of alternative-fuel vehicles (AFVs). These include not only electrified vehicles – hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), battery electric vehicles (BEVs), and fuel cell electric vehicles (FCEVs) – but also vehicles powered by gases (e.g., natural gas, propane), alcohols (e.g., ethanol, methanol, butanol) and vegetable and waste-derived oils (e.g., bio-fuels). These technologies vary in their emissions, fueling needs, and implications for infrastructure and user behavior – all of which shape consumer decisions and market adoption.

While electrified vehicles have drawn increasing attention, a full understanding of the U.S. LDV landscape must also consider the full set of

AFVs. That said, the number of U.S. light-duty vehicles powered by compressed natural gas (CNG), FCEVs, or biofuels is small in comparison to the number of HEVs, PHEVs, and BEVs. As of the end of 2023, electrified vehicles made up approximately 4.3 % of the U.S. fleet – including HEVs (2.57 %), BEVs (1.24 %), and PHEVs (0.46 %) – while FCEVs made up just 0.01 % (U.S. Department of Energy, 2023).[3] CNG and biofuel-compatible vehicles together likely represent less than 1 % of the fleet, with most vehicles used by government or commercial fleets. In short, electrified vehicles account for a significantly larger share of the current U.S. LDV fleet than all other types of AFVs.

Fig. 1 illustrates the proportion of new 2024 U.S. LDV sales by vehicle drive train, with an emphasis on whether the vehicle type depicted has zero or non-zero tailpipe emissions. In Fig. 1, the zero tailpipe emission vehicles – sometimes called zero-emission vehicles (ZEVs) – are BEVs and FCEVs. The non-zero tailpipe emission vehicles in Fig. 1 leverage the internal combustion engine to at least some extent. These non-zero emission

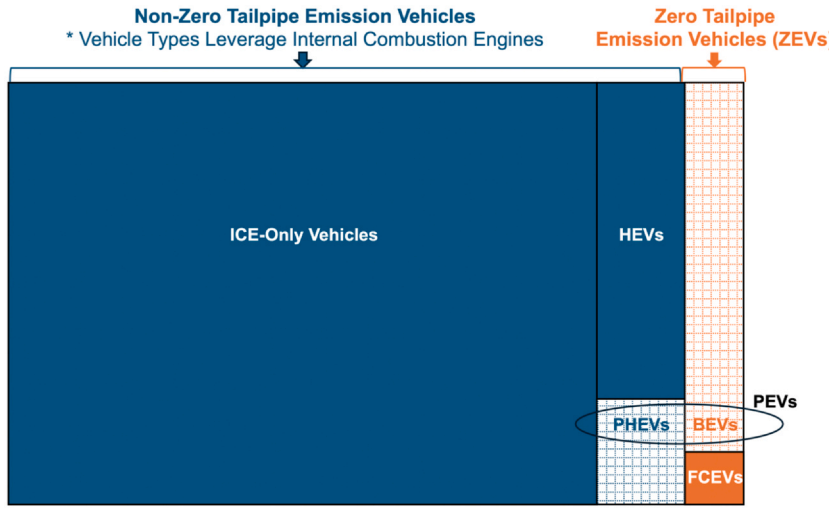

Fig. 1 New U.S. light-duty vehicle sales in 2024 by share attributed to different drive trains. Author derived from public Energy Information Administration data.

[3] Derived from "2023 Vehicle Registration Counts by State and Fuel Type" at the Alternative Fuels Data Center (AFDC) (U.S. Department of Energy, 2023). The underlying data are compiled and rounded to the nearest 100 vehicles by the National Renewable Energy Laboratory (NREL) based on vehicle identification numbers (VINs) in data from Experian Information Solutions.

vehicles include both internal combustion engine-*only* vehicles as well as HEVs and PHEVs. HEVs and PHEVs both combine internal combustion engines with electric motors; unlike HEVs, however, PHEVs can charge their electric motors from external sources. It is the ability of BEVs and PHEVs to charge from electric infrastructure that accounts for why they are often referred to as plug-in electric vehicles (PEVs). The 2024 U.S. new vehicle market share of PEVs is represented in Fig. 1 through cross-hatching and a circle around the labels for PHEVs and BEVs.

ZEVs rely on alternative drivetrains to ICE-only vehicles. BEVs are propelled by one or more electric motors that are usually powered by a large traction battery pack. BEV batteries must be charged offboard (i.e., externally) by plugging the vehicle into an external power source like a standard outlet or electric vehicle charging equipment (often abbreviated as EVSE). Additional power is also generated onboard (i.e., internally), by capturing braking energy through "regenerative braking." Most BEV drivers charge at home, with 75 % of BEV-owning households doing so (U.S. Energy Information Administration, 2020). When BEV drivers cannot charge at home, they have access to 83,837 public EVSE stations in the U.S. and Canada with 232,982 available charging ports, to date (U.S. Department of Energy, 2025). Note that these numbers include all charger types – Level 1, Level 2, and DC Fast Chargers – as well as all connector types.[4]

FCEVs also use electric motors, but their electricity is generated on board via hydrogen fuel cells, typically supplemented by a small battery.[5] These vehicles emit only water vapor and warm air. Drivers replenish the

[4] According to the AFDC, "a station location represents a physical place with one or more EV charging ports," where each port "provides power to charge only one vehicle at a time even though it may have multiple connectors," which are the devices – sometimes called plugs – that are connected to a vehicle to charge it. "Multiple connectors and connector types (such as CHAdeMO and CCS) can be available on one EV charging port." Level 1 chargers use 120-volt AC outlets and can usually add 2–5 miles of electric travel range per hour of charging. Level 2 chargers use a 240-volt AC outlet and add 10–20 miles of electric travel range per hour of charging. DC fast chargers make it possible for a typical EV to reach 80 % of a full battery charge in 20–60 min. Both Level 1 and Level 2 chargers regularly serve people's home charging needs, but Level 2 chargers account for most (~75 %) of non single-family residential chargers, typically as "located at gasoline stations, workplaces, restaurants, shopping centers, sporting facilities, and hotels. Most other charging ports are DC Fast Chargers, typically located along interstates." (U.S. Department of Energy, 2025).

[5] Most FCEVs are based on polymer electrolyte membrane (PEM) fuel cells, which have a positive electrode (cathode), a negative electrode (anode), and an electrolyte membrane between the two. The structure of the cell creates the conditions for an electrochemical reaction – aided by a catalyst – to break down hydrogen molecules introduced to the anode into protons and electrons. Protons pass through the electrolyte membrane to the cathode, while electrons travel through an external circuit to power the motor before recombining with protons and oxygen to form water.

hydrogen in fuel cells by dispensing compressed hydrogen gas into the vehicle at stations that are either public or private (public stations serve all brands of FCEV). FCEVs can carry enough hydrogen in their on-board tanks to provide the vehicles with 300–400 miles of range, and these tanks can be refueled quickly, typically 3–5 min. Infrastructure remains limited, however. As of June 2025, the U.S. had 54 retail stations and 21 non-retail stations, for a total of 75. Of these, California alone had 53 retail stations and 6 non-retail stations (U.S. Department of Energy, 2025).[6] While hydrogen is more expensive than gasoline, FCEVs can travel about twice as far per unit of fuel and many lease deals include complimentary fuel (California Air Resources Board, 2024).

Non-zero emission vehicles (Non-ZEVs) – which Fig. 1 defines to include ICE-only vehicles, HEVs, and PHEVs – rely largely on engines that burn fuels to propel the vehicle. Non-ZEVs emit a variety of gases from their tailpipes, including unburned hydrocarbons, nitrogen oxides, carbon monoxide, and particulate matter, gases which damage human airways and contribute to health issues like lung cancer, asthma, and cardiovascular disease (Hsueh et al., 2020). In addition, Non-ZEVs emit carbon dioxide and other greenhouse gases which "contribute to the greenhouse gas pollution that threatens public health and welfare" (U.S. Environmental Protection Agency, 2009). Although control technologies exist that can reduce some of the tailpipe emissions of Non-ZEVs (e.g., gasoline particulate filters, catalytic converters), when LDVs burn less of the fuels that emit these byproducts, it reduces the vehicle's emissions of these gases.

HEVs are a subset of Non-ZEVs for which most of the power needs are met by their internal combustion engines. They also receive supplemental energy – for auxiliary loads, very low-speed driving, and idling of the vehicle – from an electric motor powered by a battery pack. That battery pack is charged exclusively onboard the vehicle via the internal combustion engine and regenerative braking. That supplemental energy makes smaller internal combustion engines possible in HEV designs, resulting in greater fuel efficiency, less fuel burned, and an overall reduction in tailpipe emissions. Drivers of HEVs are fully reliant on refueling their vehicles at gasoline stations.

PHEVs offer greater flexibility with respect to refueling, as PHEV drivers can use home chargers, public EVSE stations, or gas stations. Fig. 1

[6] As of June 2025, Canada had only 6 stations: British Columbia had 5 and Quebec had 1. https://afdc.energy.gov/fuels/hydrogen-locations#/analyze?tab=station&fuel=HY&country=US&access=public&access=private&region=US-TX.

groups PHEVs as Non-ZEVs because, like HEVs, they use both an internal combustion engine and an electric motor. PHEVs typically run on electricity first, switching to gasoline once the battery is depleted. When fully-fueled for both the electric motor and the combustion engine, PHEVs operate as BEVs for short trips and as HEVs for longer journeys. To get the lowest emissions, however, PHEV drivers need to charge their electric motors fully; there are indications that this does not occur consistently across the full population of PHEV drivers. Understanding this phenomenon better is an important subject for future emissions research.

Fueling stations, commonly referred to as gas or gasoline stations, offer gasoline, and sometimes also diesel, biofuels, or other combustible liquid fuels. While exact numbers vary, the U.S. likely has between 122,000 and 145,000 stations, with Canada reporting 11,713 as of the end of 2023.[7] The total number of gas stations has declined significantly over the past several decades. In the U.S., gasoline stations peaked in 1969 at roughly 236,000, declining to 180,000 by 1978 (Jakle, 1978), reaching 190,246 in 1996, and 156,065 by 2012 (U.S. Department of Energy, 2025). The number of fueling stations in Canada experienced a similar decline over time, resulting in 11,713 retail gasoline stations operating in December 31, 2023 (Kalibrate, 2023). This trend reflects shifts in land use, competition, vehicle efficiency, and consolidation. Gas stations have also evolved over time from businesses focused primarily on fueling and servicing Non-ZEVs to more diversified business models. Most U.S. and Canadian gas stations now include convenience stores, which play a key role in stations' viability due to the low margins on fuel sales. The importance of that role is reflected in the fact that two North American Industry Classification (NAICS) codes apply to gasoline stations, one for stations with convenience stores (NAICS code 457120) and another for stations without (NAICS code 457120).[8] In

[7] The IBIS World analyst report 44711 on gas stations with convenience stores accounted for a total of 108,136 U.S. establishments (Ross, 2024), while report 44719 on stations without convenience stores accounted for 13,871 U.S. establishments (Thomas, 2025). The combination appears to result in 122,007 total gas stations, but this does not match the numbers provided by the American Petroleum Institute (API). The API cites the National Association of Convenience Stores when reporting that there "are more than 145,000 fueling stations" across the U.S.," with "127,588 of these stations … convenience stores selling fuel."

[8] Note that gas stations with convenience stores in the vicinity of the interstate highway system have been protected since the late 1950s, to a certain extent, from competition due to federal law 23 U.S.C. § 111. Rest areas are only permitted to have commercial activities limited to advertising, State tourism media and tickets, travel information, lottery machines, vending machines, and motorist call boxes.

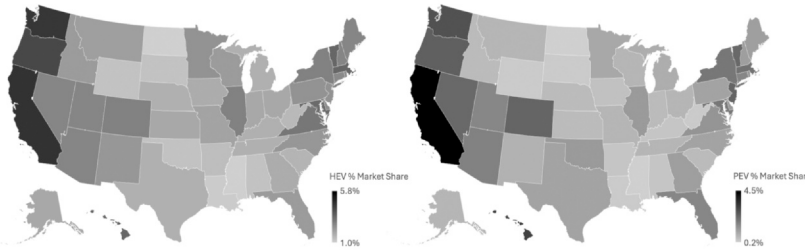

Fig. 2 Vehicle registration share of HEVs and PEVs in U.S. States through 2023. *Source: Author calculations from Alternative Fuels Data Center Transatlas, https://afdc.energy.gov/transatlas#/ (February 2025).*

2023, 89 % of U.S. and 82 % of Canadian stations had convenience stores larger than 500 square feet (Kalibrate, 2023).

The aggregate result of consumer decisions about these various LDV technologies and fueling infrastructures is reflected in the cars on the road. As of late 2023, internal combustion-only vehicles still dominated vehicle registrations, with electrified vehicles comprising a small but growing segment. There is considerable regional variation, however; Fig. 2 illustrates the U.S. share of vehicle registrations attributed to HEVs and PEVs (which include both BEVs and PHEVs). On the higher side, HEVs comprise more than 4 % of all registered vehicles in three States (California, Oregon, and Washington) plus Washington, D.C.; PEVs achieve that large a share of vehicle registrations in only one State, California. On the lower side, the lowest two States for HEVs have a HEV vehicle registration share of only 1 % (North Dakota and Mississippi). At the same time, 24 States have a PEV vehicle registration share of 1 % or less (from highest to lowest market share, these are Minnesota, Michigan, New Mexico, Wisconsin, Tennessee, Ohio, Montana, Missouri, Alaska, South Carolina, Nebraska, Kansas, Indiana, Idaho, Iowa, Kentucky, Arkansas, Alabama, Wyoming, West Virginia, South Dakota, Louisiana, North Dakota, and Mississippi). These patterns highlight not only consumer preferences but also differences in infrastructure, policy, vehicle access, and the age of vehicle stock across regions.

3. The purchase decision-making process and the factors that influence it

Just as Section 2 positioned PEV adoption within the broader U.S. landscape of LDV technologies and refueling infrastructure, this section

frames it within the consumer vehicle purchase decision-making process and its key influences. The mix of LDV technologies on U.S. roads today reflects the cumulative outcome of consumer decisions that are shaped by this process and the factors that inform it.

Consumer behavior research provides a structured way to consider the interplay between consumer characteristics and vehicle attributes in the process by which individuals or groups select, purchase, use, or dispose of products and services, while attempting to meet their needs and desires (Solomon, 1995). A seminal framework in the consumer behavior literature is a five-stage model of the purchase process that encompasses problem recognition, information search, alternative evaluation, purchase, and post-purchase behavior. This model has its roots in early 20th-century work by Dewey (1910) and was formalized in the influential Engel et al. (1968) model introduced in 1968. Subsequent versions, including Blackwell, Miniard and Engel (1986), further refined the model to reflect evolving understandings of consumer cognition and behavior. The model has been widely applied to product markets and later adapted for online and high-involvement purchases (e.g., Darley, Blankson, and Luethge, 2010).

In Fig. 3, we expand on this model to illustrate the purchase decision process, including both its composite stages and many of the internal and external factors that influence it; these influences draw from other frameworks and branches of behavioral research and involve connections that are not always highlighted in other studies. Although the stages of the decision-making process are connected with solid arrows in the figure, indicating the general sequential path of the purchase process, the figure also uses dashed arrows to indicate feedback loops that may occur between individual stages, particularly when consumers reassess their options or refine their preferences.

To structure our analysis of how consumers adopt PEVs, Section 3 is divided into two parts: one that walks through each stage of the vehicle purchase decision process, and another that examines the internal and external factors that influence it. For additional information of relevance to this section, please see Taylor and Fujita (2018).

3.1 Decision-making stages

3.1.1 Problem recognition

Problem recognition is the first stage of the purchase decision-making process, the step in which a consumer identifies a gap between their current situation and his or her needs and/or desires (i.e., the consumer's "ideal

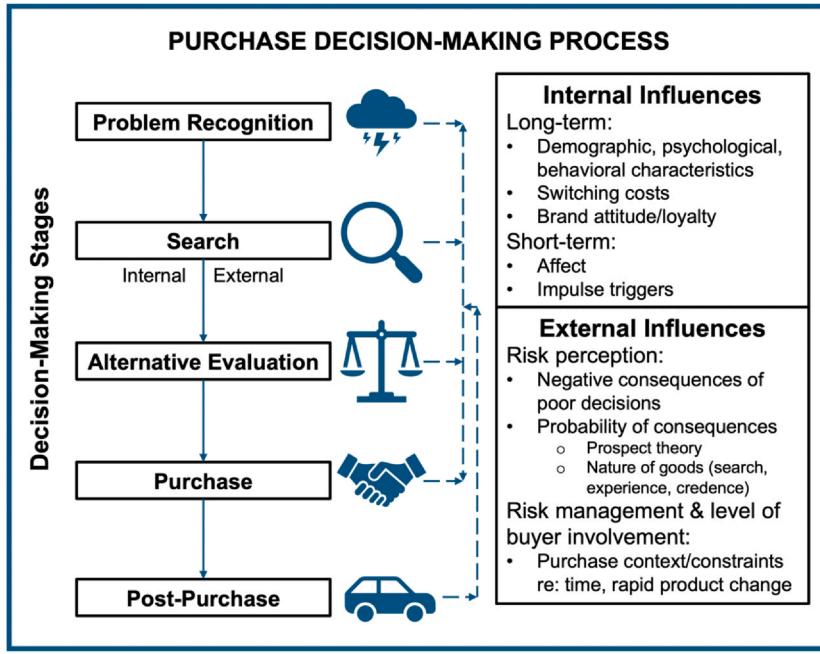

Fig. 3 Purchase decision process. *Adapted from Darley et al. (2010) with modifications by authors.*

situation"). In general, the larger this gap appears to the prospective buyer, the more likely they are to recognize the problem and act to address it (Bruner and Pomazal, 1988). This stage of the purchase decision-making process is the one most focused on the *characteristics* of the vehicle buyer rather than the *attributes* of the vehicle; note that we try to maintain this nomenclature throughout this chapter. People are often characterized by their observable and latent traits. *Observable traits* are often measurable, and include an individual's age, income, education, race, gender, residence location, homeownership status, household size and composition, and number of household vehicles. For the most part, these observable traits are external to the individual. *Latent traits*, by contrast, are more internal to a person and not as easily measured. Latent traits include people's attitudes, values, beliefs, lifestyles, interests, opinions, preferences, knowledge and perceptions, emotions, personality traits, sense of identity and status, and social ties. In some cases, these characteristics can be gauged through a consumer's self-reporting of their psychographics, political leanings, and socio-demographics through mechanisms like surveys.

Problem recognition is generally considered to be under-researched, with few theoretical or empirical papers in the scholarly literature, and even less in the context of vehicle purchases. In the vehicle purchase decision context, the ability of a prospective buyer to identify the gap between their current and ideal situation is influenced by several factors, including: (1) the attributes of any currently owned vehicle and the perceived attributes of other vehicle options; (2) the characteristics of the prospective buyer within their lifestyle/travel behavior contexts; and (3) the interaction between vehicle attributes and buyer characteristics, particularly as either undergoes change in the current day or in the perceived future.

In the EKB framework, several reasons for purchase emerge from the problem recognition stage of the decision process, including: (1) depletion of a currently-owned product (e.g., the existing car is quite old and becoming difficult to maintain); (2) a product is regularly or habitually purchased (e.g., the prospective buyer routinely leases a new car every few years); (3) a currently-owned product is unsatisfactory (e.g., the existing car breaks down too often and is unreliable); and (4) the consumer has a new need for a product (e.g., the prospective buyer has a new job for which the commute cannot be accomplished through public transportation; see, e.g., Clark et al. 2014); (5) the prospective buyer wants to acquire a complementary product but the currently-owned product is incompatible (e.g., the prospective buyer wants to transport their electric bicycle but their small sedan lacks the ability to host the required hitch and rack); or (6) the higher expected satisfaction associated with the features of a new product (e.g., newer cars have desirable ADAS features that the existing car does not). Fig. 4 illustrates some of the internal and external factors that drive problem recognition and some of the main purchase reasons that emerge from this stage of the purchase decision process.

Punj and Srinivasan (1992) is one of the few papers that has tested the value of segmenting problem recognition (PR) purchases reason to better understand and predict variation in vehicle buying behavior. Their motivation was to advance understanding of PR by addressing two key limitations of this area of research: the absence of a strong theoretical foundation and the lack of empirical specification. The authors developed a conceptual framework derived from four central ideas: (1) the type of PR event influences how much cognitive and physical effort a consumer invests in the subsequent purchase decision; (2) perceptual and motivational factors that precede PR help explain why PR events differ; (3) long-term

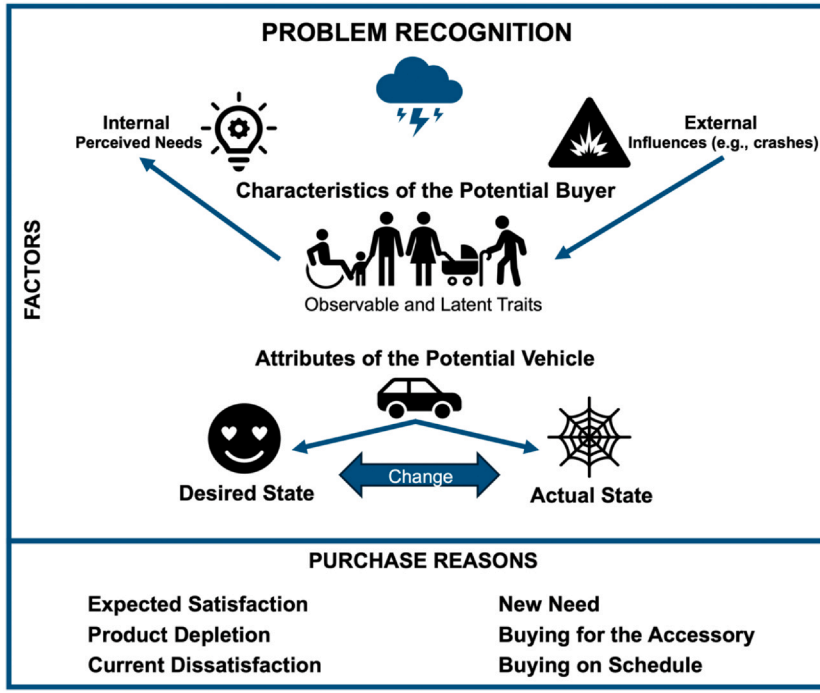

Fig. 4 Problem recognition factors and purchase reasons described in the EKB model.

memory plays a role in how PR events activate later decision steps; and (4) the nature of the PR event shapes how consumers assess their satisfaction after purchase.

The framework developed in Punj and Srinivasan (1992) organized PR into four distinct segments based on consumers' motivations for entering the vehicle purchase process, each of which is expected to produce different patterns of decision behavior (e.g., time spent searching, number of vehicles considered, number of dealership visits). The authors focused on four segments which they identified and empirically tested with survey data from 1056 new car buyers in three U.S. metropolitan markets: (1) *New Need (14 % of the sample)*, for example when a car is needed for a new purpose or the consumer did not previously own a car; (2) *Product Depletion (19 %)*, for example when the consumer's current car has stopped working or is due for replacement due to age; (3) *Expected Satisfaction (24 %)*, for example when the current car works well enough, but the consumer is enticed by the attributes of a new vehicle (e.g., better styling or fuel economy, incorporation of ADAS); and (4) *Current Dissatisfaction (43 %)*,

for example when the current car is unreliable or repairs are too frequent or costly. The analysis found statistically significant differences between the *New Need* and *Product Depletion* segments in how they approached the vehicle purchase decision process. In contrast, although *Expected Satisfaction* and *Current Dissatisfaction* were conceptually distinct, they did not exhibit significant differences.[9] Regarding vehicle technology adoption, the findings of Punj and Srinivasan (1992) suggest that it is not sufficient to treat all segments of the vehicle-buying population in the same way when conducting analysis.

3.1.2 Search

Information search is the second stage of the purchase decision-making process. In this stage, consumers actively gather and interpret information about products that could potentially address the purchase reason identified in the problem recognition stage of the process. The scope and depth of search are shaped by factors like the complexity of available product options, perceived differences between brands, the consumer's level of involvement in the purchase decision, and the consumer's time constraints. At the end of the search stage, consumers should be prepared to consider and evaluate the set of product options they are aware of – which is usually smaller than the universal set of options available in the market.

There is an extensive literature on consumers and information search. Many papers – including those that inform and build on the EKB model – recognize that when prospective buyers are trying to determine their product purchase options they look for useful information sources that reside in two places: inside themselves (*internal search*) and outside themselves (*external search*). Internal search draws from sources like memory, personal experience, and emotional associations. It is also informed by "ongoing search," the process by which consumers gather information even in the absence of a specific purchase need or intention, sometimes driven by general interest in certain categories of products or services (Pham et al., 2024; Zander & Hamm, 2012).

[9] The *Product Depletion* consumer segment was statistically distinct from the other segments on three variables: they considered the smallest number of makes before visiting a dealership, made the smallest number of pre-decisions, and shopped for the smallest number of aggregate models across dealership visits. Meanwhile, the *New Need* consumer segment was statistically distinguished from the other segments on only one variable: they shopped for the highest number of aggregate models across dealer visits.

External search is a more active process in which consumers draw from four types of information sources: personal (e.g., family and friends), commercial (e.g., advertisements, packaging, manufacturer websites), public (e.g., government webpages, third-party reviews performed by non-profits, companies, and individuals, news articles), and experiential (e.g., direct experiences like test drives and product trials, free samples, demonstrations). Consumers typically weight internal information and information from friends, family, and other consumers more highly than information from business sources.

Research on external search is more extensive than on internal search. According to Pham et al. (2024), significant research areas include search intensity (i.e., the amount of information searched or time spent on a search), search direction (i.e., the content of information searched, such as products and services, brands, and product attributes), and search order (i.e., the sequence of searching information sources and product attributes. Most research is conducted on search intensity, in part because of the difficulty of assessing search direction and order to generate generalizable insights (ibid.). Fig. 5 illustrates some of the internal and external sources that consumers consult during search, as well as the three research areas of search intensity, direction, and order.

During the search process, consumers rely on perception to make sense of the information they encounter. Perception encompasses sensing, selecting, and interpreting information to derive meaning. Processes that

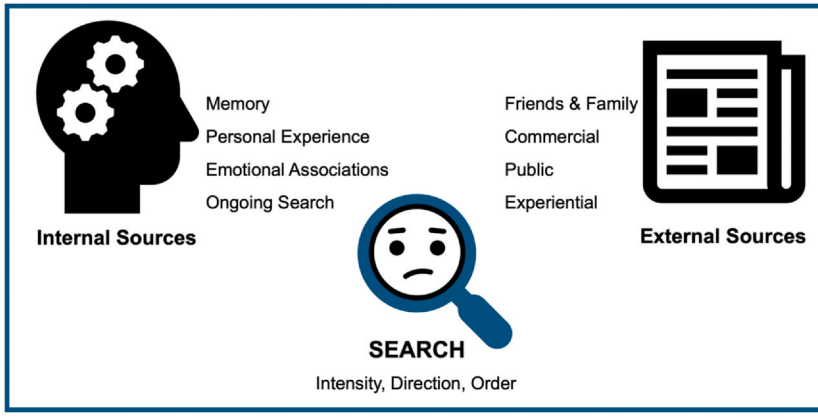

Fig. 5 Internal and external sources consumers consult during search, with research areas summarized in Pham et al. (2024).

can help or hinder perception include a person's openness to information sources, attention to different messages, comprehension of information with respect to consistency with the consumer's beliefs, and retention of information. These processes are inherently "selective," meaning that consumers choose to what extent they will be exposed to new information, pay attention to information, comprehend information, and retain information. Research on search and perception encompasses several areas, with brand perception a particularly important topic (see, e.g., Avery & Keinan, 2015).

3.1.3 Alternative evaluation

Alternative evaluation is the third stage of the purchase decision process, in which prospective buyers assess available options based on product features and attributes relative to their purchase criteria (Fig. 6). Examples of product *features* in the vehicle context include tangible components like backup cameras or automatic braking, while product *attributes* are generally derived qualities like vehicle performance, safety, or comfort. Attributes can be further distinguished by whether they are relatively objective or subjective. Objective attributes of vehicles tend to be measurable, like fuel economy or electric range, cargo space, seating capacity,

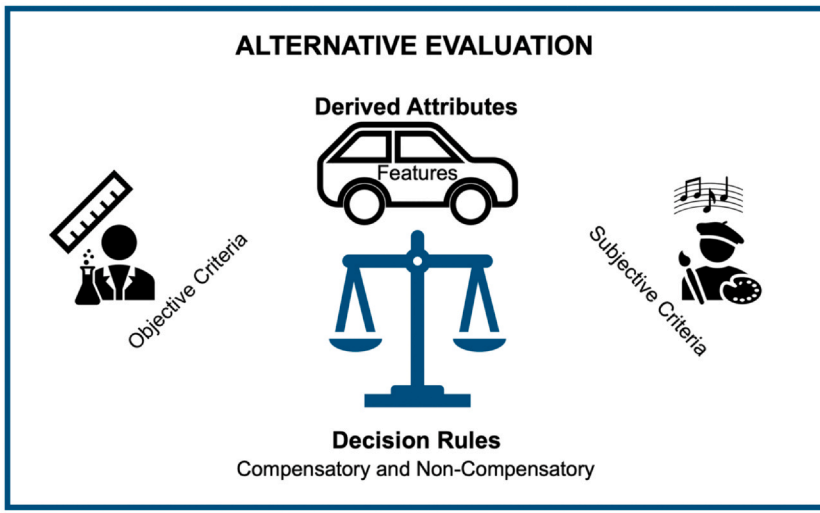

Fig. 6 Prospective vehicle buyers apply decision rules to evaluate alternatives, weighing the objective and subjective attributes derived from combinations of product features.

and price (Higgins et al. 2017). Subjective attributes are more intangible qualities of a vehicle, like aesthetics, emotional appeal, and status conferred by the brand (Gerber Machado et al. 2023).

Consumers have different purchase criteria; they also use different evaluation methods and weights, with their decision rules broadly categorizable as compensatory and non-compensatory (Hauser, Ding, & Gaskin, 2009). A compensatory decision rule allows consumers to trade between product attributes, meaning a weakness in one area can be offset by strength in another. A vehicle example of a compensatory decision rule is when a lower price might outweigh an undesirable color. In contrast, a non-compensatory decision rule involves a requirement that a consumer believes must be met. A vehicle example of a non-compensatory decision-rule is when a consumer refuses to consider any vehicle unless it has all-wheel drive.

3.1.4 Purchase

Purchase is the fourth stage of the purchase decision-making process, the step in which a consumer decides to buy (or not buy) a product with certain attributes. For vehicles, this stage often involves consumers negotiating with dealerships over price, financing terms, and the trade-in values of previously owned vehicles. The consumer's favored product, as identified via alternative evaluation, can change at the point-of-sale for several reasons. These include situational constraints (e.g., lack of inventory/product availability, financial limitations, incentives for competing products) and social influences (e.g., pressure from salespeople or customers encountered at a retail outlet, peer group opinions). These dynamics underscore that purchase is not merely the execution of a prior decision but a distinct step subject to disruption, revision, and reinforcement in real time.

In the context of U.S. vehicle purchases, sales predominantly occur at franchised dealerships. Over the last few decades, consumers have made fewer and fewer dealership visits. According to Yavorsky, Honka, and Chen (2021), prospective vehicle buyers made an average of 4.6 dealership visits in 1986, 2.2 visits in 2002, and 1.3 visits in 2016. This has coincided with a decline in the number of U.S. dealerships since the 1970s and a concomitant increase in average sales per dealership. The decline in dealership numbers also makes external search via experience (i.e., test drives) more difficult for consumers, given limitations on inventory and personnel. It also raises the stakes of individual dealership interactions, particularly in light of the strong influence of the dealership experience in shaping consumer decisions. Research indicates that positive dealership interactions –

characterized by knowledgeable staff, available inventory, and test drive opportunities – can encourage purchase, while negative experiences can heighten perceived risks or reinforce existing consumer doubts.

At the point-of-sale, the vehicle purchase involves several potentially overlapping steps involving both consumers and dealership personnel. As outlined in Sullivan, Jones, and Reynolds (2020), the four main steps are: (1) consumers choose the car with dealer assistance; (2) consumers and dealers negotiate the price of the new car, as well as the price of any trade-in; (3) consumers and dealers agree to financing terms, sometimes with contract add-ons like extended warranties and service contracts which the dealer introduces late in the process[10]; and (4) the consumer signs the paperwork, sometimes confronting additional processing fees, and takes the car. This multi-step process can be lengthy. In the in-depth interviews reported on by Sullivan, Jones, and Reynolds (2020), the process could take five hours or even several days, fatiguing consumers.

This fatigue hampers consumer bargaining, as does the limited number of dealerships available for negotiating a final vehicle price. In addition, dealerships generally hold strong negotiating positions due to structural factors, including the complexity and opacity of the purchase process at the point-of-sale and the relative inexperience of most consumers. Furthermore, dealerships often adjust margins across the four steps of the point-of sale process (Fig. 7). For example, if a consumer negotiates a strong new vehicle price, the dealer may recoup profit on the negotiations for the value of the trade-in (Busse and Silva-Risso, 2010). Consumers who gather more pricing information, such as dealer invoice prices or quotes from other dealers and online buying services, tend to pay lower prices (Zettelmeyer et al. 2006; Scott Morton et al. 2011). Consumers with strong credit and external loan pre-approvals typically secure better terms through this process, while those with limited credit face steeper costs and may be more sensitive to down payment requirements (CFPB, 2016; Adams et al. 2009). Note that products and fees introduced late in the point-of-sale process can be linked to higher final costs due to "drip pricing" (Gabaix and Laibson, 2006) and consumer decision fatigue.

[10] Some studies suggest that extended warranties often cost more than the repair expenses they offset (Consumer Reports, 2014; Lee and Venkataraman, 2016). Risk-averse or credit-constrained consumers, however, may find value in rolling the cost of a warranty into vehicle financing to avoid potentially sizable, unexpected repair bills (see, e.g., Kelley and Conant (1991)). Extended warranties may also be more appealing for vehicles with lower reliability (see, e.g., Consumer Reports (2014)).

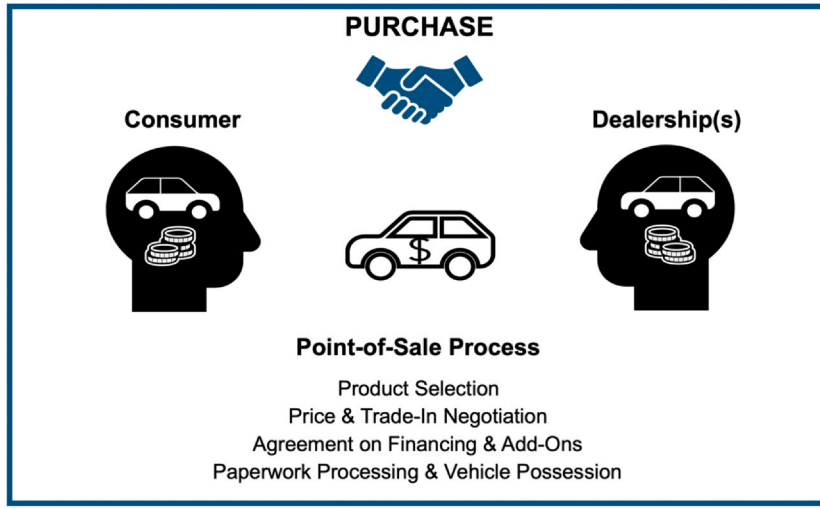

Fig. 7 Purchase at the point-of-sale is typically complex and negotiated between consumers and dealerships, with dealerships structurally advantaged.

3.1.5 Post-purchase

Post-purchase behavior is the fifth stage of the purchase decision-making process, the step in which a consumer uses the product, evaluates their feelings about the purchase, determines if it meets their pre-purchase expectations, and engages in actions that influence their own future purchases or those of others (Fig. 8). With respect to the future purchases of the individual, outcomes of interest to a wide variety of individuals and institutions include: repurchase intentions, brand loyalty, commitment, share of wallet, and willingness to pay. With respect to the influence of a post-purchase consumer on the purchase decisions of others – either directly through product evangelism or through indirect effects stemming from their interactions with the product ecosystem – Bove, Robertson, and Pervan (2003) and Soch and Aggarwal (2013) provide helpful guides.

The customer citizenship behaviors typology developed in papers like these include: (1) "Voice," in which the consumer communicates with the manufacturer or retailer about problems with the product; (2) "Service Improvement," in which the consumer communicates with the manufacturer or retailer about ideas or suggestions for how the organization can improve; (3) "Display of Affiliation," in which consumers convey to others their affinity for the product or brand (e.g., by putting a bumper sticker on the car); (4) "Policing," in which consumers ensure that others behave

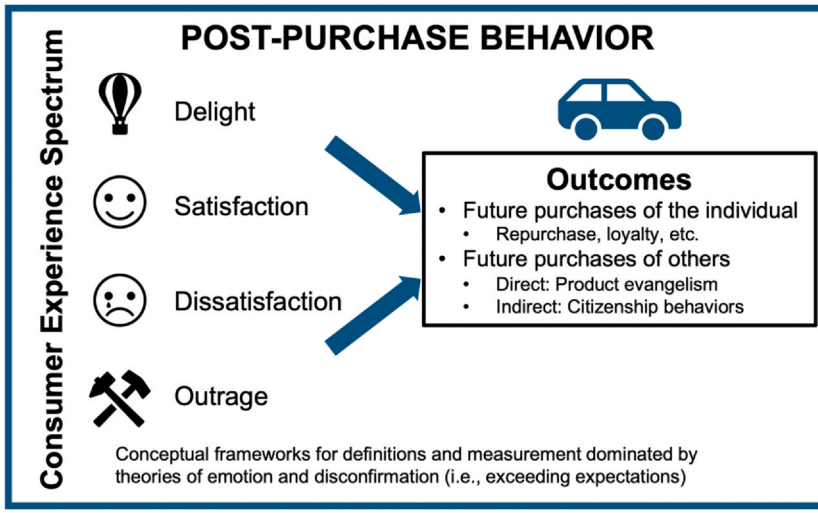

Fig. 8 The spectrum of customer satisfaction and the extent to which expectations of satisfaction and dissatisfaction are exceeded by actual experience influence repurchase and the decisions of others to purchase, via mechanisms like customer citizenship behaviors.

appropriately with the product (e.g., enforcing PEV charging etiquette); (5) "Flexibility," in which consumers adapt to issues that arise with the product (e.g., waiting to charge a PEV at home until electricity rates are lower); (6) "Referral/Recommendation," in which consumers communicate to others a favorable review of the product/service; and (7) "Act of Service," in which consumers help employees of the product or service provider (e.g., by providing additional information to PEV dealerships about local time-of-use rates).

The psychological aspects of the consumer purchase experience drive actions like customer citizenship. For this reason, we use the term "post-purchase" behavior instead of "outcomes" – the original name of the post-purchase stage in the EKB model – to emphasize the importance of psychological elements of the purchase experience. There is considerable research, for example, on the spectrum of consumer satisfaction and dissatisfaction – particularly in their extremes of customer delight and outrage – that is closely tied to the likelihood and degree to which customer citizenship behaviors occur (see, e.g., Jacobs et al., 1998, Stange et al. 2025, Schneider and Bowen, 1999, Souca, 2014).

A substantial body of empirical research suggests that customer delight is a stronger predictor of favorable post-purchase behavior than customer

satisfaction alone. In their recent systematic review, Stange et al. (2025) identify two dominant theoretical foundations for defining and measuring customer delight: emotion and disconfirmation (i.e., the experience of exceeding expectations).[11] They highlight Oliver et al. (1997) as particularly influential in uniting these perspectives, proposing that when a product or service exceeds a consumer's initial expectations, it triggers emotional responses – specifically surprise, positive affect, and arousal – which together give rise to customer delight.

3.2 Influences on the purchase decision-making process

Although many factors influence the vehicle purchase decision-making process, this section focuses on those highlighted in Fig. 3: internal factors, which may be either long-term or short-term in nature, and external factors, which shape how risky the consumer perceives the purchase to be and how much attention they devote to it.

3.2.1 Internal factors

Several of the "longer-term" factors that influence the purchase decision-making process relate to the consumer as an individual with a generally stable decision-making style. Researchers have identified and tested a number of such styles across different purchase contexts, with one widely used framework being the eight-category Consumer Style Inventory ("CSI"; see Sproles and Kendall, 1986). The CSI decision-making styles, which are considered to be relatively stable, are: (1) "Quality conscious/Perfectionist," in which a consumer systematically shops around, making numerous comparisons to get the best quality product; (2) "Brand conscious," in which a consumer develops product purchase quality heuristics from things such as brand, high price, and/or higher-end retail channel; (3) "Recreation-conscious/Hedonistic," in which a consumer approaches the purchase process as an activity to be enjoyed for its own sake; (4) "Price-conscious," in which a consumer systematically shops around on the basis of price, discount size, and value; (5) "Novelty/fashion-conscious," in which a consumer seeks the latest products, often in a quest for variety or excitement; (6) "Impulsive," in which a consumer is typically not cognitively engaged with the purchase, instead buying spontaneously; (7) "Confused (by over-choice)," in which a consumer is overwhelmed by too

[11] The authors also find two other theories to have been usefully applied – needs-based theory and cognitive appraisal theory – but these do not dominate the literature on consumer delight.

much information and choice; and (8) "Habitual/brand loyal," in which a consumer uses past purchase patterns to routinize purchases and reduce purchase effort. See Jain and Sharma (2013) for a review of research using the CSI.

Other relatively stable factors that influence the purchase decision-making process reflect on the consumer, not as an individual, but in relation to a given product or brand. One such factor is the consumer's cumulative experience with a product or brand, which can have a strong influence on product search and alternative evaluation. According to Carroll (2013), more experienced consumers: (1) have a richer set of internal sources to turn to in internal search; (2) have less motivation to conduct external search but are more adept at conducting it, often consulting a wider set of external sources and processing the information more efficiently; (3) may consider a wider set of alternatives (see, e.g., Johnson and Lehmann, 1992), given a lower perception of the risk of the purchase than a less experienced consumer; and (4) use more sophisticated heuristics to evaluate alternatives.

A second stable factor that involves the consumer in relation to a product or brand is the consumer's attitude toward the brand, the study of which draws on theoretical frameworks from social psychology (Spears and Singh, 2004). Brand attitude has predictive utility regarding consumer behavior and contributes to brand loyalty, in conjunction with patronage behavior. For example, Dick and Basu (1994) identify four types of brand loyalty resulting from combinations of brand attitude and patronage behavior, as experienced over time. Brand attitudes become "sticky" due to situational factors that can impose so-called "switching costs" on consumer that can lead a brand or product design to become "locked-in," regardless of product or brand cost or performance. Switching costs can be monetary or related to time, effort, convenience, the presence of complementary goods, learning effects, network externalities, and other factors. Examples of products with high switching costs due to learning effects and network externalities include: Android cell phones versus iPhones; PC laptops versus Macs; top-loading clothes washers versus front-loading machines; and conventionally-fueled vehicles versus alternative-fuel vehicles. Note that habits, social factors, and emotional bonds to brands or products also make it hard for consumers to switch.

In contrast to the stable, long-term factors shaping consumer behavior, "shorter-term" influences are more malleable and situation-dependent.

These include affect – the experience of emotion during decision-making – and conation – the translation of emotion and cognition into action, such as impulse buying.[12]

Affect plays a central role in many aspects of consumer behavior (Luce, Payne, and Bettman, 1999), though the emotional dimension of decision-making remains underexplored (Johnson and Stewart, 2005).[13] Positive emotions are particularly tied to: processing information efficiently; making useful connections between pieces of information; generating creative solutions to problems; arriving at decisions more quickly; and being satisfied more readily with a purchase. Neuroeconomic research suggests that emotion plays a dominant role during alternative evaluation, often outweighing neutral or objective information (Murray, 2013). Affect also remains critical after the purchase, shaping satisfaction and influencing future repurchase intentions.

Affect is especially influential, however, during the search stage of the purchase decision-making process, when intuitive, affect-driven System 1 thinking tends to dominate (Kahneman, 2003; Sloman, 1996; Stanovich and West, 2000). System 1 processes – shaped by brand familiarity, prior experience, and emotional impressions – create durable internal associations that guide which options consumers consider or ignore. System 2, by contrast, governs slower, effortful, and rational thinking. It is typically activated when consumers perceive themselves to have greater time or cognitive resources available for comparing alternatives. While System 1 may dominate early in the search process, both systems interact: consumers often begin with intuitive judgments that narrow the options they consider, then shift to deliberative evaluations of their top candidates. This dual-process model also helps explain how consumers integrate internal and external search, relying first on memory and experience, and then turning to third-party information to validate or refine their impressions.

Impulse buying behavior is another way affect translates into action. Defined by Bayley and Nancarrow (1998), impulse buying is a "sudden, compelling, hedonically complex buying behavior in which the rapidity of

[12] Affect (the experience of emotion), cognition (the acquisition of knowledge), and conation (the translation of feeling and thought into action) are the three major divisions of psychology. Affect can be characterized by valence (subjectively positive or negative), arousal (elicitation of a physiological response), and motivational intensity (the urge to act).

[13] See, e.g., Sheller (2004) and Steg et al. (2001) for discussion of the important role that emotions play in the vehicle purchase decision. In addition, Moons and de Pelsmacker (2015) focus on the role of emotion in the intention to use a PEV.

an impulse decision process precludes thoughtful and deliberate consideration of alternative information and choices." Impulse buying illustrates how affect can override deliberation. Emotional arousal often leads consumers to prioritize immediate rewards over future consequences (Cohen, Pham, and Andrade, 2006). Muruganantham and Bhakat (2013) categorize impulse buying influences into four groups: (1) internal stimuli (e.g., emotions, identity); (2) external stimuli (e.g., store layout, cues); (3) situational/product factors (e.g., time pressure, product visibility); and (4) demographic and sociocultural factors (e.g., age, gender, education). Classic marketing techniques identified by Stern (1962) – such as limited-time offers, hands-on product interaction, or personalized product prompts – shape impulse buying by activating emotional and intuitive processes.

3.2.2 External factors that influence purchase decision-making

External stimuli that can trigger impulse buying are one of several factors that are external to the consumer that can influence the purchase decision-making process. We focus here primarily on the perceived risk of a purchase and how consumers process that risk, but we also touch on other aspects of the external context of a given purchase.

Risk analysis provides a useful framework for considering some of the most important aspects of the purchase context. These are the consequences of a purchase (i.e., the significance of an outcome) and the probability that those consequences will occur. Potential negative consequences of a purchase include financial loss (e.g., the feeling of "throwing money away" on a poor purchase); psychological loss (e.g., the purchase is shown after the purchase to conflict with the consumer's beliefs or values); a loss of social status (e.g., the purchase is not favorably viewed by the consumer's peers, social influencers); performance/functional loss (e.g., the purchased product does not work as intended); and physical loss (e.g., the purchase might cause bodily harm to the consumer or his/her family) (see, e.g., Dowling and Staelin, 1994; Ross, 1975). Positive consequences of a purchase, by contrast, drive positive affect and the related search efficiencies, repeat buying behaviors, and so on, as described above.

The likelihood that a negative purchase outcome will occur is something that a consumer must assess from available evidence. Some goods are more transparent about their likely quality before a purchase than others. According to a three-part economic classification of goods, "search goods" have price and quality characteristics (including performance) that a consumer can readily evaluate before purchase through inspection, comparison

shopping, and other means. Search goods are often relatively substitutable, with high price elasticity of demand (Nelson, 1970).[14] "Experience goods" are products in which the quality becomes apparent only as or after they are consumed. These goods – such as luxury goods (e.g., a vintage bottle of wine), beauty products, and health care – are prone to greater information asymmetry between the seller and the buyer and often have less elastic demand than search goods (Vining and Weimer, 1988). Consumers use several cues when deciding to purchase an experience good, including price, with a heuristic equating lower price with lower quality; reputation, with a heuristic equating greater popularity or fame with higher quality; referral, with a heuristic that third-party judgments are trustworthy sources of information regarding such goods; and a consumer's own prior experience, as influenced by affect, as described above. "Credence goods" have quality characteristics that a consumer has difficulty evaluating even after purchase, such as vitamins or an oil change for a car. Many of the same cues used to inform experience good purchases also inform credence good purchases, and the two types of goods exhibit similarly low price elasticities of demand and information asymmetries between sellers and buyers. Credence goods, however, often involve an additional element of managing future risks. In both the vitamin and oil change examples, the consumer believes that the good is preventative of a future harm.

Consumers weight the probability of a poor purchase outcome against the intensity with which they expect to feel the loss from the poor outcome. This phenomenon is described in prospect theory, which is informed by experimental and neural-imaging evidence about how people think and behave. It contrasts with theories in which people are treated as perfectly rational. Prospect theory can be applied to break down a prospective consumer's purchase risk analysis into two stages. In the first stage, the consumer identifies potential purchase outcomes, sets a reference point, and frames outcomes as favorable and unfavorable (i.e., gains and losses) relative to the reference point. In the second stage, the consumer "evaluates" their perception of the value of the outcomes and weighs the

[14] The price elasticity of demand reflects how a change in the price of a good changes the quantity demanded by a consumer. It is higher (i.e., more elastic, or responsive) in several circumstances, including: when there are more substitutes available for the good; when the good is not a necessity; when the price change endures for a significant period of time; when the price of the good represents a higher proportion of a consumer's income; when the good is considered by consumers to be a narrow product category of its own rather than one of many goods in a category; and when brand loyalty does not influence the consumer's evaluation of the good.

probability of these outcomes. In general, people are more averse to losses from a reference point than they are inclined toward gains; this is even more pronounced when the reduction in probability goes from "a sure thing" to a less certain probability. Kahneman (2011) provides a useful 4-part schema of risk attitudes that relates gains and losses to probabilities of outcomes. In the context of gains, "risk averse" people have a fondness for certainty and fear disappointment even in situations in which the probabilities of gains are high, while "risk seeking" people tend to hope for a large gain, even when the probabilities of gains are low. In the context of losses, "risk averse" people fear large losses, even when the probability of loss is low, while "risk seeking" people hope to avoid losses when the probability of loss is high. Note that "risk neutral" behaviors are those that would be expected in decisions made by a perfectly rational actor.

A consumer's assessment of the risks of a purchase plays an important role in their "involvement" in the purchase decision-making process, particularly in their motivation to spend time and resources (e.g., mental and physical effort) during search and alternative evaluation. In general, purchase decisions in which consumers perceive that the financial and psycho-social consequences are high will prompt higher involvement and more extensive problem-solving. Automobile purchases are a classic example of a high involvement purchase, due to the cost and infrequency of the purchase (with the exception of people who buy on schedule), as well as their social visibility. By contrast, purchase decisions in which consumers perceive that the financial and psycho-social consequences are low will prompt lower involvement. In lower involvement purchases, problem-solving may be limited or even reduced to habit or routine. Impulse purchases, as described above, are made with almost no involvement.

The consumer's involvement in a purchase can be constrained by factors related to the purchase context or the consumer's psychology; the consumer's perception of time is a particularly important mediating variable. For example, consider the situation in which a consumer perceives that little time is available to make a purchase decision about an expensive, high social visibility product that the consumer considers necessary to everyday life. This circumstance regularly occurs in the case of a major car crash when a consumer has limited access to other transportation options to reach work, school, and other critical locations. In that circumstance, instead of engaging in an extensive problem-solving process that relies heavily on slower System 2 conscious reasoning, the consumer is likely to rely more heavily on faster, intuitive System 1 mental processing. As

discussed above, System 1 mental processing is heavily influenced by past affective experience with a brand and/or product which has created lasting impressions for a consumer.

A contrasting example related to time and vehicle purchases arises when a consumer feels no immediate pressure to buy but perceives that vehicle attributes and features – such as performance, overall quality, or incorporation of new ADAS components – are evolving rapidly. This dynamic can heighten the consumer's sense of uncertainty and increase concern about making a poor or premature purchase decision. Decision avoidance and choice deferral are likely to be particularly applicable in the context of PEV purchase decisions, given the prevalence of consumers "waiting for the technology to advance" (National Academy of Sciences, 2015). Relevant topics include: relying on the default option (Baron and Ritov, 2009; Heidenreich and Kraemer, 2015; Johnson and Goldstein, 2004); anchoring (Ben-Elia and Avineri, 2015); and engaging in inaction inertia (Mairesse et al., 2012; Tykocinski et al.1995). Finally, Greenleaf and Lehmann (1991) explored reasons for consumer delay in significant purchase decisions and revealed the following five major causes: (1) task avoidance and unpleasantness; (2) time pressure; (3) uncertainty; (4) difficulty of selecting the best brand; and (5) perceived risk of product performance. Of these, the authors found that difficulty of selection and time pressure are the most important causes of consumer delay (also see Otto et al. 2014).

4. The 4-A framework and current understanding of U.S. acceptance of PEVs

This section reviews recent literature on U.S. consumer acceptance of PEVs, where "acceptance" is a condition that new technologies can achieve in the hearts and minds of a population. This review is structured around a recently introduced framework that conceptualizes acceptance as the cumulative result of consumers progressing through four key stages: becoming aware of a new technology, gaining access to it, determining that it meets their needs and preferences (approval), and ultimately adopting it. These stages – Awareness, Access, Approval, and Adoption – form the 4-A framework of new technology acceptance (Jackman et al., 2023).

This section is organized in two parts. It begins by introducing the 4-A framework and situating it within two key contexts: first, alongside other

conceptual models that have informed understanding, modeling, and policy related to technology diffusion; and second, in relation to the vehicle purchase decision-making process and influencing factors described in Section 3. The second part presents a streamlined review of the peer-reviewed literature on U.S. consumer acceptance of PEVs since 2016, structured by each stage of the 4-A framework. Additional context and supporting material can be found in Jackman et al. (2023).

4.1 The 4-A framework in context

Given this book's focus on transitions in transportation, it is helpful to briefly review several leading energy transition frameworks in order to situate the 4-A framework within a broader conceptual landscape. Here we briefly consider four theories which have usefully been applied in the context of PEV adoption: diffusion of innovation (DoI), the multilevel perspective (MLP), technological innovation systems (TIS), and social practice theory (SPT).[15]

One of the most prominent frameworks for understanding how a new technology becomes widely accepted is Diffusion of Innovation (DoI) theory (Rogers, 2003). DoI explains diffusion as a social process that unfolds over time through networks, with the result often a characteristic S-shaped adoption curve. DoI outlines five different types of adopters, in the order in which they adopt a new technology: (1) the first to adopt are "innovators "(roughly the first 2.5 % of a population defined by a normal curve); (2) second are "early adopters" (the second 13.5 %); (3) third are the "early majority" (the third 34 %); (4) fourth are the "late majority" (the fourth 34 %); and (5) the final segment of the population, known as the "laggards" (the last 16 % to adopt). Key aspects of DoI include its emphasis on communication channels and perceptions of an innovation's relative advantage, compatibility, complexity, trialability, and observability. A number of articles have used this framework to analyze consumer adoption of PEVs (see, e.g., Axsen et al., 2015; Rezvani et al., 2015).

The Multilevel Perspective (MLP) on transitions in socio-technical systems (Geels, 2002) is another widely cited framework. The MLP conceptualizes transitions as dynamic interactions across three levels of analysis:

[15] Also relevant to our conception of the acceptance of PEVs are: (1) the Theory of Planned Behavior (Ajzen, 1991), which emphasizes the processing of information and addresses behavior generally, not limited to the context of innovation; (2) the Theory of Reasoned Action (Fishbein and Ajzen, 2009); and the Technology Acceptance Model (Venkatesh and Davis, 2000), which emphasizes the perceived ease of use and usefulness of a new technology.

technological niches, socio-technical regimes, and broader landscape pressures. Technological niches are so-called "protected spaces" where emerging technologies mature through learning and experimentation. Regimes encompass the established system of rules, norms, practices, and technologies that govern a particular sector like energy or transportation. Landscape is the broader context that encompasses economic conditions, cultural values, and political systems. MLP has been widely applied to transportation, helping to explain how policy shifts, cultural values, and incumbent industry structures shape the emergence or resistance to PEVs (e.g., Geels, 2012). It emphasizes the co-evolution of technologies with institutions, markets, and user practices. Note that protection from the dominant regime that supports existing technology can occur through things like policy carve-outs and subsidies, or simply because of the nature of pilots and demonstration projects. This concept underlies the strategic niche management (SNM) framework that is closely related to the MLP (see Schot and Geels, 2008). For SNM application to PEVs, see Smith and Raven (2012) and Sierzchula (2014).

Also complementary to the MLP is Technological Innovation Systems (TIS) theory, which focuses more closely on the system-level functions that support innovation. It examines the roles of actors, networks, institutions, and system dynamics in fostering or inhibiting technological change (Hekkert et al., 2007). TIS research has been applied to PEVs by analyzing factors such as resource mobilization, knowledge development, and market formation (see, e.g., Langeland et al., 2022).

Finally, Social Practice Theory (SPT) focuses less on the emerging technology than on humans who might use the technology, with particular attention to the routines, norms, and material arrangements that shape everyday behavior. SPT offers insight into why certain mobility patterns persist despite the availability of new technologies, and emphasizes that widespread technological change actually requires reconfiguring entire bundles of practices (e.g., Shove et al., 2012). This makes it particularly valuable in exploring behavioral inertia in PEV adoption.

Table 1 provides a summary of these leading frameworks in energy transitions, as applied to the context of PEV adoption. It also adds a final row for where we believe the 4-A framework fits into the context of these theories. As mentioned above, we define "acceptance" as the condition that new technologies can achieve within the hearts and minds of a population. It is the result of many different individual consumers being *aware* of the technology, having *access* to the technology, *approving*

Table 1 Leading energy transition frameworks and the 4-A framework.

Framework / theory	Overview and application to vehicles	Key citations
Diffusion of Innovations (DOI)	Explains how innovations spread through stages of knowledge, persuasion, decision, implementation, and confirmation. Explains adopter categories (e.g., innovators, early adopters) and factors influencing adoption such as relative advantage, compatibility, complexity, trialability, and observability. Used to model PEV adoption stages and influential adopter characteristics	Rogers (2003), Ozaki and Sevastyanova (2011), Axsen et al. (2015), Carley et al. (2013), Rezvani et al. (2015)
Multilevel Perspective (MLP)	Analyzes transitions across three levels: niche innovations (micro), socio-technical regimes (meso), and landscape (macro) developments. Explains transitions from ICE vehicles to PEVs within broader societal and policy shifts	Geels (2002, 2005), Wells and Nieuwenhuis (2012), Sovacool and Hess (2017)
Technological Innovation Systems (TIS)	Focuses on the structure and dynamics of innovation systems including actors, networks, and institutions. Applied to identify system weaknesses or bottlenecks in the PEV innovation ecosystem	Bergek et al. (2008), Markard and Truffer (2008), Kieft et al. (2017), Hekkert et al. (2007), Langeland et al. (2022)
Social Practice Theory (SPT)	Views consumer behavior as socially and materially situated, focusing on routines and practices. Highlights how vehicle use habits and social norms influence transition to PEVs	Shove et al. (2012), Walker et al. (2015)
4-A Framework of Acceptance	Operationalizes consumer-focused transition stages of awareness, access, approval, and adoption. Particularly suited for practical policy applications.	Jackman et al. (2023)

of the technology as suitable to their needs and wants, and *adopting* the technology. Given its novelty, we describe the 4-A framework in more depth below.

The 4-A framework was developed as part of the U.S. Environmental Protection Agency's literature review on PEV acceptance (Jackman et al., 2023). Motivated by the breadth, depth and complexity of this literature,[16] the 4-A framework emerged as a definitional and organizational framework for understanding acceptance as the cumulative result of a series of interdependent stages through which people become increasingly engaged with a new technology. It was further refined to articulate stage-specific objectives, metrics, and indicators in a format accessible to multidisciplinary, policy, and lay audiences. Designed for both research and practical application, the 4-A framework offers an actionable lens through which to measure and support consumer acceptance. Each stage has distinct goals, behavioral cues, enablers, obstacles, and metrics. While the stages of the 4-A framework are presented as a linear sequence, they are more accurately understood as having partially overlapping stages with possible feedback loops. We describe each stage of the 4-A framework below, highlighting the connections between each stage and the purchase decision-making process and factors described in Section 3, above.

The first stage of the 4-A framework, *Awareness*, refers to a consumer's familiarity with a new or emerging technology at a level sufficient to include it among the options they consider for potential purchase. Awareness aligns most closely with the search step of the consumer purchase decision-making process, following the problem recognition step in which consumers assess the gap between their ideal and actual state and decide to purchase or lease a new vehicle.[17] In the case of PEVs, consumer awareness involves knowing that the vehicle category exists, recognizing

[16] The literature on PEV acceptance includes a large and diverse collection of topics, objectives, and methods and data. Topics include vehicle attributes (e.g., body style, durability, range, prices, costs); consumer characteristics (e.g., demographics, purchase criteria and behavior); and aspects of the system/context in which vehicles are purchased and used (e.g., incentives; fees; education; sales; infrastructure; charging; production; model availability). The objectives of the reviewed studies included descriptions (e.g., of consumers, markets), efficiency, cost effectiveness, feasibility, optimization, equity, progressivity/regressivity, reliability, durability, and so on. Methods included surveys, descriptive statistics such as vehicle sales and production statistics, econometric and other projections, and conceptual and theoretical models. Data included survey data, census data, odometer readings, consumer reported vehicle use behavior, charging locations, and charging time.

[17] We do not view awareness as part of problem recognition, except perhaps in cases in which consumers are replacing a PEV and already see it as the default solution.

key models or brands, and having a general sense of how PEVs differ from internal combustion engine-only vehicles. Awareness is closely related to both internal search, which draws upon sources like memory, personal experience, and emotional associations, as well as to external search. As a reminder, the four main sources which consumers draw from in external search are: personal (e.g., family and friends), commercial (e.g., advertisements, packaging, manufacturer websites), public (e.g., government webpages, third-party reviews performed by non-profits, companies, and individuals, news articles), and experiential (e.g., direct experiences like test drives and product trials, free samples, demonstrations).

The second stage of the 4-A framework, *Access*, refers to the degree to which consumers are able to realistically evaluate and obtain a new or emerging technology, based on the availability, affordability, and suitability of product and infrastructure options in their local context. Access is closely linked to experiential sources of external search in the vehicle purchase that allow consumers to interact with the product directly, such as test drives and ride-and-drive events. It also shapes how consumers evaluate alternatives, especially when consumers begin to assess criteria related to logistics, financial feasibility, the desirability and availability of products with certain features, and overall personal fit. In the case of PEVs, access includes the physical presence of relevant vehicle models at local dealerships, the availability of home or public charging infrastructure, the affordability of both vehicles and charging options, and the ability to conveniently and affordably maintain and service the vehicle. Access also touches on the purchase stage of the purchase decision-making process, as it constrains whether an informed purchase will be possible at the point-of-sale.

The third stage of the 4-A framework, *Approval*, refers to the point at which consumers with different characteristics regard a new or emerging technology as a viable and personally suitable option that they evaluate favorably based on their needs, preferences, and values. Approval aligns most closely with the alternative evaluation and purchase stages of the consumer decision-making process. During alternative evaluation, consumers compare a set of options using both objective attributes (e.g., cost, range, performance) and subjective ones (e.g., emotional fit, brand identity, lifestyle alignment). Approval reflects the outcome of this comparison, whether that is reached prior to visiting a point-of-sale venue like a dealership, or formed during discussions at the venue itself (in the purchase stage of decision-making). Approval of PEVs is shaped by consumers'

positive beliefs, attitudes, and emotional responses toward the vehicles,[18] as well as toward associated recharging infrastructure options like home or public charging. Approval represents the stage at which consumers develop an intent to purchase, even if the purchase itself has not yet occurred.

The fourth stage of the 4-A framework, *Adoption*, refers to the point at which a consumer takes concrete action to obtain and begin using a new or emerging technology. In the context of PEVs, this includes purchasing or leasing a vehicle, registering it, arranging for home or public charging, and incorporating the acquired vehicle into daily routines through driving and charging behaviors. Adoption therefore reflects not only the culmination of Awareness, Access, and Approval but is also shaped by logistical readiness, confidence in recharging options, and alignment with broader lifestyle or identity goals. Adoption connects most directly with the purchase and post-purchase behavior stages of the consumer decision-making process. As a reminder, the purchase stage of that process involves selecting a specific vehicle model, negotiating terms, and finalizing the transaction, while the post-purchase stage encompasses product use, satisfaction or dissatisfaction, and the potential for direct or indirect influence on future purchase decisions. Through product purchase, Adoption marks the completion of the consumer decision process but through use – and the related spectrum of the consumer experience from delight to satisfaction to dissatisfaction to outrage – Adoption can also influence the speed and direction of future purchases.

Fig. 9 summarizes the 4-A framework for assessing the acceptance of a new or emerging technology. It provides brief descriptions of each stage (Awareness, Access, Approval, and Adoption), as grounded in the context of PEVs. It also indicates, through icons, the connection of each stage of the 4-A framework to the purchase decision-making process elaborated upon in Section 3.

4.2 Literature on U.S. acceptance of PEVs since 2016

This subsection provides a streamlined review of the peer-reviewed literature on U.S. consumer acceptance of PEVs since 2016, structured by each stage of the 4-A framework. It draws heavily from Jackman et al. (2023), which provides additional context and supporting material. For each stage, we emphasize the state of U.S. acceptance and review the enablers and obstacles to that acceptance. We preview this material in Table 2.

[18] This is true of both consumer attitudes toward PEVs in general as a category of vehicles and toward specific PEV models available for purchase.

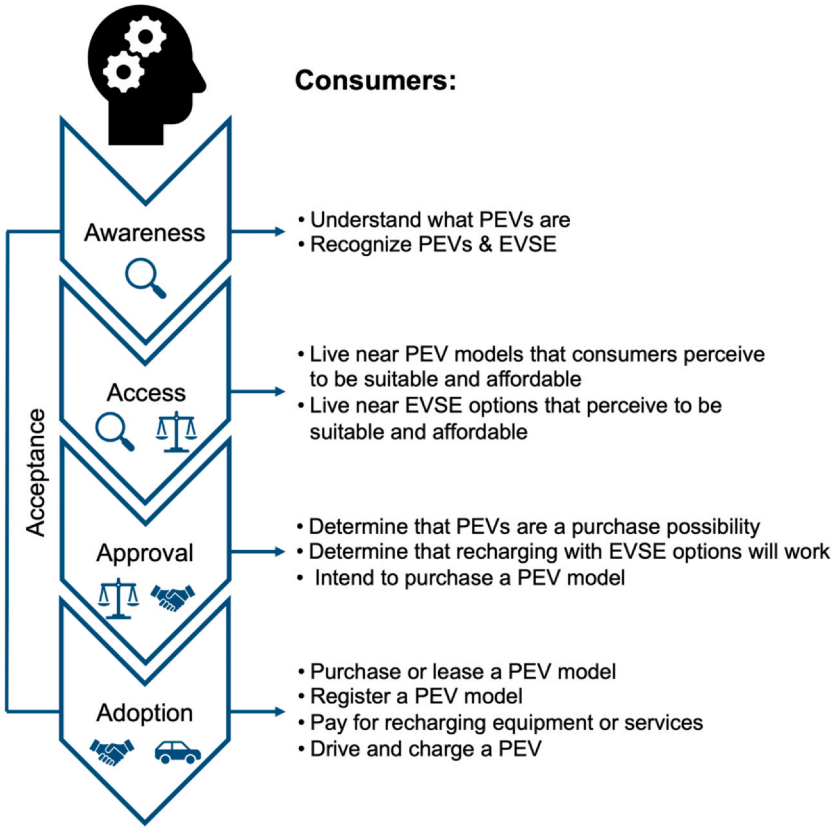

Fig. 9 The 4-A framework and its connection to the consumer purchase decision-making process, in the context of PEV acceptance.

4.2.1 Awareness

Awareness, as developed in the 4-A framework and applied to PEVs, refers to a consumer's familiarity with PEVs and their associated infrastructure at a level sufficient to include PEVs amongst the options they consider for purchase. Because Awareness is not directly observable, it is typically assessed through consumer self-reports in surveys that ask about recognition of vehicle makes/models, understanding of technology and performance characteristics, knowledge of incentives, and visibility of charging infrastructure.

Studies show moderate but uneven levels of PEV awareness among U.S. consumers. For example, Singer (2016) found that 49 % of respondents reported seeing PEVs during regular travel, and only 18 % had

Table 2 Summary of the state of acceptance, the enablers, and the obstacles of each of the stages of the 4-A framework on consumer acceptance of PEVs.

		Awareness	Access	Approval	Adoption
Definition: Consumer…		…has generally correct PEV knowledge	… has convenient access to PEV & EVSE	… perceives PEV at least as ICE-only substitute	… acquires (buy or lease) PEV
State of Acceptance	Metrics:State of…Dynamics	• Know about, name, recognize vehicles and EVSE; recognize PEV & EVSE-relevant signs and symbols; accurate knowledge • 50−80 % varies by metric; geographically & socio-economically uneven • Stable/stagnant	• Physical/geographic availability of vehicles and EVSE (number, proximity and density of vehicles, vehicle models, body styles, charging sites and ports); affordability, purchase price and ownership costs • Geographically & socio-economically uneven • More vehicle models, body styles, and geographic distribution expected • More public EVSE expected	• Stated preferences ("consider purchase," "at least as good as," purchase intent; high willingness to pay; included in consideration or evoked set • >50 % varies by metric; geographically & socio-economically uneven • Increasing	• Sales, purchases, registrations, and production (as a proxy) • About 4−5 % of new vehicle sales in 2021; geographically & socio-economically uneven • Projections vary widely

(continued)

Table 2 Summary of the state of acceptance, the enablers, and the obstacles of each of the stages of the 4-A framework on consumer acceptance of PEVs. (*cont'd*)

		Awareness	Access	Approval	Adoption
Enablers & Obstacles	• Consumer • Process • Criteria • Characteristics • Segments	• Location of residence: access to public charging, incentives, PEVs for sale • Receptivity to information • Processing ability	• Location of residence • High income • Home charging capable • Workplace charging available	• Location of residence • Demographics: high income, educated, homeowner, single family home • Favorable attitudes, image and identity associations • Charging convenience & concerns • PEV & EVSE experience and confidence • Accurate PEV knowledge	• Consumer awareness • Consumer access • Consumer approval • PEV experience
	• Vehicle • Features • Attributes • Availability	• High PEV numbers, percentage of vehicle sales • High PEV & EVSE visibility	• Purchase price; total cost of ownership • Supply & distribution of vehicles & models	• Price, total cost of ownership, range, body style, segment • PEV driving performance • State of the art/ innovation	• Test drives

• Systems • Market • Social • Physical • Government	• Exposure to PEVS, EVSE, and incentives and benefits • Targeted & abundant advertising • Targeted & abundant education	• Availability of reliable, convenient, affordable charging • Ease of obtaining incentives • Eligibility for incentives	• Exposure to PEVs & EVSE • Reliable, convenient, affordable charging • Financial & non-financial incentives & benefits	• Financial & non-financial incentives & benefits • Sales practices • High gasoline prices • Low electricity prices

noticed public charging stations. While 48 % could name a specific PEV model, Consumer Reports (2020) noted that 68 % of respondents admitted they "don't know much" about PEVs, and 30 % cited insufficient knowledge as a reason for not adopting one. Meckler-Pacheco and Hardman (2022) reported that 50% of Californians surveyed were aware of PEV advertisements, indicating increased visibility in certain regions.

Exposure is a critical enabler of awareness. Casual encounters – like seeing PEVs in traffic, at a neighbor's home, or at a charging station – can help to ground awareness in the memory of consumers. More deliberate external search experiences, such as participating in test drives or ride-and-drive events (Singer, 2020), interacting with online tools (Sanguinetti et al., 2020), or engaging with targeted marketing campaigns (Meckler-Pacheco and Hardman, 2022), further increase familiarity. Regional variation plays a strong role: consumers in California and the Pacific Northwest report higher exposure to PEVs than those in other U.S. regions (Singer, 2020). Outreach interventions that provide tailored, experiential information – such as incentive calculators and route planners – are especially effective in boosting understanding.

Obstacles to awareness include geographic disparities in vehicle deployment, a lack of visible distinguishing features between PEVs and conventional vehicles, and cognitive barriers such as limited information retention or processing. Even when consumers are in proximity to PEVs, they may not recognize them due to visual similarity with ICE-only vehicles or lack of clear signage (Kurani et al., 2018). In some cases, symbolic interpretations (e.g., the tension between "green" aesthetics and perceptions of safety) may also limit PEV salience (Bi et al., 2017). Low awareness can further reinforce inequities, as communities with limited PEV presence may lack both exposure and access to trusted sources of PEV information.

4.2.2 Access

Access refers to the physical and economic availability of a new or emerging technology to a consumer. In the context of PEVs, access can best be considered to be a multifaceted concept that incorporates both physical and financial feasibility, as well as personal and contextual compatibility. It means that consumers have proximity to PEV models that meet their needs at a price point they can afford. It also means that consumers can access EVSE through some combination of home, work, and/or public charging that is convenient, reliable, and cost-effective, and can conveniently and reliably service and maintain their vehicle.

PEV access is enhanced when local dealerships offer a broad selection of models (e.g., body style, driving range, brand image, or even color), when dealers have inventory available for test drives, when vehicles are affordable to a consumer's income bracket, and when charging is visible and affordable. These enablers are evident in areas where PEV access has historically been concentrated – particularly in urban areas, states that have adopted California's Zero Emission Vehicle (ZEV) mandate under Section 177 of the Clean Air Act, and along the U.S. Northeast and West Coasts. In these areas, consumers typically encounter a broader selection of models and more extensive charging infrastructure (Badiei and do Prado, 2023; Brown et al., 2021; Le and Lindhardt, 2019; Bui, Slowik, and Lutsey, 2020).

The affordability of PEVs is a critical consideration, however, as prohibitive costs relative to an individual's financial resources can render a physically available vehicle inaccessible. Even when a PEV is suitable and affordable, a lack of nearby and convenient locations for purchase, charging, or service can act as a barrier. These factors not only shape how consumers evaluate individual PEVs as an option for purchase, but also determine whether they can even seriously consider PEVs as a category of vehicle for purchase and use.

4.2.3 Approval

In the context of PEVs, *Approval* refers to the stage at which consumers perceive PEVs to be suitable, personally relevant, cost-effective, and compatible with their lifestyles. In other words, Approval coincides with the perception that PEVs are a viable substitute for internal combustion engine-only vehicles. Approval is shaped by favorable attitudes, opinions, and emotions toward PEVs and is evident when consumers seriously consider or intend to purchase a PEV. While approval often leads to adoption, it is conceptually distinct. A consumer may express interest or intent without ultimately completing a purchase (Jia and Chen, 2021). Indicators of approval include positive perceptions, evaluations, and willingness to pay, which can be assessed through surveys, interviews, or focus groups (Carley et al., 2019; White and Sintov, 2017; Singer, 2017; Spurlock et al., 2019). Approval can be inferred when a consumer seriously evaluates a PEV as a potential purchase or can be revealed through their actual buying behavior.

Note that in some cases, factors that shape Awareness and Access also directly influence Approval. For example, Approval is strengthened when consumers gain exposure to PEVs. On the other hand, Approval

may be hindered by misinformation, limited knowledge, or perceived mismatches between the attributes of available models and consumers' needs and desires.

4.2.4 Adoption

In the context of PEVs, *Adoption* refers to the act of acquiring a new vehicle through purchase or lease and use. It is the most readily observable stage of the Acceptance process, as it can be measured through vehicle sales, registrations, or – by proxy – through vehicle production data. As alluded to in Section 2, although the number of PEVs on U.S. roads has grown steadily since 2016, PEVs currently represent only a few percent of all vehicles registered in the U.S.

The transition from Approval to Adoption – the tipping point for purchase and use – is not well understood. One consistently noted influence is the consumer experience at the point-of-sale – particularly at dealerships – where a negative experience can present a barrier to adoption (e.g., Lunetta and Coplon-Newfield, 2017; Le and Lindhardt, 2019).

Key enablers of PEV adoption include: purchase incentives that are either financial (e.g., tax credits or rebates) or nonfinancial (e.g., high-occupancy vehicle lane access, waiving of tolls); PEV experience, such as test drives; effective sales practices, both in-person and online; high fuel prices and low electricity prices; and PEV vehicles with attributes and features that satisfy the criteria of consumers (e.g., Fujita et al., 2022; Hardman, 2019; Carley et al., 2019; Narassimhan and Johnson, 2018; Hardman and Tal, 2016; Jenn, Springel, and Gopal, 2018). In addition, positive PEV ownership experiences can foster post-purchase behaviors such as product evangelism and customer citizenship, as many owners actively share information, offer recommendations, and support other potential adopters, thereby encouraging further PEV adoption (see, e.g., Meckler-Pacheco and Hardman, 2022).

Obstacles to PEV adoption often stem from gaps or deficiencies in the earlier stages of the 4-A framework. When awareness, access, or approval are weak or absent, adoption becomes far less likely. Contributing barriers include limited consumer outreach, inadequate charging infrastructure, complicated or narrowly targeted incentives, and high vehicle prices. The dealership experience also plays a pivotal role, as it is often where consumers first engage directly with PEVs. Positive point-of-sale interactions can support adoption, but negative experiences – such as inaccurate or incomplete information, salesperson unfamiliarity with PEVs and/or incentives, or lack

of PEV inventory – can impede it. Marketing strategies that fail to reflect the varied needs, preferences, and motivations of potential buyers may also reduce adoption rates. Recent shifts in manufacturer and dealership practices, however, suggest a growing effort to address these challenges (e.g., Stanton, 2021; Lowell and Huntington, 2019).

5. Conclusion

As the U.S. transportation sector continues to evolve, so too does the range of technologies and consumer behaviors that shape its trajectory. This chapter focused on the behavioral foundations of technology acceptance in the light-duty vehicle (LDV) market, a very useful case to explore from the context of better understanding how emerging technologies emerge, compete, and gain traction with the public. While plug-in electric vehicles (PEVs) served as a focal point throughout, many of the concepts and frameworks developed here – including the consumer purchase decision-making process and the 4-A framework of technology acceptance – are broadly applicable across new and emerging technologies, including those associated with improvements to all vehicles, regardless of fueling type, such as the features that comprise advanced driver assistance systems (i.e., ADAS).

Section 2 introduced the current landscape of LDV technologies and fueling infrastructure in the U.S., highlighting the coexistence of multiple fuel and powertrain options. Consumer choices underlie this state of affairs, as technology adoption is impacted by the way that many individual consumers perceive the usability of vehicle options across geographic areas with differing degrees of vehicle and infrastructure visibility, availability, suitability, and affordability.

Section 3 examined how consumers make vehicle purchase decisions. The first part described the five classic stages of the decision-making process – problem recognition, search, alternative evaluation, purchase, and post-purchase behavior – while the second part explored internal and external factors that influence consumer thinking at each stage. Together, these two lenses offer insight into why consumer responses to emerging vehicle technologies vary, and why some perceived barriers remain despite changes in the market.

Section 4 introduced the 4-A framework – Awareness, Access, Approval, and Adoption – as a behavioral model of technology Acceptance. After situating the framework alongside other conceptual models from the literature,

the chapter applied the 4-A framework in a brief review of peer-reviewed research on U.S. consumer acceptance of PEVs since 2016. This review identified key enablers and obstacles at each stage, emphasizing how factors such as infrastructure availability, exposure to technology, dealership interactions, and personal relevance can influence movement through the 4-A stages. Designed for both research and practical application, each stage has distinct goals, behavioral cues, enablers, obstacles, and metrics, and can be a useful tool to inform modelers and policy-makers.

This chapter underscores that understanding vehicle technology uptake requires attention to both supply- and demand-side factors, as well as to the behavioral dynamics that link them. Whether the goal is to improve consumer satisfaction, inform infrastructure planning, or support informed choice across vehicle types and fuels, the frameworks explored in this chapter can provide useful tools for researchers, policymakers, and practitioners alike.

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CHAPTER FOUR

Policy mix for decarbonization of the transport sector

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Contents

Abstract

This chapter explores the evolution and effectiveness of Sweden's climate policy mix for decarbonizing the transport sector—a major contributor to national greenhouse gas (GHG) emissions. Despite early leadership in climate policy, Sweden faces challenges in aligning policy implementation with ambitious goals, such as a 70 % reduction in transport emissions by 2030. The chapter shows that Sweden's policy mix has developed through a process of "policy patching," where instruments from various domains interact, often inconsistently. While there is substantial support for low-carbon technologies and energy carriers, efforts to improve transport efficiency and reduce demand remain weak. Institutional fragmentation, path dependency, societal norms, and political acceptability constrain transformative change. Moreover, recent political shifts and rising energy costs have led to weakened policies and setbacks in emission reductions. The chapter emphasizes that even in favorable contexts, strong climate policy is difficult to sustain without public support, policy coherence, and mechanisms to manage trade-offs. Lessons from local cases and other countries suggest that shifting societal norms, improving governance coordination, and

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managing vested interests are crucial. The Swedish experience offers broader insights into the complexity of developing effective, acceptable, and resilient climate policy mixes for transport decarbonization.

1. Introduction

The transport sector contributes to a significant share of global greenhouse gas (GHG) emissions, and these emissions have historically been difficult to mitigate. In addition, the sector is attached to several other problems such as air pollution, encroachment in natural and cultural environments, road accidents, congestion etc. Although new technologies have come to the market, increases in demand counteract the potential gains in terms of emission reductions. In order to achieve deep GHG reductions three main strategies need to be pursued in parallel: increasing the use of low-carbon energy carriers, increasing vehicle efficiency, and transport efficiency and demand reduction (Bhardwaj et al., 2020).

General economic policy instruments, including carbon pricing, are often advocated as the key policy instruments for climate policy, including the transport sector. Carbon pricing is argued to be the most cost-effective instrument because it sends price signals to the market actors letting them decide on the appropriate measures instead of politicians. However, there are important conditions that make general economic policy instruments insufficient, such as multiple market failures and lack of political acceptability (Rosenblom et al., 2020; Stern and Stiglitz, 2021). The first means that a combination of policy instruments is desirable in terms of meeting different existing market failures efficiently (Söderholm, 2012). The latter means that although efficient in theory, the economic policy instruments that are possible to implement are often too weak and inadequately designed to meet set targets.

Therefore, there is a need to look for policy mixes to address the multiple challenges of emission reductions in the transport sector (Axsen et al., 2020; Lam and Mercure, 2021). When looking at the actual policy landscapes in different countries and jurisdictions, we find a complex web of different policy instruments that both interact and overlap. These policy mixes have not necessarily been designed purposefully but have grown organically as a result of messy political processes and are compromises between the priorities of various policy domains. There is a risk that it leads to reduced policy coherence and might not reflect the best way to design

effective policy mixes. To learn how to improve future policy design it is important to increase the understanding about how policy mixes develop and how they are affected by the structural, historic and political context.

This chapter aims to contribute to such knowledge by looking at the Swedish case, studying how various factors have contributed to the development of the current policy mix with its flaws and merits. Sweden is an interesting case to study because the country has been a pioneer in climate policy according to several studies (Sarasini, 2009; Zannakis, 2015). Domestic transport contributes to around one third of total GHG emissions in Sweden and constitutes one of the most challenging sectors for deep cuts in GHG emissions (Johansson, 2021). There is a sector specific goal for transport to reduce its GHG emissions by 70 % in 2030 compared to the level 2010. In 2023 the emissions had been reduced by 34 %, but to be on track for the 2030 goal there is a need to accelerate emission reductions (Swedish Environmental Protection Agency, 2024). Many different policy instruments are being used to address emissions from the transport sector, which makes Sweden an interesting case to study also as a policy mix. By examining the Swedish case we expect to find results that are interesting from a more general perspective that can be applicable to other jurisdictions and political and institutional contexts.

In the chapter we seek to answer the following research questions:

- What does the transport policy instrument mix look like in Sweden and how well suited is it to govern decarbonization?
- Which factors have affected the development of the policy mix and what are the barriers to implementing more far-reaching policies?

Our hypothesis is that the policy mix has been developed through policy patching where policies developed in different policy areas with sometimes counteracting policy goals interact and together exert influence on transport GHG emissions. The specific policy context is thought to be important for instrument choices and designs. They are influenced by factors such as path dependency, societal norms, policy styles and policy traditions. These norms, styles and traditions influence what is regarded as desirable and practically feasible policies in that specific context. To be practically feasible political acceptance is necessary which requires balancing various interests and handling goal conflicts. Acceptance is needed among citizens as well as powerful business groups (Bhardwaj et al., 2020).

The outline of the chapter is as follows. Section 4.2 is a review of the existing literature on policy mixes for GHG emission reduction in the

transport sector. Section 4.3 describes key aspects of Swedish transport policy context, and the dominating policy goals, policy styles and policy principles, from which an analytical framework used in the paper is developed. Section 4.4 describes the methods and data used for the study. In Section 4.5, the transport policy mix in Sweden is presented and analyzed in relation to the three main strategies for emission reductions and the needs for deep cuts in GHG emissions. In Section 4.6, an analysis is made of the factors that affect the development of the policy mix and the design and implementation of policy instruments. In Section 4.7 the main conclusions are summarized together with a discussion of the wider implications of the results.

2. Policy mixes for decarbonization in the transport sector

Research on energy transitions has shown that policy mixes are necessary to achieve a deep decarbonization of society (Kern et al., 2019; Rogge et al., 2017). Rosenblom et al., 2020 argue that carbon pricing, which is often seen as the main policy approach to address climate change, is not sufficient on its own. Instead, they argue in favor of a broad mix of sustainability transition policies with an emphasis on transformative change and tailored policies that are adapted to local and sectoral contexts. Kern et al. (2019) state that policy mixes must go beyond addressing traditional market failures such as underinvestment in R&D and environmental externalities and address institutional failures to enable broader transformational processes. Recent research addressing transport climate policies specifically suggests that policy mixes are also needed in this sector to achieve the kind of changes required for a deep decarbonization (Axsen et al., 2020; Lam and Mercure, 2021). Several studies have identified that an efficient decarbonization of the transport sector relies on three main strategies that should be pursued in parallel, and this has also been acknowledged by various policy bodies. They can broadly be described as (1) increasing the use of low-carbon energy carriers, (2) increasing the efficiency of vehicles, and (3) transport efficiency and demand reduction (e.g. Axsen et al., 2020; Bhardwaj et al., 2020). The third strategy can be achieved either by shifting to lower emission modes (e.g. from car and aviation to rail, bus, cycling, and walking) or by reducing transport and/or traffic demand (e.g. through city planning, mobility management, improved logistics, and digitalization of services).

While carbon pricing is efficient through its broad incentives for CO_2 emission mitigation, it is not regarded as sufficient and instruments specifically targeting the three strategies are also needed (Axsen et al., 2020; Bhardwaj et al., 2022; Lam and Mercure, 2021; Thaller et al., 2021). Different types of regulations are highlighted both for reducing the carbon intensity of fuels (e.g. low carbon fuel standards, zero emission vehicle mandates, and bans on fossil fuel cars) and for increasing the efficiency of vehicles (e.g. vehicle emission standards), often in combination with economic instruments (Axsen et al., 2020; Lam and Mercure, 2021). Specific policies to reduce traffic and shift transport patterns towards public transport, cycling and walking, are also seen as necessary in the policy mix (Axsen et al., 2020; Thaller et al., 2021). Another conclusion in the literature is that there is a need to find a balance between pull and push in the policy mix (Dugan et al., 2022; Wicki et al., 2019). Policy instruments with a push effect (e.g. fuel tax, mileage tax, emission requirements, and EV mandates) are more efficient for widespread carbon mitigation but incur costs or restrictions on users and are therefore more unpopular and difficult to implement. Pull instruments (e.g. subsidies for low-emission cars and fuels, public transport subsidies, and information campaigns) are easier to implement but risk being rather costly for the government or having unclear impact. Pull instruments also have key roles to play during early development phases and market build-ups for new technologies (Dugan et al., 2022).

While there are studies indicating how a policy mix should be designed in a broader sense, less is known about what actual policy mixes look like and what shapes them. A few empirical studies of national or regional transport policy mixes have been conducted. Sperling and Eggert (2014) study transport policies in California and argue that the state has been a pioneer in devising policies to reduce energy use and GHG emissions of vehicles. California has a coherent policy model that combines regulations, incentives, and market-based instruments. However, when it comes to policies for reducing travel demand and increasing modal shift California has not succeeded, which is partly explained by a very high car dependency. Kivimaa and Virkamäki (2014) provide an analysis of the policy mix for climate policies for transport in Finland. They also found that there is stronger policy support and more policies for efficient vehicles and low-carbon energy carriers than for reducing travel demand or supporting modal shift. Possible explanations they give are that there is a general technology dominance in transport policy and research and that these strategies align with other strong policy regimes in Finland such as the electricity regime (electric vehicles) and the forest industry regime (biofuels).

In the literature there is a lack of studies that seek to analyze which factors affect the outcome of a policy mix and the feasibility of different policy instruments. Bhardwaj et al. (2020) is an exception, and they acknowledge the importance of the policy process and political acceptability for policy mixes. Building on Howlett et al. (2018) they distinguish between the concepts of policy packaging and policy patching. Policy packaging refers to an idealized, technocratic approach where the policy makers can discard previous policies and design the policy mix from scratch according to the goals and principles decided upon. Policy patching, on the other hand, refers to a more realistic view where policymakers need to consider both the existing policy framework, the current circumstances, and the political feasibility of new policies. Bhardwaj et al. describe policy patching as "the effort to increase the coherence of a policy mix, in how the policies interact and ultimately can collectively achieve the overall objectives. Often, policymakers might find it more politically plausible to amend an existing policy mix by strategically adding certain instruments rather than developing a brand-new policy mix" (p. 313). Howlett et al. (2018) argue that in cases with existing policy mixes there are significant policy legacies that restrain the alternatives for policy makers, and they state that "even where intentionality to systematically design may be high, it may only be partial in the sense that patching and not replacement is on the table" (p. 140). They recognize that policy patching can be done well but say that this requires that governments have "enough capacity to be able to adopt a governance strategy and set of policy tools likely to lead to a sustainable socio-technical transition" (p. 141). Another possible outcome is policy stretching which is an example of poor patching leading to a mix of goals, instruments and measures that do not support each other and in the worst case are contradictory.

We will depart from the concept of policy patching in our analysis of how policy development unfolds in the Swedish case. While government capacity is an important aspect, we argue that there are several other factors relating to the policy context in a given jurisdiction that affect the possibilities to introduce new policy instruments or re-design existing ones, which will in the end be crucial for the success of policy patching. In our analysis we will study the influence of these factors on policy outcome. To do so we need to describe the policy context of Swedish transport policy and the various factors that influence it, which is done in the next section.

3. Policy context for Swedish climate and transport policy

There are several factors that affect the design and implementation of policies and the possibilities to achieve a coherent policy mix. The importance of these factors in any given jurisdiction will vary and depend on the specific policy context. In this section we give an overview of the policy context for climate and transport policy in Sweden, which serves as the basis for the analytical framework of the paper.

Social norms can have an important impact on policy making. The transport system of today, both in Sweden and globally, is characterized by a high degree of car dependency, which has developed over a long period of time where several factors have contributed. The flexibility of the car, growing economic resources, cultural norms supporting individualistic values as well as influence by business interests are examples of factors that have led to the current socio-technical system dominated by cars (Falkemark, 2006; Lundin, 2008; Melin, 2000; Tengström, 1991). Lundin (2008) shows how the development of the "car society" in the 1950s and 60s was driven by planning experts and how the car became integrated into the planning of cities and infrastructure. Paterson (2007) explains the dominance of the car as a combination of political economy and cultural politics where the car is both integral to the economic system and embedded in cultural norms connected to individualism, freedom and mobility. This means that attempts to challenge the dominance of the car and road transport will face resistance from multiple actors. Public acceptance will be an issue when individual mobility and people´s everyday logistics is seen as threatened. The industry will protest when they see their interests as threatened through, for example increased transport costs or reduced mobility. Sweden also has a powerful vehicle industry. Influential industries have been important players in defining infrastructure development (Falkemark, 2006).

Bhardwaj et al. (2020) see *political acceptability* as a particularly important factor for the design and implementation of policies, and they include both acceptance among the general public and interest groups. For example, it is difficult to find political acceptance for carbon pricing policies at the level required to reach climate policy goals, and in an overview of such policies Khan and Johansson (2021) found that they are almost always modified through exemptions or lower tax levels to address the concerns of businesses or citizens. While all types of policies can face problems of political acceptability, such problems are most likely to arise for policies that incur

costs or limitations on users (e.g. taxes and regulations) or that target interest groups that have political influence (e.g. key industries or important voter groups).

Policy norms can be decisive in influencing how policy making is carried out and the feasibility of specific instruments. One important policy norm is the strong political support for market solutions which has led to an increased interest in economic policy instruments. The long history of fuel taxation in Sweden (fuel taxes were introduced in Sweden in 1924) has made taxes an accepted instrument for reaching policy goals. An economically efficient transport system has since at least the 1960s been a dominant policy objective, and the free choice of individuals to choose the most feasible way to transport themselves has been an important imperative (Swe Gov, 1963). The principle of socio-economic efficient pricing of transport services developed during the 1960s and 1970s (e.g. SOU, 1961:23; Swe Gov, 1963; SOU, 1978:31) replacing cost responsibility as the main governing principle. Cost-benefit analyses and systems for socio-economic valuation of policy choices have been assumed to play a key role in policy development and infrastructure planning (Thoresson, 2011).

At the same time, infrastructure development has largely been based on a predict-and-provide paradigm combined with assumptions of growing transport demand, which has led to the development of growing transport capacity and induced traffic (e.g. Goodwin and Noland, 2003; Næss et al., 2012; WSP and Rand Europe, 2018). This has put pressure on technology to deliver energy efficient solutions and low carbon energy carriers, while measures to reduce transport demand have not been seen as a realistic policy option by the dominant political powers (Isaksson, 2023).

There are also several *institutional factors* which can hinder or facilitate different policy choices. Related to the discussion above is the role of path dependency when it comes to policy design. Policy path dependency reflects a tendency to stick to solutions and policies that have already been tested and utilized (e.g. Kay, 2005; Kirk et al., 2007). Fuel and vehicle taxes are examples of instruments that have been used in various forms for a century and have remained a fundamental part of transport policy. A number of investment programs directed at local actors have in different forms been used as policy. The importance of path dependency does not, however, make it impossible to introduce new types of policy instruments following pressure or inspiration from policies implemented outside the national context.

In Sweden, as in many other countries, multiple transport goals exist that sometimes are contradictory or perceived as such. Transport policy also interacts with other policy domains, but a comprehensive approach is sometimes hampered by a policy principle of functional separation where a policy instrument ideally should deal with an individual policy problem. An example is that climate policy is not supposed to focus on distributional aspects which should be dealt with in the financial or social policy arenas. This makes it more difficult to design comprehensive policy packages that address negative side effects of policies.

In addition, transport policy is carried out in the context of multi-level governance. The development of national transport policy has during the last three decades been partly driven by EU policy through common objectives and policies enforcing emission reductions, while at the same time a more integrated market pushes for more transport and trade regulations limiting the instruments a member state can introduce. Transport policy is also carried out at the municipal and regional level, for example through the planning of cities and urban transport infrastructure and the management of urban public transport. However, although many regions and municipalities have high policy ambitions for sustainable transport, they lack many tools to achieve that as the power to implement them lies on national or supranational levels. The multi-level governance context thus creates a challenge for developing an effective policy mix.

The factors presented above contribute the context around which we build an analytical framework (Table 1) that helps us understand the design of the climate policy mix for Swedish transport and identify potential challenges for developing a more efficient policy mix for the future. The analytical framework will be applied in Section 4.6.

4. Methods and data

We used a stepwise method for this chapter to address the research questions. In the first step, we identified and categorized the climate policy instruments used in the transport sector in Sweden during the period 2000 to 2024. The aim of this exercise was to get a comprehensive picture of all policies that have been in place during this period in order understand the policy mix configuration and potential gaps in the policy mix. We used written secondary sources to identify the policy instruments, and mainly two types of documents were used. First, we used the National Communications

Table 1 Analytical framework for the factors affecting policy mix development.

Type of factor	Factor	Possible effect
Social norm	Dominance of car traffic to meet transport demand	Difficult to introduce policies that lead to higher car traffic costs Difficult to introduce policies that regulate travel choices
Political acceptability	Public acceptance	Difficult to introduce policies that have (perceived) negative effects on households and individuals
	Business influence	Difficult to introduce policies that have a negative effect on industrial competitiveness (e.g. increased costs)
Policy norm	Focus on market and economic efficiency	Economic policy instruments favored
	Predict and provide in infrastructure planning	Perpetually increasing transport as a norm for planning
Institutional factor	Path dependency	Policy instruments that align existing policy logics become easier to implement and difficult to deviate from
	Policy fragmentation and policy separation	Difficult to introduce policy packages across policy domains
	Multi-level governance	National policies restricted by EU regulation Difficult to co-ordinate policies between levels

on Climate Change, which the government reports to the UNFCC on a regular basis and which contains a summary of Swedish climate policy, including a review of policy instruments in different sectors. We used the third to eighth communications, which were published between 2001 and 2023 (Swe Gov, 2001, 2005, 2009, 2014, 2017a, 2023). Second, we used government inquiries and reports from government agencies that suggest new policy instruments for the transport sector and that also contain overviews of past and existing policies (SOU, 2013:84, SOU, 2021:48, Swedish Transport Administration, 2020).

The policy instruments were categorized into one of the three strategies for reducing emissions, namely increasing the use of low-carbon energy carriers, energy-efficient vehicles, and transport efficiency and demand reduction (Swedish Environmental Protection Agency, 2022). In addition, we included a fourth category of instruments labelled general policy instruments. These instruments contribute to all three strategies simultaneously. The focus was on national-level policy instruments, and the aim was to provide a comprehensive picture of these policy instruments. We also covered the main relevant policy instruments at the EU-level and those used by local and regional authorities in Sweden.

In the second step we carried out an analysis of the different factors that affect the design and outcome of the policy mix and the possibilities to implement specific policy instruments. We have used written primary material for this analysis such as government inquiries and reports by state agencies. In Sweden proposals from government inquiries undergo a mandatory referral procedure in which different societal actors have the opportunity to submit their comments to the proposals as an input to the decision process. This means that there is often good material on the points of view from a variety of stakeholders. To deepen the analysis, we have studied the policy process around four policy instruments in more detail (Bonus-malus system for light-duty vehicles, Emission reduction obligation for transportation fuels, the investment program Environmental City Agreements, and a kilometer tax for heavy duty vehicles). When analyzing factors that contribute to the development of the policy mix, we use the framework based on contextual factors presented in Section 4.3.

5. A policy mix for transport decarbonization?

Sweden has a sector-wide national goal to have no net emissions of GHGs by 2045, of which a fraction (corresponding to 15 % of 1990 emissions) can be covered by net uptakes in forests, bio-CCS and emission reductions abroad. There is also a specific interim goal for domestic transport which is a 70 % reduction of emissions by 2030 (compared to 2010 levels). Domestic transport accounts for around one third of territorial GHG emissions in Sweden and amounted to 14 million tons of CO2eq in 2023 (Swedish Environmental Protection Agency, 2025).

The Swedish transport climate policy mix includes a broad variety of policy instruments at the national level, as well as EU-wide policies, and

policies and measures initiated at the city and regional level. In this section we will provide an overview of the main policy instruments used as well as an assessment of how well the policy mix governs towards deep emission reductions. In Fig. 1 we illustrate the policy mix with the policy instruments that we assessed to be most influential in each of the categories mentioned above.

Fuel taxes have been the *main general policy instrument* over the period and affect all three strategic areas. Fuel taxes in Sweden date back to the 1920s and have since 1991 been divided into a carbon tax and an energy tax. The taxes have improved the competitiveness of low-carbon fuels (whenever tax deductions have been used for these fuels), made energy-efficient vehicles more attractive due greater cost savings from efficiency improvements, and made transportation more expensive thus giving incentives to reduce vehicle travel and shift to transport modes with lower emissions. During the period 2000–2021 fuel taxes and VAT contributed with an average of 63 % of the price of petrol and 54 % of the price of diesel, i.e. they more than doubled the price for the consumer (Ekonomifakta, 2023a, Ekonomifakta, 2023b). This indicates that such taxes have contributed to a significant reduction in energy use as estimates have indicated a historic long-term price elasticity of approximately 0.7 to

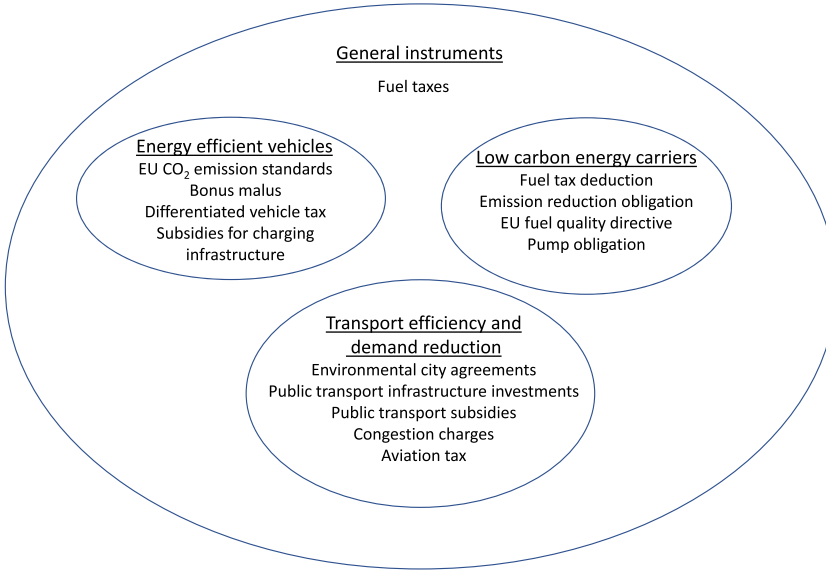

Fig. 1 Policy instruments contributing to the three strategic areas for a low-carbon transport system.

0.8, (cf. Sterner, 2007). After decades of stable or increasing taxation levels there was a break in 2022, after which the fuel taxes have repeatedly been reduced with the argument of protecting consumers from high energy prices. This has diminished the potential of fuel taxes to contribute to emission reductions. It is also worth noting that there are some fiscal taxes on transportation, which, although not introduced to affect transport, indirectly have an effect, since they increase the total cost of transportation and vehicle ownership. Examples are the vehicle tax,[1] road use fees for heavy vehicles, and the tax on vehicle insurance premiums.

For the strategy "Energy efficient vehicles", the EU fuel efficiency regulation (CO_2 emission standards) has been instrumental in setting limits on the emission levels of new cars, pushing the industry to increase the general efficiency of cars. This reduces the importance of fuel taxes, although the taxes can mitigate some of the rebound effect expected from improved vehicle efficiency. At the national level there have been subsidies for the purchase of cars with low carbon emissions (from 2009), a differentiated annual vehicle tax with higher tax on high-emitting cars (from 2006), and a tax exemption for low-emitting cars (from 2010). In 2018 the Bonus Malus system was introduced, which combined a climate subsidy (the Bonus) and differentiated annual vehicle tax (the Malus) into the same package although regulated in two separate legislative acts. In November 2022, the government removed the bonus part of the Bonus Malus system, while preserving the differentiated annual vehicle tax.

For the strategy "Low-carbon energy carriers", there are also EU regulations in place, namely the Fuel Quality Directive that regulates the GHG intensity of fuels and the Renewable Energy Directive that has set national targets for biofuel use. National policy instruments in Sweden have mainly been focused on supporting the introduction of biofuels. This fitted well in Swedish bioeconomy developments with an influential forest industry and the widespread use of bioenergy for heat and electricity production that has been in place for decades. The main policy instrument to support biofuels was initially an exemption on the energy and carbon tax for biofuels, which was introduced in the 1990s along with the carbon tax (Swe Gov, 2014, 2017a). Since tax exemptions conflict with EU regulation they were replaced, in 2018, by the Emission Reduction Obligation, which stipulates annual mandatory emission reduction targets for diesel and

[1] This is, however, as mentioned above, differentiated according to CO2 emissions and thus has a design that also has a direct climate policy element in it.

gasoline (Swe Gov, 2017c). The targets are set several years in advance and gradually become stricter.[2] In effect, the only way for distributors to comply with the targets is to blend biofuels with the fossil diesel and gasoline. The tax exemptions and the Emission Reduction Obligation have contributed to a significant expansion of biofuels, and in 2020 these corresponded to 21 % of the energy used for domestic transport. In 2024 the Emission Reduction Obligation was heavily reduced (to 6 % for both petrol and diesel in 2024) following an electoral pledge by the new government to reduce fuel prices in the aftermath of the price increases in 2022. Consequently, the use of biofuels for transportation declined by 50 % between 2023 and 2024 (Swedish Energy Agency, 2024). In August 2024 it was announced that the level would be increased again, now to 10 % from January 2025.

There have also been several policy instruments, mainly subsidies, to increase electrification such as subsidies for investments in electric buses, public charging infrastructure, and charging at businesses and households. These subsidies, although important, have been fairly small scale. Regional authorities, which are responsible for local and regional public transport in Sweden, have been active in promoting biofuels and electrification in the bus sector using green public procurement, and this has led to an almost complete phase out of diesel in the bus fleet (Aldenius, 2021).

Regarding the strategy "Transport efficiency and demand reduction" there has been a lack of policy instruments at the national level. Several recent government inquiries have concluded that increased transport efficiency is an important part of developing a low-carbon transport system and that additional measures and policy instruments are needed at the national level because traffic volumes are not declining and modal shift is happening at too slow a pace (SOU, 2021:48, WSP, 2022; SOU, 2022:21).

Targeted policy instruments at the national level have mainly been in the form of subsidies. The Environmental City Agreement was introduced in 2015 and provides subsidies to municipalities for investments in public transport and cycling infrastructure. The scope of this instrument is broader than just climate mitigation, and it has resulted in rather limited GHG mitigation in the short term at a rather high cost (Brundell-Freij et al., 2022). Its role in the long-term transition to a low-carbon and resource-efficient

[2] The levels of emission reduction were in the starting year (2018) 19.3 % for diesel and 2.6 % for gasoline. In 2022 the levels were 30.5 % and 7.8 %, respectively, and in the end year, 2030, the levels were set for 66 % and 28 %.

transport system with high accessibility and a livable city environment is, however, difficult to assess. Other subsidies have also been introduced for electric bikes and freight transport on sea and rail (all from 2018). As an exception to subsidies the aviation tax, which was introduced in 2018 is also intended to reduce air trips. The tax was set at a low level compared to, for example, the taxation of road transport (Swe Gov, 2022a). While the modest level of the tax has limited its actual impact on emissions, it has been of high symbolic value and created debate both among proponents and opponents. In 2023 the government decided to phase out the Environmental City Agreements and in 2024 a removal of the aviation tax was decided.

Actors at the regional and municipal level have been more active regarding transport efficiency. At the regional level the main policy is subsidies to public transport, which account for about half of the revenues for public transport, while the other half comes from ticket fees. Many local municipalities have various goals relating to transport efficiency (e.g. increased public transport, cycling, and walking and decreased share of road traffic). Examples of policies and measures include infrastructure for public transport, cycling, and walking; prioritization of these modes in the traffic system; restrictive parking policies; car-free zones; city planning for reduced travel need; and increased attractiveness of public transport. The degree to which the policies are implemented depends on various factors such as political majorities, size of the municipality, and levels of congestion. In Stockholm and Gothenburg there are congestion charges, which strictly speaking are decided on by the national government but are still initiated by the local government. While the general picture is that municipalities are active, there are still large variations between municipalities.

The review above illustrates a broad policy mix directed towards the transportation sector in Sweden. The most general policy instruments are the fuel taxes that affect all three pillars of low-carbon transport policy. The EU fuel economy regulation and the Emission Reduction Obligation are two strong instruments directed towards fuel efficiency and low-carbon fuels, respectively, but there are no instruments of similar scale at the national level directed towards transport efficiency and demand reduction.

The policy mix has contributed to a steady decrease in emissions, and in 2023 emissions had decreased by 34 % compared to 2010. However, the emissions are not decreasing fast enough and according to the Swedish Protection Agency the target of 70 % decrease of emissions by 2030 will not be reached with current and adopted policy instruments (Swedish Environmental Protection Agency, 2024). With the change of government

in 2022 there has been a break in transport policy. During the election campaign in 2022 fuel prices were rising and several political parties promised to take measures to cut fuel prices. The liberal-conservative government[3] that came to power has since cut back or abolished several policy instruments such as the carbon tax, the Emission Reduction Obligation, the subsidy part of the Bonus Malus, the Environmental City Agreement and the aviation tax. As of yet there are no other policy instruments planned to replace these. In 2024, there was a break in the trend of increasing emission reductions and instead there was a slight increase in emissions.

6. Factors influencing the policy mix

CO2 emission reduction has been a central part of transport policy since the mid-1990s. The need for all three strategies for reducing carbon emissions (low-carbon fuels, efficient vehicles, and transport efficiency) has been repeatedly reflected in government policy documents and inquiries, which shows that there is holistic view on what kind of policies and measures are needed (SOU, 2021:48; Swedish Transport Administration, 2020; Transport Analysis, 2022). There have been several government inquiries during the period studied that have taken a broad view of the transport sector and the policies needed to reduce GHG emissions. The most important of these was the FFF-inquiry (Fossil-free road transport), which presented its results in 2013 (SOU, 2013:84). The report contained a comprehensive review of existing policies and proposed several policy instruments that addressed the three strategic areas of low-carbon fuels, efficient vehicles, and transport efficiency. This is thus a good example of an attempt at policy packaging as discussed by Bhardwaj et al. (2020).

A holistic understanding of the need for a broad transport policy mix does not automatically translate into a corresponding policy implementation. On the contrary, the policy process for the design and implementation of individual policy instruments is long and uncertain with setbacks and unexpected events. Furthermore, the design and ambition level of policy instruments can be altered during the policy process, and policy instruments that have been implemented can be revoked.

[3] The government consists of three liberal conservative parties but is dependent on and cooperates closely with the nationalist right-wing party, the Sweden Democrats.

Following the mapping of the policy instrument mix in the previous section we explore how various factors have influenced the policy mix design. For this purpose, we apply the analytical framework that was presented in Section 4.3.

6.1 Dominance of the car and public acceptance

One of the recurring criticisms of the transport policy mix is that there is a lack of effective policy instruments that target transport efficiency such as modal shift from car transport to bus, rail, cycle and walking or measures to reduce transport demand (Kivimaa and Virkamäki, 2014). This situation can be traced to the dominance of the car, which has evolved during the last 100 years and has been a central condition for transport planning over many decades. Individuals and companies rely on passenger cars and trucks for their daily lives and businesses and rapid increases in costs or a strict regulation of road transport would have dramatic effects in society. There are also norms upholding the position of the car as a central part of our lifestyles (Lundin, 2008; Paterson, 2007).

In addition to this there is a general reluctance among policy makers to introduce policy instruments that directly affect behavior and lifestyle decisions, unless there are very strong reasons for this, often related to health and safety (e.g. policies on smoking and traffic safety). In the environmental field the reasons are often not deemed compelling enough.

For this reason, it is very difficult to introduce policy instruments that challenge, or are perceived to challenge, road traffic and the use of cars. The Environmental City Agreement, which was introduced in 2015, is an interesting case since it is one of the few national policy instruments aimed at increasing transport efficiency by giving subsidies to municipalities to increase the share of public transport and cycling in urban transport. An interesting feature of the design process is that the policy instrument was more radical in early drafts compared to the final decision (Isaksson and Knaggård, 2019). An initial idea was that the policy instrument should be accompanied with an explicit goal of zero growth in car traffic, which exists for a similar program in Norway. For political reasons, this goal was however not included in the final design and instead the softer goal of increased shares of public transport and cycling was used, allowing for a de facto increase in car traffic. Both the Swedish Environmental Protection Agency and the Swedish Energy Agency criticized this (Isaksson, 2023). In October 2023 the liberal-conservative government decided to terminate the Environmental City Agreement. No new subsidies are granted, and the last of these subsidies will be paid out to municipalities in 2027.

Also, other policy instruments such as the Emission Reduction Obligation, which has as a main aim to increase the use of renewable fuels, can become questioned if they are perceived to threaten car traffic by increasing the cost of fuels. The case of the Emission Reduction Obligation shows that political acceptability can change after the implementation of a policy instrument. When the policy instrument was being prepared in 2017 the stakeholder feedback in the referral procedure were predominantly positive, although some stakeholders raised concerns about increases in prices and a possible lack of supply of domestic biofuels (Swe Gov, 2017c). There was also support from a broad majority of political parties in parliament, where only the Sweden Democrats opposed it. Although it was not the aim of the Emission Reduction Obligation it has become clear that the increase in biofuel demand has contributed to higher biofuel prices, something that was exacerbated by a lack of domestic supply (Swedish National Audit Office, 2023). This happened at a time when fuel prices increased due to other reasons as well, such as the Russian war on Ukraine and resulting geopolitical uncertainty. With the sharp rises in fuel prices in 2022, the Emission Reduction Obligation (as well as the carbon tax on fuels) came under heavy political attack as fuel prices became an important topic in the Swedish general election campaign. This led the Social Democratic government to temporarily halt the planned annual increase in the level of biofuels in the fuel mix. With the change of government in September 2022 the future of the Emission Reduction Obligation has become highly uncertain. The parties in the new liberal-conservative government had promised to lower the price of diesel and gasoline and a main way to do so was by lowering the levels of the ERO.

A policy instrument that affects transport efficiency negatively is the tax deduction for commuting. First, it gives incentives for longer commuting distances with resulting increase in energy demand. Second, the instrument is currently designed in a way that benefits commuting by car rather than public transport (Swe Gov, 2021). An effort to increase the competitiveness of commuting alternatives to cars was the proposition to redesign the existing tax deduction for commuting in a way to make it neutral in relation to the choice of mode of transport. A government bill was approved by parliament in 2022 (Swe Gov, 2021). But with the new government, this reform was stopped before it came into effect and instead the tax deduction level for car commuting was increased (Swe Gov, 2022b).

6.2 Business influence

Concern for industrial competitiveness has a strong influence on climate policy making and there is a reluctance among policy makers to introduce

policy instruments that put high costs on industry. Furthermore, individual companies and sectors have an interest in influencing the design of specific policy instruments to avoid negative effects or to secure a more positive outcome from their point of view.

The kilometer tax for freight transport is an example of a policy instrument that has been resisted by industry. A kilometer tax has been proposed by several government inquiries (in 2006, 2007, 2013 and 2017). The main rationale for such a tax is to internalize the costs caused by freight transport in terms of damage to roads, but also that such a tax reduces the incentives for road transport and favors rail and sea. Another argument is to find an alternative way to tax transport when the carbon tax loses significance as biofuels and electric vehicles become more common. The kilometer tax has met with consistent opposition from industry, mainly the forest industry who rely a lot on freight transport on road, but also from the national industry association. Their argument is that it will harm business profitability and the competitiveness of Swedish industry. The last time a kilometer tax was suggested was in 2017 by a government inquiry (SOU, 2017:11). However, the process was stopped by the government itself before the remitting procedure started. When the government proposed a modified version of the tax in 2018 (Swe Gov, 2018), it was heavily criticized by industry interests (Swedish Forest Industries, 2018; Swedish Confederation of Transport Enterprises, 2018). A dividing line also emerged in the political landscape where the Left Party, the Social Democrats, and the Green Party were in favor of the tax and the Liberal-Conservative parties opposed it, meaning that it did not have support from a majority of the parliament.

The Swedish vehicle industry has also opposed the introduction of a carbon differentiated sales taxes as it would have a negative effect on new vehicle sales.[4] A neighboring country, Denmark, on its part has had a significant sales tax on vehicles. It might be too simplistic, however, to attribute the hinder for implementing vehicle taxes to industry only. Economists have also argued against vehicle taxes as a cost-efficient climate policy instrument and that fuel taxes should be enough for the consumer to internalize the negative effect of GHG emissions in their decisions (see e.g. National Institute of Economic Research, 2019).

[4] See e.g. the opinion statement BilSweden (the Association of Swedish Vehicle producers and importers) wrote over the FFF-investigation (SOU 2013:84).

6.3 Focus on market and economic efficiency

In Sweden there is a strong emphasis on the use of market-based instrument and cost benefit analysis (CBA) as a guiding principle for the evaluation of policy instruments and infrastructure investments. Thoresson (2011) has for example shown the dominance of CBA in transport planning and the evaluation of infrastructure projects. In the overview of policy instruments used in the transport sector we can see a predominance of economic and market-based instruments such as different taxes and subsidies. Taxes are often favored by economists since they put a price on emissions and leave the decision on the appropriate response to increased prices to the affected businesses and households, which according to the market rational are best placed to do this.

Fuel taxation was initially mostly a way to finance new infrastructure and cost responsibility was seen as an important design principle. Later, the focus was on efficient resource allocation in the transport system as a whole, where the price mechanism, which since 1991 included carbon pricing, was thought to play an important role. The existence of a fuel taxation system made the choice to use fuel taxation as an environmental policy instrument less radical and easier to adopt, discussed further below.

Regardless of the advantages of taxes and their alignment with polluter pays principles, subsidies are frequently chosen instead as they are politically easier to implement since they give benefits to the target group and do not incur cost to anyone. Examples of subsidies are the Environmental City Agreement, the bonus in the Bonus Malus system, and subsidies to electric bikes, rail transport, sea transport and charging infrastructure. They do not fully follow the market rationale as well as carbon taxation and fuel taxes. as they don't leave the choice of mitigation measure to the consumer. However, as long as they are seen dealing with market barriers they fit well in the dominant paradigm.

6.4 Predict and provide in infrastructure planning

Infrastructure planning could in principle be dedicated to reducing vehicle travel and supporting more efficient modes of travel, but in Sweden it is still largely guided by a predict-and-provide approach that results in expanding and upgrading both road and rail infrastructure (SOU, 2021:48). There is a long tradition in Swedish transport planning to take development of traffic for granted as an exogenous phenomenon that depends mainly on economic activity. The Swedish Transport Administration regularly makes

forecasts on the development of person and freight transport which are based on established forecast models. The latest forecast from 2024 showed an increase in both passenger and freight transport on road of 27 % to 2045 (compared to 2019) (Swedish Transport Administration, 2024a, 2024b). Car transport was forecasted to increase by 26 % maintaining a share of 72 % of all personal transport kilometers travelled. In light of these forecasts the task of transport infrastructure planning has been interpreted to provide the infrastructure that is needed to serve the projected transport increase. The economic importance of infrastructure planning can be illustrated by the amount spent annually in the national infrastructure plan. In 2022 it amounted to approximately 36 billion SEK (more than 30 times more than the budget for the Environmental City Agreement).

Although the predict-and-provide approach is still dominant it has been challenged and there is a critique arguing that the focus of sustainable transport planning should be to decide how we want the future situation to look like, to meet climate and other sustainability goals, and use infrastructure planning to achieve these goals (Lyons and Davidson, 2016). Eriksson et al. (2024) relate a case where the clash between the predict-and-provide approach and a sustainable transport approach played out within the Swedish Transport Agency in their long-term planning, leading to the exclusion of a report that showed that the suggested long-term plan would fail to reach the climate goals and that a shift in planning focus was needed. Such a shift would mean focusing more on achieving a modal shift to lower emission transport modes and to find ways to reduce the need for transport. To date in Sweden, infrastructure planning is not used as an active policy instrument to reduce the climate emissions of transport.

6.5 Path dependency

Policy path dependency can be an important influence on the feasibility and design of policy instruments. As indicated above, the use of fuel taxation as a main policy instrument has been helped by the fact that a taxation system has been in place with all the practical aspects such as tax collection, control etc. Sweden was one of the first countries to adopt a climate tax in 1991, something that was helped by a changed attitude among the Social Democrats towards the use of economic policy instruments, and further by it coinciding with a general reform of the tax system (Hildingsson and Knaggård, 2022).

The existing policy configuration and policy history also affected the introduction and design of the Bonus Malus system which was introduced

in 2018. The policy instrument, which consists of a subsidy for cars with low carbon emissions and a fee for cars with high emissions, was built upon two already existing policy instruments. Purchase subsidies for low-carbon cars were first introduced in 2007 and have been renewed and modified several times. There has also been a differentiated vehicle tax since 2006 with higher tax levels for cars with higher emissions. The innovation with the Bonus Malus was that it merged two existing policy instruments into a single more coherent policy package with the aim of creating greater long-term stability of the policy. The fact that it built on existing policy instruments also affected its design. The fee was designed as an increase in the annual vehicle tax for the first three years building on the existing differentiated vehicle tax (Swe Gov, 2017b). This was done even though experts argued that a one-time fee would send a stronger signal to consumers of high-emission cars (Kågesson, 2011; SOU, 2016:33). In 2022, when the subsidy part of the instrument was removed this meant that the coherence and long-term ambition was dropped.

The Emissions Reduction Obligation for renewable transportation fuels was, in contrast, a new policy instrument in the transport policy mix when it was introduced in 2018, although it had some resemblance with the green certificate scheme in place for electricity since 2003. The policy instrument replaced the existing biofuel tax exemption which went against EU legislation on state aid and was therefore not a long-term solution. The fact that this was a new policy instrument meant that an alignment with the policy mix was more difficult to achieve. One example is that the policy instrument was not accompanied by additional policies to support domestic biofuel production, although this need was brought up by several actors in the review process. This has meant that the increase in biofuel use has mainly come from imports. Also, the effects of the policy instrument on fuel prices were not properly understood. Only a few actors suggested that it could lead to increased fuel prices, and this was not identified as an issue in the impact analysis of the policy instrument (Swe Gov, 2017c). After implementation, it has become clear that the increase in biofuel demand contributed to higher biofuel prices, which was exacerbated by the lack of domestic supply (Swedish National Audit Office, 2023).

6.6 Policy fragmentation and multi-level governance

Transport policies that lead to increased costs for fuel, either directly in the case of a carbon tax or indirectly as with the emission reduction obligation, are difficult to introduce and maintain due to public protests. One way to

overcome this could be the use of compensating policies to counteract the price effects particularly for vulnerable or specifically affected groups. Examples could include investments in rural and car-dependent areas to strengthen public transport and rural services. While this has been discussed in Sweden (Spiro, 2024) it is not so easy to implement since it covers different policy domains that are not connected. Furthermore, fiscal policy instruments such as taxes are not earmarked in Sweden but go into the wider state treasury.

The fact that transport policy is carried out in a multi-level governance context creates other challenges. National policies are restricted by EU and international regulations. For example, EU regulation on state aid made it necessary to phase out the biofuel subsidies in Sweden which were replaced by the emission reduction obligation. The design of the taxation on aviation was likewise affected by restrictions due to international regulation. According to the 1944 Chicago convention and the energy taxation directive it was not possible to tax fuels used for non-domestic flights (SOU, 2016:83), which left the government with the less efficient solution to tax trips which gave no incentive for efficiency improvements or low carbon fuels which a tax related to GHG emissions would have provided.

It can also be difficult to co-ordinate between levels, something that is needed when it comes to policies for increased transport efficiency and a modal shift to walking, cycling and public transport. At the moment, it is mostly municipalities that are active in this regard while national policies have been lacking. However, municipalities have less muscles and lack authority to use regulation and taxes, and there is also a risk that there will be differences in ambition between municipalities.

7. Discussion and conclusions

The analysis of the Swedish case shows that up until 2022 a broad climate policy mix has been developed in the transport sector with carbon pricing as a main general policy instrument and targeted instruments addressing the three strategies of energy-efficient vehicles, low-carbon energy carriers, and transport efficiency and demand reduction. Like previous studies, we find that the focus is on technical solutions and policy instruments focusing on the introduction of low-carbon energy carriers and energy-efficient vehicles. While there is recognition of the importance of transport efficiency and demand reduction, there are only a few relatively

weak policy instruments at the national level addressing this strategy, with subsidies to municipal investments in public transport and cycling. No policies are aimed specifically at reducing road traffic or transport demand. Neither is infrastructure planning used to increase transport efficiency or reach climate goals but instead it follows a predict-and-provide approach based on forecasts of the expected growth in transport that are based on historic trends and assumptions about economic and population growth.

We discern an attempt in the policy mix to find a balance between push and pull measures, which is in line with the policy mix literature where it is argued that policy mixes need to be both effective and acceptable to users and stakeholders (Dugan et al., 2022; Wicki et al., 2019). Push measures include the carbon tax, the emission reduction obligation, and EU regulations on the climate performance of cars and fuels, while there are a number of pull measures consisting of various subsidies to, for example, cars with low carbon emissions, electric buses, electric bikes, freight transport on rail and sea, and investment in infrastructure for electric charging, public transport, and cycling.

While emissions have been reduced between 2000 and 2022 the pace is too slow to reach existing climate goals and there is no clear policy path towards full decarbonization. Furthermore, since 2022 there has been a backlash in climate policy with the scrapping or weakening of several policy instruments and with transport emissions increasing in the year 2024. The Swedish climate policy council now assumes that the 2030 target for transportation will not be met (Swedish Climate Policy Council, 2025). The new EU ETS2 system might, however, be a joker in the pack as several studies indicate that it will lead to rapidly increasing prices on fossil fuels. This will probably lead to both better profitability for non-fossil fuels and to reductions in transport demand.

In this chapter we have shown that it is difficult to develop a strong and comprehensive policy mix for decarbonization. The concept of policy patching is fruitful to understanding the dynamics of the policy process. We find that the policy process is a combination of strategic planning and bounded rationality. It is important to acknowledge that broad strategic understanding exists in Sweden about what characterizes an effective policy mix. This is shown in both the formulation of policy goals and strategies and in the analyses made in various government inquiries. This does not mean that there exists one correct blueprint for the policy mix; on the contrary, there is a constant debate and struggle over what constitutes effective policies and what the policy mix should look like, for example,

concerning issues such as cost effectiveness and how to deal with various goal conflicts. The point is that strategic thinking is present and is reflected in the policy process.

However, even if it would be possible to theoretically identify the most effective policy mix, this would be very difficult to realize in practice due to various factors affecting the policy process. Policy design is strongly affected by dominant social and policy norms, political acceptability and various institutional factors. In this chapter we have analyzed the specific factors affecting Swedish policy making. Although each case is unique, we can expect that some factors are more general while others are context specific. The dominance of the car and the sense of car dependency is important as it limits what is regarded as feasible policies. This is by no means limited to Sweden but of more general relevance. Policy norms such as a focus on market solutions and the dominating predict-and-provide paradigm can shift over time and between political contexts but have been prevalent in most industrialized countries the last decades.

The historically broad acceptance of fuel taxation as a policy instrument may be more country specific and anchored through path dependency and generally high acceptance of a strong welfare state financed through taxation. The political system in Sweden with strong and relatively independent municipalities is also important. On the one hand, it means that policy making is also carried out at the local level, which we see particularly for transport efficiency measures. On the other hand, it makes it difficult to co-ordinate between policy levels and design a strong national policy, giving room for the state to hand over responsibility for sensitive policy decisions.

Political acceptability is critical in all jurisdictions, but the nature of this issue can vary depending on which industries are influential in a certain country or the nature of political mobilization. In Sweden, the car industry and the transport dependent heavy industry, are important players which have clearly influenced the policy process and the possibility to implement specific policy instruments. The fact that energy prices became a top issue for voters in the election of 2022 was also important, and several parties made pledges to reduce the cost of fuel, which resulted in lowering the fuel taxes and a reduction of the quotas of the emission reduction obligation.

What the development shows is that even with a strong support for ambitious climate goals throughout society it is not easy to implement a stringent policy package consistent with these ambitious goals. An energy intensive transport system largely relying on individual mobility and road-based freight transport, is sensitive to increases in fuel costs emanating from

implemented policy instruments as well from effects from geopolitical developments. To maintain high climate ambitions and a comprehensive policy mix under these circumstances the negative consequences have to be handled in a way that is perceived as fair. This could include economic compensation, designed in a way that does not reduce the incentive for GHG mitigation, as well as measures supporting energy efficient technologies or reducing the need for individual transport. The latter spans from investments in public transport to increased availability of local services. In their chapter, Schojan and Schmidt-Hamburger show that there is an urban-centric bias in transport planning in Austria leading to a lack of attention to the concerns of rural inhabitants. This has also been the case in Sweden and much of the discontent with high fuel prices emanates from rural areas which see no alternatives to the car (Portinson Hylander et al., 2024).

Changing the norms in society from that of car society would help develop a low carbon transport system but how this could be done and what role various actors would play in such a change and with what tools is not evident. Van der Craats and van Lierop show in their chapter how social movements in Amsterdam have historically challenged the dominant car-centric urban model and presented alternative mobility narratives that have helped put Amsterdam at the forefront reducing car dependence in cities. An important question is how national policy and infrastructure planning can support such ambitions at the urban level instead of, as is often the case, counteract it.

In their chapter on transport and land use planning in the Swedish city of Umeå, Isaksson et al., study in detail the interactions of several of the factors identified in this chapter. They show how the provision of road infrastructure at the urban level counteracts the ambitions to reduce car traffic and plan for a sustainable transport system. While the Swedish Transport Agency saw the need for investments in road infrastructure based on traditional predict-and-provide traffic forecasts, the municipality lifted the possibility to reduce transport demand by other initiatives. The case also pointed to a difference between the two parties in terms of priorities and mandates, with the STA as responsible for road infrastructure and prioritizing the goal of accessibility and reduced travel times over climate and environment. Although the chapter points to some signs of change towards more transformative planning the main picture is that of several types of path dependency (technical, institutional, discursive) locking planning into unsustainable and energy-intensive practices.

It will also be necessary to apply strategies to address resistance to change by business interests either by creating broad coalitions that counteract vested interests or by working together with companies to find common solutions. An example of the former, from another policy area, is how a coalition in favor of wind power and solar power developed in Germany in the early 2000s which managed to push for ambitious policies although there was a strong initial resistance from the dominant utilities and energy companies (Jacobsson and Lauber, 2006). An example of the latter is the Swedish government policy the Industrial Leap which hands out financial support to companies to make investments in innovations for an energy transition.

This chapter has shown that it is not possible to design a transformative policy without considering the existing policy landscape, goal conflicts and societal interests. Even in a country like Sweden, with a strong general support for ambitious climate policies and a long tradition of environmental governance, it has proven difficult to move beyond more incremental changes and introduce policies that lead to deep emission reductions. Furthermore, we have seen that the system is vulnerable to unexpected events such as the increase in fuel prices that was largely a result of the Russian invasion of Ukraine in 2022. What seemed to be a broad political consensus on the policy direction (including stable or increasing fuel taxes as well as policies such as the Emission reduction obligation, the Bonus-Malus and the urban investment program for public transport and cycling), withered away when people's worries about increased costs became a main focal point on the political agenda. The vulnerability was exacerbated in the Swedish case by a reluctance to introduce policies that addressed transport volumes and modal shift which led to an overreliance on the Emissionduction obligation and the introduction of biofuels.

Still, climate change will not go away and the need for decarbonization of the transport sector remains and becomes even more pressing as time passes. What can we expect from future policy making? One possibility is that the increasing effects of climate change leads to more crisis awareness and puts political pressure on the system. The Covid pandemic that started in 2020 showed the ability for rapid and far-reaching policy measures as well as the readiness of the public to accept such measures if the stakes are felt to be high enough. It is, however, far from certain that climate change will ever be perceived in this way. Another difference is that the changes in behavior due to climate change will need to be permanent while many of the changes during the Covid pandemic (such as restrictions in movement)

were meant to be temporary. Another possibility is that we learn to navigate the goal conflicts and different interests and manage to incrementally implement policies that gradually lead to larger transformations (of both technology and behavior). This process, however, needs to be fast enough to meet the urgency of the problem and result in rapid and substantial emission reductions. Furthermore, the polarized political landscape in much of the world today will complicate the search for broad consensus based political solutions.

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CHAPTER FIVE

Whose transition? Power and discourse in Austria's rural mobility transition

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Abstract

This chapter examines power relations and discourse in Austria's rural mobility transition through a critical analysis of national and regional climate policies. Using Hajer's discourse analysis framework, we investigate how rural areas are constructed in Austria's decarbonization agenda, focusing on the *Waldviertel* region in Lower Austria as a case study of conflicting urban-rural mobility paradigms. Our analysis of key policy documents including Austria's National Energy and Climate Plan (NECP), Mobility Master Plan 2030, and regional strategies, reveals an urban-centric bias that frames rural communities through deficit-oriented narratives while marginalizing their knowledge and agency. The research identifies two dominant storylines: the "Urban-Rural Divide" and "Economic Modernization and Strategic Ambiguity," which together

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reinforce power asymmetries between urban policy centers and rural peripheries. However, our examination of the *land.mobil:LAB* rural mobility laboratory demonstrates how hybrid institutions can create spaces for more inclusive transition governance by enabling rural communities to participate as knowledge producers rather than passive policy recipients. The findings suggest that effective rural mobility transitions require disrupting urban-centric power dynamics through participatory approaches that recognize rural innovation potential while maintaining connections to formal governance structures. Ultimately, this analysis asks: whose transition is this, and how do power and discourse shape rural mobility transformation?

1. Introduction

As part of the global decarbonization agenda since the Paris Agreement, national governments had to outline comprehensive governance mechanisms and political strategies to drastically reduce carbon emissions across different sectors (Tobin and Wylie, 2021). Within the European Green Deal framework, which mandates member states to achieve a 55 % overall emission reduction by 2030, the transport sector faces particularly ambitious targets: a 90 % reduction in emissions by 2050, with interim milestones including the complete energy transition from fossil fueled to zero-emission vehicles by 2035 and introduction of carbon taxes. These EU-level requirements have catalyzed transport and energy policies, particularly those targeting the transition towards renewable energy in mobility. Both of the concepts "mobility transition" and "energy transition" embrace the necessity of the need to reduce greenhouse gas emissions, hence interconnected processes that collectively aim to address climate change and promote sustainability (Collazos et al., 2024).

This transition is a very challenging undertaking, as mobility requires behavioral change connected to practices in place for decades, for example the use of cars. We do, however, risk a backlash from energy transition policies in mobility due to the institutional constraints of democracies that often limit ambitious climate action (Blühdorn et al., 2019; Hausknost, 2020). Modern western democracies embraced "*limitless mobility*" through private motorized transport, which evolved into more than just transportation - it became a comprehensive lifestyle. This is powerfully illustrated in the 1991 road movie "Thelma and Louise", where the protagonists find liberation on the open road, and explored in Jean Baudrillard's philosophical work on driving in America, where he describes how it creates an experience of "*amnesia*" – forgetting what lies behind while constantly

moving forward (Baudrillard, 2000). This era of unrestricted mobility contributed to what we now call the "Great Acceleration" (Briggle, 2021) of the Anthropocene, or what Heurtebise (2020) more specifically terms the "*petrocene*". As Taylor and Fujita demonstrate in their chapter on the behavioral dimensions of light-duty vehicles, the evolution of mobility has created deeply entrenched patterns, where consumers have developed decision-making criteria reinforcing car-dependent lifestyles.

Governments seek now to change the "c(o)urse" of acceleration in the "*petrocene*" and institutionalize ecological modernization with administrative climate policies (Hausknost, 2020; Hausknost and Hammond, 2020; Machin, 2020, 2019). Consequently, top-down climate policies in EU member states such as National Energy and Climate Plans (NECPs) have become a focal point to outline national policies as the following hierarchical level of the subsidiary principle of EU governance. But as Hajer notes about environmental discourses "*…political decision-making takes place through […] fragmented and contradictory discourses within and outside the environmental domain*" (Hajer, 1995, p. 15). We find this is also the case for decarbonizing transport and mobility and want to dive deeper into the conflicting discourses.

Through a discourse analysis framework on policies by Hajer, we analyze the policy discourse for the Austrian "*Mobilitätswende*" (mobility transition) in relation to energy transition issues of decarbonization through its representation in storylines. Both transitions are essential for achieving a sustainable and low-carbon future in the transport sector, and their success depends on coordinated efforts across multiple sectors and levels of governance (Bickel, 2017; Payakkamas et al., 2023). Therefore, we go along the federal hierarchy from Austria's government, down to the federal state of Lower Austria and eventually focus on the rural *Waldviertel* region. We have chosen to focus on this region as an example of conflicting discourses between rural mobility contexts and urban-centered decarbonization agendas. Located in the northwest of Lower Austria and bordering Czechia to the north, it exemplifies the challenges that characterize many peripheral rural regions in terms of mobility and transport needs.[1] However, it is not only the peripherical and rural characteristics that makes the region

[1] According to the federal statistical office's "Urban-Rural Typology", most of its communities are classified as rural areas (districts of Gmünd, Waidhofen an der Thaya, Horn, Zwettl, parts of Melk and Krems) The area is characterized by distinctive mountainous topography, creating complexities for transportation planning.

interesting for our analysis. Three other reasons justify our choice of case study as one that illuminates conflicting discourses in the energy transition in transport and mobility.

First, the Republic of Austria consists of nine federal states with distinct urban-rural characteristics. According to Statistics Austria's Urban-Rural Typology, 44 % of Austria's 9 million inhabitants live in predominantly rural regions (Statistik Austria, 2025a). While Vienna, the capital and city-state with its 2 million inhabitants, serves as the center of federal policy institutions, most of Austria's territory represents a diverse spatial structure ranging from densely populated urban areas to rural regions (Statistik Austria, 2025b). The *Waldviertel* for instance is home to 232,000 inhabitants and with 47 inhabitants per km^2, representing one of the lowest population densities in Austria. Since the establishment of the first republic after the fall of the Austro-Hungarian empire in 1918, the dissonance between its imperial metropolis and its peripheries, which are predominantly rural, emerged as a pivotal point of contention (Rathkolb, 2011). This dichotomy is strongly connected to local identity, where *Heimat* (homeland) and *Tradition* are a key fundament of political narration in Austrian policymaking, particularly among the eight mostly rural and politically conservative federal states against its dominant left-leaning urban capital Vienna (Schmidt-Lauber, 2023). This implies a strong political "us" vs. "them" discourse coming along with resistance against any governance and policy measures coming from the capital, regardless of its rationality or urgency. This tension is important to take into consideration for the decarbonization agenda.

Second, private motorized transport has been integral to Austria's modern economic development since the 1960s. It transformed rural areas that previously lacked adequate transport infrastructure and fundamentally shaped Austria's settlement patterns through increased suburbanization and the development of car-dependent residential areas (Várdai, 2011). This historical development is still reflected today in regional differences: While Vienna shows notably low car ownership rates, the *Waldviertel* region records the highest motorization rate in Austria (VCÖ, 2024), highlighting the continuing significance of private vehicles in rural mobility (Emberger et al., 2023). Vienna also boasts the country's most sophisticated public transport system, while rural and alpine regions face significant challenges in public transport accessibility and infrastructure development. Decades of investment prioritization favoring the road network while simultaneously neglecting rail infrastructure has led to an infrastructural backlog (Emberger

et al., 2023). Rural mobility constraints in Austria stand in contrast with neighboring Switzerland with its guaranteed hourly service for routes with 500+ passengers daily. The low population density in rural regions exacerbates economic viability issues, as fare revenues in regional transport cover only 45 % of costs. These factors create a vicious cycle of poor service and low demand, as demonstrated by lower usage rates in underserved areas (der Standard, 2024; die Presse, 2010; VCÖ, 2021).

Thirdly, the urban vs. non-urban political rift expressed during elections was particularly prominent in the latest 2024 parliamentary election, where the far-right Freedom Party of Austria (FPÖ) won in most non-urban areas with pro-car and anti-climate narratives such as "*climate-insanity*" (MOMENT Magazin, 2023), "*Eco-Marxist car driver chicanery*" (Fpoe.at, 2023) and "*elites without empathy*" (der Standard, 2025; Freiheitlicher Parlamentsklub, 2023) building on the anti-elitist and anti-intellectual "us" vs. "them" discourse.[2] Similar cases such as the Yellow Vest movement in France highlight that climate policies have become subjects of contention, giving rise to unrest and the ascendance of green backlashes, particularly in rural regions, which heavily depend on the car (Tatham and Peters, 2023). We posit therefore the argument that decarbonization policies in transport and mobility have predominantly focused on urban decarbonization paradigms (e.g., electric mobility, bicycle, sharing concepts) while enforcing measures that apply across the country. This builds directly on Isaksson, Ryan, and Trygg's analysis of Swedish planning organizations, which reveals how institutional path dependencies undermine sustainable mobility transitions. Their Tomtebo Strand housing area case study exposes the precise disconnect we observe in Austria: municipal planners designed for sustainability and reduced car dependence, but the national transport authority enforced conventional road infrastructure expansion based on traffic projections. This clash exemplifies how transformative change fails when multiple governance levels operate with conflicting paradigms, sustainability-oriented local planning vs. car-centric national standards, leaving rural communities caught between seemingly incompatible visions.

We argue that this discursive focus leads to the exclusion of substantial parts of society in non-urban regions with car-dependency and limited

[2] A noteworthy political campaign by the Lower Austrian FPÖ is entitled "*Autofahrer belohnen*" (Rewarding car drivers), the objective of which is to antagonize climate policies that are in opposition to daily car commuters.

access to public transport (Unbehaun et al., 2014; Vecchio et al., 2024). To exemplify this we are focusing on the construction of "*the rural*" through storylines and discourse coalitions in decarbonization policies of the Austrian government and close the chapter with outlooks on alternative bottom-up approaches. Using the case of *land.mobil:LAB* (LML) in the *Waldviertel* we highlight how rural mobility laboratories function as sites where dominant urban-centric research paradigms in mobility transitions are challenged and alternative pathways can emerge outside a top-down climate and decarbonization policy imperative, which might be connected to contemporary climate backlashes in Austria. We eventually reflect how the LML's participatory approach to rural mobility innovations can help to reconfigure power-knowledge relations in the urban-rural gap: shifting from top-down climate and energy transition imperatives to people-centered rural mobility needs, creating new forms of local knowledge production, and fostering broader acceptance of energy transition policies through community engagement rather than top-down environmental mandates. This approach helps us answer our guiding questions for the chapter: How can rural communities, local companies and civil society become active participants in transport energy transitions, rather than passive subjects of climate and energy transition policies, or disruptive opponents of energy transition through democratic governance? Whose transition is it when power relations and discourse determine the direction of rural mobility transformation?

2. Understanding the energy transition in mobility as urban-centric discourse

The concept of mobility transitions encompasses a range of storylines that reflect the evolving dynamics and challenges within the mobility sector. They cover several interconnected frameworks (Reichenbach and Fleischer, 2023): While these various dimensions sustainability, technology, urban planning, social justice, and policy coordination are deeply intertwined through complex relationships that merit comprehensive analysis, this contribution focuses specifically on the sustainability and climate aspects of mobility transitions, particularly decarbonization and energy transition discourse, as a lens for understanding contemporary mobility transformations.

Energy transition policies in the transport sector encompass multiple strategic approaches aimed at decarbonization. Key policy areas include the

promotion of electric mobility through infrastructure development and incentives (Sousa and Costa, 2022), advancement of alternative fuels such as biofuels and hydrogen for heavy transport (Collazos et al., 2024), enhancement of public and non-motorized transport systems (Upham et al., 2023), technological innovations such as battery technology development (Seck et al., 2022) and the need for cross-sectoral integration of energy and mobility systems (Van Baal and Finger, 2020). These policies are considered to balance complex challenges including social welfare and economic impacts (Upham et al., 2023). But we also highlight that successful implementation of these policies requires balancing urban and rural needs while ensuring equitable access to clean transportation solutions (Van Der Koogh et al., 2021). Adding to that, it is noted in the scientific discourse that policies also require not only continued innovation and investment but also careful consideration of how they interact with existing social structures and power relations (Blühdorn et al., 2019; Hausknost, 2020; Sovacool and Brisbois, 2019).

We find this particularly relevant in rural mobility contexts where the dominant technical and behavioral solutions presented in academic discourse may not adequately grasp local needs and realities. Bourdieu's discussion of academic language and how it functions as a form of symbolic power underlines this argument. Academic discourse, while presenting itself as neutral and objective, works to maintain power relations by using certain ways of thinking and speaking without reflecting the own production of knowledge structures (Bourdieu, 1988, p. 14). This process operates through established academic power relationships in centers of cultural capital accumulations (for instance Vienna), thereby wielding influence over the subjects of research (the rural). Consequently, it is unsurprising that individuals with greater access to the cultural capital of academic institutions in urban areas tend to prioritize dominant paradigms in policy formation and research (Liu, 2019; O'Neal and Perkins, 2021). Therefore, understanding how top-down policies are framed and communicated becomes crucial, as such narratives shape how mobility transitions in non-urban areas are understood, implemented, and potentially contested on the lower end of the administrative hierarchies.

Building on this discursive perspective, Avelino (2017) understands any form of sustainability transition as powerful discourse driven by actors, standing in relationship to each other and executing power. Scoones (2016, 309) considers transformations, particularly in the case of sustainability, as a construct of "…networks, alliances, and coalitions and connect diverse

actors – including state and business actors, scientific-technical elites and citizens movements". As far back as 1944, Polanyi (2001) assigned transitions a "double movement" functionality, either movement or countermovement against transitions. This critical interaction represents the main interest of our chapter, and we argue that decarbonization efforts in mobility transitions are too focused on urban perceptions and needs while neglecting non-urban areas. Opposition to such sustainability transition requires careful analysis of arguments and narratives, as highlighted by Aitken (2010, 2009) who points out that top-down policies should also respect the opposition instead of dismissing it. This is what Sovacool and Brisbois (2019) label as "elite-power" in transitions where power relationships eventually lead to undesired policy blowback. Opposition to energy transitions can also help to create democratic responses that foster what Machin (2020) calls "*ecological agonism*", which serves as a "*political (re) source*" rather than fomenting only discontent. Can this feedback to climate policies be a productive means to create beneficial outcomes? Brisbois and Cantoni (2025) argue that decarbonization policies have reproduced previous injustices and that the resulting resistance is not necessarily based on inherently anti-climate resentments but occurs because of perceived injustices. Therefore, they underline the importance of bottom-up and inclusive approaches to facilitate transformations.

The decarbonization of mobility represents more than just a technical transition – it emerges as a powerful political discourse where elite actors significantly influence environmental policy formation. Through Foucault's discourse analysis framework, we can examine how language in texts constructs and maintains power relations (Foucault and Rabinow, 1984). This analytical lens proves particularly valuable in understanding how the discourse around energy transition in transport decarbonization both shapes and reflects existing power structures. To grasp the full implications of this dynamic, we must consider Foucault's (1972) fundamental paradigm that discourse actively shapes social reality. This understanding illuminates how energy and mobility transitions can both be constructed through different discourses, with some narratives gaining dominance over others. Foucault (1972, pp. 107–108) defines discourse as "*the group of statements that belong to a single system of formations*", where statements are defined as series of signs that exist under specific conditions, not just what is said (language), but the conditions in which the function that gave a series of signs an existence. His framework includes three key properties particularly relevant to analyze energy transitions of the 21st century: contestation, instability, and historical

contexts. Historical contexts shape what can be meaningfully stated e.g. about energy transitions at specific moments, as Foucault (1972, 125ff) demonstrates, as discussed earlier regarding Austria's car-dependent development since the 1960s and the entrenched urban-rural divide, these historical conditions determine which mobility solutions appear viable or legitimate in current policy discourse. Foucault (1981, pp. 52–53) later argues that "*discourse is not simply that which translates struggles or systems of domination but is the thing for which and by which there is struggle, discourse is the power which is to be seized*". Instability is also inherent in discourse, as *"…we must conceive discourse as a violence that we do to things, or, at all events, as a practice we impose upon them; it is in this practice that the events of discourse find the principle of their regularity"* (Foucault, 1972, p. 229). The instability property of discourse creates opportunities for transformative change in response to climate change which is subject to power struggles. Pushbacks from "*counter-movements*" can put any sustainability transition into question (Sovacool and Brisbois, 2019). However, the question arises how to involve the diversity of perceptions.

The increasing complexity of such challenges demands innovative research approaches that effectively connect science and practice. Real-world laboratories have emerged as a significant transdisciplinary research format in this context. Real-world labs operate at the interface between science, society, and politics, representing a specific mode of transdisciplinary research (Renn, 2021). While a uniform definition is lacking, essential characteristics can be identified: they function as research infrastructures where real experiments are conducted (Engels and Rogge, 2018; Schneidewind et al., 2018). Central elements include knowledge co-production, co-design of the research process and social and societal learning. A key goal of the real-world lab approach is generating transferable results with the potential to initiate societal transformation processes (Kern and Haupt, 2021). This assumes that equality among all actors involved is a prerequisite for successful project implementation (Engels and Rogge, 2018; Schneidewind et al., 2018). Furthermore, it assumes that scientists must be familiar with the research and project environment for effective collaboration, and all participants should bring a certain degree of openness and reflexivity (Singer-Brodowski et al., 2018). The real-world lab approach has diverse roots. Since the late 1980s, the sociological concept of "real experiments" has been widespread (Krohn and Weyer, 1989). These real experiments focused on societal reactions to modern challenges, based on the assumption that in

complex societies, everyone is directly or indirectly involved in knowledge production and should therefore be included in the research process (Krohn and Weyer, 1989). Real-world lab research has established itself in German-speaking countries as an interdisciplinary field involving scientists from various disciplines: from sustainability sciences to sociology, economics, geography, education, psychology and engineering (Kern and Haupt, 2021).

While real-world labs represent primarily a Germany/Austria-centered discussion, there are parallel international concepts such as Urban Living Labs and experimental approaches. Urban Living Labs, significantly supported by EU funding, also aim at testing innovations in urban spaces but emphasize more strongly the territorial demarcation of experimental spaces (Voytenko et al., 2016). The international debate on urban experiments, in turn, focuses more on basic research on local transformations (Bulkeley and Castán Broto, 2013). Recently, German researchers have begun to promote internationalization of the discourse by using the English term "Real-World Labs" (Engels and Rogge, 2018).

Nevertheless, German real-world lab research remains relatively isolated internationally, which could be overcome through stronger networking with international investigations. Despite the promising potential of real-world labs, substantial challenges exist. Systematic evaluation of projects rarely takes place (Singer-Brodowski et al., 2018), limiting knowledge about their actual effects on sustainability transformations (Bulkeley and Castán Broto, 2013). The scaling of successful projects, both in temporal (institutional perpetuation) and spatial dimensions (transferability to other jurisdictions), has been recognized as a problem, but has rarely been systematically investigated. This is particularly problematic since sustainability transformations require effective outcomes on precisely these scales (Kern and Haupt, 2021).

3. Background: Austria's administrative capacity for energy and mobility transition in the EU context

Austria aims to achieve climate neutrality by 2040, 10 years ahead of the EU target, but has reduced its GHG emissions by only 25 % between 2005–2023, below the EU average of 30 %. Since the Paris Agreement was signed in 2015, Austria's decarbonization agenda has been governed by multiple political coalitions: SPÖ-ÖVP (Social Democrats & Conservatives)

until 2017, ÖVP-FPÖ (conservatives & far-right) until the 2019 Ibiza affair,[3] an intermediary expert government, and the ÖVP-Greens coalition until 2025.[4] The FPÖ is a right-wing populist political party established in 1956. With nationalist and Eurosceptic positions, the party has evolved from its pan-German origins to focus more on anti-immigration and anti-Islamization platforms. At the provincial level, the party has gained significant influence in several states. The party is known for its critical stance toward climate policies that it perceives as economically burdensome, particularly those affecting rural constituencies (Heinisch, 2016; Horaczek, 2024).

Climate policies faced a challenging environment amid political scandals and coalition conflicts that undermined public trust in government and democratic institutions, especially following the COVID-19 pandemic (Praprotnik and Perlot, 2023). Despite these challenges, significant climate policies were implemented under the Greens, including a national carbon pricing system, the "climate ticket" for public transport (€3/day), €21.1 billion for railway expansion and heavy subsidization of electric vehicles. Furthermore Austria is a leader in the EU in rail utilization (2.160 km per person annually – approximately twice the EU average), while maintaining below-average car usage (7.770 km versus EU average 9.200 km) (der Standard, 2024).

Despite these advances in climate action, Austria's energy governance system, shaped by historical legacies and European policies, exhibits stable but slow political dynamics that can impede the rapid changes needed for energy transition (Wenz, 2022). The country continues to face challenges including heavy Russian gas dependence (comprising 98 % of gas imports) and incomplete legal frameworks like the pending Climate Change Act revision. Democratic dynamics involving contention and conflicts remain prominent in Austrian climate policy discourse, as evident in the documents

[3] The Ibiza affair was a 2019 Austrian political scandal involving a secretly filmed video from 2017 showing Vice-Chancellor Heinz-Christian Strache (FPÖ) discussing corrupt deals with a woman posing as a Russian oligarch's niece. The video's publication led to Strache's resignation and the collapse of Austria's coalition government (Kern and Miller, 2025)

[4] Since March 3, 2025, Austria has been governed by Chancellor Christian Stocker's three-party coalition (ÖVP-SPÖ-NEOS) after the far-right FPÖ failed to form a government despite winning the September 2024 election (Murphy, 2025). While facing economic recession and implementing fiscal consolidation measures including cuts to climate spending (abolishing the "climate bonus") the coalition agreement commits to ambitious mobility transition goals such as doubling cycling modal share from 7 % to 14 % and expanding rail infrastructure "as an important part of creating the necessary mobility transition with regard to climate goals." This reflects a pragmatic balance between continued decarbonization support and economic pressures, while the FPÖ opposition continues criticizing EU climate measures as economically burdensome (Bundeskanzleramt Österreich, 2025).

we will analyze. Also, advances in certain areas of mobility and energy transitions masks significant regional disparities, with 27 % of Austrians lacking adequate public transport connections at all, particularly in eastern and southern regions (die Presse, 2010). From an emissions perspective, Austria also faces substantial challenges. The transport sector has increased by 49 % since 1990 and accounts for 28 % of total GHG emissions, while industry remains the predominant emitting sector at 36 % (European Commission, 2023). Despite codifying climate neutrality by 2040 in legislation and committing to a 48 % emissions reduction by 2030 under the EU's Effort Sharing Regulation (compared to 2005 levels), Austria is projected to miss this target by 21 %, with a 79 % deviation from the linear trajectory necessary for climate neutrality (European Commission, 2023). Austria's strategic framework encompasses reducing transport volume through enhanced spatial planning, modal shifts toward energy-efficient alternatives, and accelerating electrification. Through the EU Recovery & Resilience Facility, Austria has allocated 52 % of its financial plan to environmental initiatives, particularly railway development (European Commission, 2023).

However, the Austrian case also illustrates how historical infrastructure decisions create path dependencies that constrain transition trajectories, demonstrating both the potential and limitations of partial transformation approaches in advanced industrialized economies. Austria operates as a federal republic comprising nine states (*Bundesländer*) under a complex multi-level governance framework. This administrative system significantly shapes climate and mobility policy implementation through its distribution of responsibilities and authorities (Parlament Österreich, 2025). At the federal level, the national government establishes overarching legislative frameworks, secures international commitments, and develops national strategies like the NECP (National Energy and Climate Plan). The Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK)[5] serves as the central institution for climate and mobility policy, wielding substantial regulatory authority and funding allocation powers. However, implementation authority is largely devolved to lower levels (Steurer and Clar, 2015).

[5] The name of the ministry has changed after change of government on 3 March 2025 into Federal Ministry for Innovation, Mobility and Infrastructure. The responsibility of climate action has changed to the Ministry of Agriculture and Environment since then.

The state governments within Austria's federation occupy a critical intermediate position with significant constitutionally protected powers. They develop state-level implementation plans (such as the *Mobilitätspaket Niederösterreich*), manage regional infrastructure development, and hold primary authority over spatial planning - a crucial determinant of mobility patterns (Fallend, 2010). States also control substantial budgets for public transport and infrastructure development, allowing them considerable discretion in how federal goals are operationalized. At the municipal level, local governments implement specific measures tailored to community needs, manage local transportation infrastructure, and coordinate with regional planning bodies. While municipalities have limited legislative powers, they significantly influence implementation through land-use decisions, building permits, and local mobility services.

When the decarbonization discourse gets translated into policies, the institutionalization processes become a critical focus for analysis. Discourse analysis serves as a valuable tool to deconstruct how power-knowledge relations materialize in policy documents and become institutionalized through policies (Sharp and Richardson, 2001). Hajer's reading of the Foucauldian discourse analysis framework is particularly relevant here, as it emphasizes how discourse becomes a structured institutional arrangement that shapes (environmental) policies (Hajer, 1995). His concept of "*discourse institutionalization*" explains how certain ideas move from being merely discussed to becoming embedded in institutional practices and concrete policies (Hajer, 2006). The institutionalization of Austrian climate governance began during the late 1980s and early 1990s with the establishment of environmental ministries and coordination mechanisms. The formation of the Austrian Conference on Spatial Planning (ÖROK, n.d.) in 1971 created an enduring coordination platform between federal and state levels that has maintained continuity in spatial development approaches regardless of political shifts (ÖROK, 2018). A significant turning point came with Austria's entry to the European Union in 1995, which embedded climate policy within supranational requirements (Steurer and Clar, 2015). This created institutional obligations that transcended domestic political cycles, establishing a persistent framework that subsequent administrations could not easily dismantle. The Climate and Energy Fund (*Klima- und Energiefonds*), established in 2007, further institutionalized climate action through a semi-autonomous funding body (Kettner-Marx and Kletzan-Slamanig, 2018).

On the administrative execution level, the Austrian bureaucratic system demonstrates remarkable continuity in climate policy implementation despite

political fluctuations. This institutional inertia manifests in several ways that maintain policy direction under potentially hostile political conditions. First, the multi-level governance structure diffuses power across different administrative layers, preventing rapid policy reversals even during political transitions (Steurer and Clar, 2015). When the conservative-far right government of ÖVP and FPÖ (2017–2019) attempted to weaken climate commitments, established state-level planning processes and EU obligations continued to drive implementation forward through bureaucratic channels (Kirchengast et al., 2019). Second, Austria's strong tradition of social partnership (*Sozialpartnerschaft*) incorporates major societal stakeholders into policy development through formalized consultation processes. This creates institutional memory and stakeholder expectations that resist abrupt policy shifts, as demonstrated by the sustained progression of transport planning initiatives, such as public transit expansion programs, that continued advancing through established consultation processes with trade unions, business associations, and environmental groups even as federal governments changed (Tálos and Hinterseer, 2019). Third, the professional civil service maintains significant technical expertise and policy continuity across electoral cycles. Within the BMK and state-level mobility departments, senior officials have maintained consistent policy directions on issues like public transport expansion and climate mitigation despite changes in political leadership (Steurer and Clar, 2015).

This bureaucratic inertia has significant implications for Austria's energy and mobility transition. On the positive side, it provides stability for long-term planning and infrastructure development, which is essential for transition processes. The consistent implementation of public transport expansion in urban areas, regardless of shifting political winds, exemplifies this advantage (der Standard, 2024). However, this same institutional character also creates challenges for transformative change. The incremental nature of Austria's administrative processes favors gradual adjustments over radical transformations, potentially slowing the pace of transition (Aichholzer et al., 2019; Wenz, 2022). This is particularly evident in rural mobility policies, where innovative approaches face institutional barriers despite being included in policy documents, which we will consider in the discourse analysis.

4. Methodology

Our study employs discourse analysis, applying Foucauldian concepts of power-knowledge relations through Hajer's reading of Foucault to

examine political rural mobility governance within the broader context of energy transitions. For Hajer (1995, p. 44), discourses are understood in a slight deviation from the Foucauldian definition as "*an ensemble of ideas, concepts, and categories through which meaning is given to social and physical phenomena.*" Therefore, discourse analysis "*…aims to understand why a particular understanding of the environmental problem at some point gains dominance and is seen as authoritative, while other understandings are discredited. This is taken on to analysing the ways in which certain problems are represented, differences are played out, and social coalitions on specific meanings somehow emerge.*" (Hajer, 1995, p. 44). In this sense, we are aiming to understand how policies are used to make sense of decarbonization and energy transition in the transport and mobility sector. Through discourse analysis, in line with Hajer, we will identify which knowledge is dominating, whereas others are marginalized.

Following (Hajer, 2006, 1995), we focus on three key elements of how to conduct discourse analysis: storylines (how mobility challenges and solutions are narrated), discourse coalitions (which actors gather around specific interpretations), and discourse institutionalization (how these narratives are institutionalized in policy). Applying Hajer's framework, we use "storylines" as our primary analytical concept, which Hajer (1995, p. 56) defines as "*generative sorts of narrative that allow actors to draw upon various discursive categories to give meaning to specific physical or social phenomena.*" Storylines are "*narratives on social reality through which elements from many different domains are combined and that provide actors with a set of symbolic references that suggest a common understanding*" (p.62). When we refer to "narratives", we mean the broader storytelling elements that comprise these storylines, recognizing that storylines are themselves specific types of narratives that perform particular analytical functions in discourse analysis. Discourse institutionalization occurs when "a given discourse is translated into institutional arrangements" and "concrete policies" (Hajer, 1995, p. 61), which is what we analyze through Austria's mobility policy documents at different administrative levels.

We distinguish between three analytical levels: discourse (the overarching framework of ideas about mobility transitions), storylines (specific narrative constructs that organize understanding of issues like rural mobility or energy transition in transport), and narratives. Following Hajer's (1995) hierarchy, discourse contains multiple storylines, which in turn contain various supporting narratives. Our analysis proceeds in four systematic steps

Table 1 Methodological framework for discourse analysis of rural mobility. Author's visualization.

Analysis level	Key questions	Methods	Outcomes
1. Structural analysis of documents	• Who is the intended audience? • What language choices were made? • What are the contextual motivations? • Who are the authors? What has been included or omitted?	• Textual analysis • Comparative document analysis	• Identification of institutional perspectives • Understanding of communication objectives • Recognition of power relations in text production
2. Framing of Rural Mobility	• How is rural mobility portrayed? • What terminology is used? • What problems are emphasized? • What solutions are proposed?	• Frame analysis • Linguistic pattern identification • Semantic analysis	• Identification of dominant frames • Understanding of problem definition • Recognition of solution narratives
3. Storyline Analysis	• What narratives are constructed? • What knowledge is presumed? • What dominant frames (economic, social, environmental) exist? • How is meaning conveyed?	• Narrative analysis • Examination of argumentation patterns • Identification of presuppositions	• Mapping of storylines • Understanding of implicit assumptions • Identification of rhetorical strategies
4. Discourse Coalitions and Institutionalization	• How are narratives institutionalized? • What power structures are discernible? • What patterns of inclusion/exclusion appear? • What contradictions exist with decarbonization agendas?	• Actor analysis • Network examination • Analysis of contradictions • Policy implication analysis	• Identification of discourse coalitions • Uncovering of power dynamics • Recognition of tensions between mobility and climate goals

Table 2 Documentation analysis framework for rural mobility policy documents. Author's visualization.

Document name	**Nationaler Energie- und Klimaplan (NECP)**	**Mobility master plan 2030**	**Mobilitätspaket Niederösterreich 2023–2027**	**Land.mobil:LAB**
Level	National Government Level	Federal Ministerial Level	State Level	Community Level
Author(s)	Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK)	BMK	State Government of Lower Austria (NÖ Landesregierung)	TU Wien
Language	English, German	English, German	German	German
Year	2024 (updated)	2021	2023	2024
Scope (Pages)	347	72	36	32
Occasion/ Purpose	EU requirement for national climate planning; Framework for emission reductions	Implementation of national climate goals in mobility sector	Implementation of federal mobility goals at state level	Community-level feedback and implementation Support; achievement of European and national climate goals

(continued)

Table 2 Documentation analysis framework for rural mobility policy documents. Author's visualization. (*cont'd*)

Document name	Nationaler Energie- und Klimaplan (NECP)	Mobility master plan 2030	Mobilitätspaket Niederösterreich 2023–2027	Land.mobil:LAB
Chronological Level	Top-level framework document that sets national targets	Secondary level document that specifies sectoral implementation	Tertiary level document that adapts national/federal targets to state context	Ground-level implementation and feedback mechanism
Administrative Process	Required by EU regulations; Provides framework for sectoral planning	Derives from NECP; Sets framework for state-level planning	Derives from Mobility Master Plan; Sets framework for local implementation	"Mobility of the Future" (MdZ) program initiated by BMK
Institutional Framework	EU climate policy frameworks; Paris Agreement commitments	National climate and transport policy framework	State planning authority; Regional development frameworks	Local governance structures; Community participation frameworks
Validity Period	2021–2030	Until 2030	2023–2027	2024–2029
Availability	Public	Public	Public	Public
Key Actors	Federal ministries; Climate and energy agencies; Environmental stakeholders	Transport ministry; Public transport providers; Infrastructure planners; Environmental agencies	State government; Regional transport authorities; Local municipalities	Local communities; Mobility users; Local businesses; Research institutions

Target Audience	Federal ministries; State governments; Sectoral planning bodies; EU Commission	Transport planners; Public transport providers; Infrastructure developers; State governments	Local municipalities; Transport planners; Citizens of Lower Austria	Rural communities; Local policymakers; Transport service providers
Key Focus	Sectoral targets including transport; Compliance mechanisms; Overall emission reduction goals	Climate-neutral mobility by 2040; Electrification strategies; Modal shift approaches	Implementation of national targets; Regional transport planning guidelines	Practical implementation; Local adaptation; Community feedback by research, technology, and innovation
Document Interlinkages	Sets framework for Mobility Master Plan and subsequent documents	References NECP; Provides framework for state mobility packages	References both NECP and Mobility Master Plan; Guides community implementation	References higher-level policy documents; Provides feedback to policy cycle

as explained in Table 1. These steps are focusing on the construction of "*the rural*" through storylines and discourse coalitions in the decarbonization agenda.

We specifically target sections in the Austrian NECP ("Nationaler *Energie- und Klimaplan)*", *Mobility Master Plan 2030* and regional strategies such as the *Mobilitätspaket*.

Niederösterreich 2023–2027 in our analysis where rural areas are discussed in relation to energy transition measures. Through systematic examination of these policy segments, alongside the official project description of "*land.mobil:LAB*" (LML), legitimized by the funding body and stakeholder communications, we trace the evolution of competing policy frames and narrations along the administrative hierarchies: from top-down climate imperatives to community-centered mobility solutions. Particular attention is paid to how local interpretations of energy transitions differ from governmental policy narratives, and how these interpretations shape acceptance of and resistance to transition policies (Hajer and Versteeg, 2005). As the NECP and the Mobility Master Plan 2030 were published in English, our analysis refers exactly to their original meaning, while the *Mobilitätspaket Niederösterreich* and LML documents were only published in German. For these German documents, we used the DeepL translation engine to provide accurate translations of the quoted text segments. Table 2 gives an overview of the analyzed documents, their core data and context.

5. Discourse analysis of Austrian decarbonization policies in transport

This study aims to address the absence of a rural perspective in existing Austrian mobility and energy transition policies. It addresses this disparity by employing Hajer's discourse analysis methodology to critically analyze Austria's federal and state-level policies. By focusing on the construction and representation of "*the rural*" in the decarbonization agenda, particularly through the analysis of national frameworks like the Austrian NECP ("*Nationaler Energie- und Klimaplan)*", *Mobility Master Plan 2030* and regional strategies such as the *Mobilitätspaket Niederösterreich 2023–2027*, the chapter explores how energy transition policies are shaped through discourse. This approach challenges the "*top-down urban-centrism*" prevalent in much energy transition research by providing insight into the complex and often contradictory perceptions in non-urban areas such as the *Waldviertel*

in Lower Austria, where local mobility needs often conflict with national decarbonization objectives and pathways. Through Hajer's discourse analysis framework, our study illuminates how certain interpretations of mobility needs become dominant in Austrian policy discussions while others, particularly those from rural areas, remain marginalized and require policy blowback or even democratic opposition to target and tailor locally adequate decarbonization efforts. This chapter outlines the results of the discourse analysis of the three beforementioned documents under the methodological framework of the previous chapter, going along the previously discussed federal hierarchy.

5.1 National energy and climate plan (NECP): Setting the scene

This document is of particular significance in the institutionalization of energy transition policies, situated at the intersection of European Union requirements and national implementation. The NECP, formally adopted by the Austrian government and approved by the Council of Ministers as part of Austria's obligations under EU Governance Regulation (2018/1999), establishes its legitimacy primarily through the deployment of technical language and expertise, with energy transition in transport mentioned in only a few short passages. Unlike mere expert advice, it represents Austria's binding commitments and guides subsequent legislative action, though the plan itself is not legislation. What elevates it to policy status is its formal executive approval,[6] its role as Austria's official roadmap for meeting EU climate targets, and its direct influence on subsequent regulatory frameworks. The document establishes concrete measures that Austria is committed to implementing, creating accountability at both national and EU levels. Hence, the 347-page document sets the scene for any other subsequent policies and can be considered the "*guiding theme*". It outlines policy measures with which the Austrian government

[6] The approval process itself was contentious, with significant disagreements between coalition partners. Climate Minister Leonore Gewessler (Greens) and Constitutional Minister Karoline Edtstadler (conservative ÖVP) clashed over several aspects of the plan. A previous draft submitted by Gewessler's ministry in autumn 2023 was withdrawn by Edtstadler, who claimed it hadn't been properly coordinated with other ministries. Key points of contention included sectoral emission targets (which were ultimately removed at ÖVP's insistence to provide "more flexibility") and the elimination of climate-harmful subsidies (particularly the diesel tax privilege and commuter allowances). The ÖVP insisted on establishing a working group led by the Finance Ministry to evaluate which subsidies would be cut rather than specifying them in the plan. Austria was the last EU member state to submit its plan, which was finally approved in August 2024 after months of coalition negotiations. (ORF.at, 2024)

communicates to Brussels, apart from four other dimensions (research, energy efficiency, energy security, internal energy market) how it aims to reduce carbon emissions and facilitate energy transitions across five sectors (mobility, buildings, district heating, agriculture, and industry). The document, authored by the Ministry of Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) under the Green Party's leadership (2019–2025), employs technical and bureaucratic discourse to frame the climate transition. This framing serves multiple purposes: it demonstrates compliance with EU frameworks, establishes the ministry's expert authority, and creates a basis for top-down policy implementation. The document makes only infrequent and limited reference to the concept of "*Ländlicher Raum*" (rural area), and then only in connection with the agricultural sector, tourism, the economy and mobility.

This technocratic approach is manifested in several ways. Firstly, the document makes extensive reference to scientific studies, expert knowledge and existing governmental initiatives or plans. But interestingly, it indirectly admits that the current state-of-the-art in research and science is not sufficient. It states on page 129:

"*As the national emissions monitoring center, the Federal Environment Agency regularly prepares GHG scenarios for Austria. In the coming years, work will be increasingly focused on creating a positive target picture for Austria in 2040. Many questions remain unanswered here, from the specific future technologies to the necessary institutional requirements, process acceleration and realization periods to socio-economic implications, interactions between climate protection, biodiversity, the circular economy and zero pollution. Another key point is transformation research and the challenge of creating solid transformation knowledge.*".

This statement contradicts in some way the extensive use of scientific references and implies that transformation research will be supported to achieve this goal. This creates the possibility that urban-centric research paradigms are privileged as discussed previously in the first three paragraphs of the section "Understanding the energy transition in mobility as urban-centric discourse". Also, that in order to circumvent political agonism, depoliticized measures are used as none of them call out for fundamental shifts in previous policies. This is visible in the following quote, because secondly, the NECP only implicitly addresses the political dimensions of energy transitions in transport. For instance, on the issue of decarbonization in transport it states on page 136:

"*Achieving the climate targets in the transport sector is a particular challenge, which is why the creation of the Mobility Master Plan 2030 for Austria, which shows the path to climate neutrality by 2040, was anchored in the government program. The Mobility Masterplan 2030 (departmental strategy of the BMK) provides the strategic framework for aligning Austria's mobility sector with ecological, economic and social goals, but the measures described in this chapter are not yet sufficient to achieve the goals of the Mobility Masterplan 2030. To date, the following measures and policies are planned and being prepared for implementation […].*".

It indicates that there have been conflicts between the coalition partners as it directly assigns the BMK the responsibility of the Mobility Masterplan 2030 while simultaneously admitting that the policy measures are not sufficient at all to achieve the goals and are "planned" or "in preparation". The "measures" and policies that are named can be mostly described as "conventional research measures" of energy transition in transport, covering the mainstream research state-of-the-art from page 4, e.g., electric mobility, the advancement of alternative fuels, the enhancement of public and non-motorized transport systems, technological innovations, and the need for cross-sectoral integration of energy and mobility systems. These measures, which appear as superficial administrative actions, conceal numerous politicized points of contention, which the document overlooks, despite acknowledging throughout that the decarbonization agenda is at stake. The political dimension on how decarbonization policies can indeed create resistance, becomes apparent later in the analysis of the *Mobilitätspaket Niederösterreich 2023–2027*.

Thirdly, it acknowledges that progress has been stagnating in the transport sector when it comes to reducing carbon emissions. However, it immediately adopts a defensive position when justifying potentially controversial measures, such as fuel price increases. The document cites external studies that highlight Austria's lower petrol prices compared to neighboring countries as a reason for contradicting trends against carbon-reducing policies, thereby constructing a technical rationale for price increases while obscuring the political nature of such decisions. Overall, this very expert and scientific framework represents, as Foucault would identify, the intertwining of power and knowledge in the "Political Economy," where technical expertise becomes a tool for legitimizing political choices through economic and political apparatuses (Foucault and Rabinow, 1984, p. 73). As Hajer would put it, the decarbonization efforts become an obscured scientific storyline to provide techno-economic

information "*to illustrate*" why climate goals could not be achieved in the transport sector and how these fits into the "jigsaw" (Hajer, 1995, p. 63). Furthermore, the document reveals two main storylines in the decarbonization discourse: the **Urban-Rural Divide** and **Economic Modernization and Strategic Ambiguity.**[7] Within the urban-rural divide storyline, multiple deficit-oriented narratives frame rural areas as lacking essential characteristics:

5.1.1 The urban-rural divide

Perhaps the most striking aspect of NECP's decarbonization discourse is its treatment of the urban-rural relationship. The document reveals significant power imbalances in how urban and rural spaces are conceptualized and addressed. Words related to "rural" (German: *ländlich*) appear only 11 times, whereas words related to "cities" (*Stadt*) and "urban" appear over 47 times. Urban areas are consistently framed as centers of growth and progress, *while rural regions are characterized through deficit-oriented narratives within the urban-rural divide storyline*. This is evident in the document's first mention of rural areas in its discussed impacts of a climate-neutral economy, which describes them primarily in terms of negative population trends and economic structural challenges:

"Population growth is primarily concentrated in urban centers, while some peripheral rural regions are experiencing a negative population trend, which in turn is due to economic structural trends." (page 18).

As political countermeasure, the policy uses a "Just Transition framework", a prominent research concept in energy transition studies. While it is intentionally designed to address potential disparities and disadvantages of regions affected by the transition, it paradoxically reinforces them through its framing of rural areas as "disadvantaged" and "non-resilient." These deficit-oriented narratives are particularly significant given that the regions identified as having the highest adaptation needs – Carinthia, Lower Austria, Upper Austria, and Styria – are also areas where far-right political mobilization has been strongest in the 2024 parliamentary election (Al-Youssef, 2024). The document's framing of these regions as requiring special assistance, while perhaps well-intentioned, may contribute to political resistance by reinforcing perceptions of urban-rural power imbalances. Khan and Johansson's analysis in this volume of Sweden's

[7] Each storyline encompasses multiple supporting narratives that reinforce its central themes and framings.

climate policy mix reveals a similar imbalance, where stronger policies are implemented for vehicle efficiency and alternative fuels than for addressing rural mobility needs – a pattern that mirrors Austria's policy landscape.

5.1.2 Economic modernization and strategic ambiguity

The NECP employs a distinctive economic modernization discourse that attempts to reframe environmental challenges, such as climate change, as economic opportunities. This is particularly evident in its treatment of tourism, where the document suggests a transition away from winter alpine tourism towards regional diversification. A similar phenomenon of framing sustainability agendas has also been identified in the context of sustainable development agendas that target economic business opportunities (Schojan et al., 2023). Nevertheless, the discourse of economic transformation remains ambiguous, particularly regarding the specifics of its implementation and the precise support measures to be provided to the affected regions. This strategic ambiguity could have several implications. It allows for some flexibility in implementation and adaptation to local conditions, but it also potentially masks uncertainty about how to effectively address the needs of rural areas within the transition framework, as it is evident that car dependency in rural areas in Austria is significantly at odds with the decarbonization agenda. The document's approach to rural mobility is an example of this. While the main objective of "*connecting and mobilizing rural areas*" (page 127) is articulated, the effective means and metrics for achieving this goal remain ambiguous, even buried in a long list of agenda items. It even contradicts the overarching aim of the Austrian government to cut emissions in the transport sector (page 83):

"*With a share of around 45 % of total emissions (outside the ETS), transport is currently the sector with the highest emissions. Austria's strategic approach to achieving low-emission mobility is based on the principle of avoidance (of non-essential transport), shifting (to efficient modes of transport) and improvement (of the technologies used). This is a path that is compatible with the goal of emission-free mobility enshrined in the government program and positions Austria as a pioneer in electromobility and the expansion of public transport.*".

The NECP's strategic ambiguity indeed creates tension between decarbonization goals and rural mobility needs. While never explicitly stating that rural mobility must decrease, the document's emphasis on "avoidance" of transport alongside rural connectivity presents an unresolved contradiction. Rural communities, highly car-dependent and accustomed to automotive mobility since the 1960s, would likely view any regression in

mobility options as unacceptable. Furthermore, the remaining principles of shifting and improvement are also not properly addressed and considering the status quo of transport in Austrian rural areas, none of the given alternatives (electric mobility and public transport) are actual alternatives to maintain current livelihoods of rural communities (die Presse, 2010; VCÖ, 2021). Their lifestyle, economic participation, and social integration depend on reliable transportation (Unbehaun et al., 2014). The document avoids politically sensitive discussions about potential trade-offs between emission reduction and rural mobility levels. Without specific alternative mobility solutions tailored to rural contexts, the implied implementation of the "avoidance" principle could disproportionately impact rural areas, creating inequities in the transition process. This represents a critical gap that requires explicit attention to ensure just mobility transitions across all geographic contexts.

5.2 Mobilitätspaket Niederösterreich 2023-2027: Between vision and control

This subsection explores the peculiar nature of Austria's Mobility Concept 2030, a policy document that has emerged as a notable exception within the complex landscape of energy transitions due to its distinctive rhetorical approach that contrasts sharply with the typically bureaucratic and technocratic language characteristic of policy documents. Unlike the administrative discourse of the NECP or the depoliticized technical framing found in most policy texts, this document employs an unambiguously positive framing and future-oriented rhetoric, like what Machin (2019) characterized as an ecological modernization discourse. However, beneath this optimistic surface, there lies a complex web of power relations that reveals the tensions inherent in governing such transitions. A further noteworthy point is the document's publication in both German and English, underscoring the intention to convey a message that resonates both domestically and on the global stage.

The document's construction of storylines is particularly striking in its deployment of positive future visions. It paints an attractive picture of transformed urban spaces where people conduct business locally, travel short distances, and enjoy convenient access to sustainable transport options. This vision is carefully constructed through a back-casting approach, which projects an ideal future state to justify present actions. Cars, when needed at all, run on renewable energy, while public transport and active mobility take a pivotal role in this reimagined mobility

landscape. However, this positive framing exists in tension with the document's clear top-down governance structure. While the language speaks of transformation and shared futures, the actual mechanisms of change reveal a more traditional authoritative political power dynamic. Citizens are consistently positioned as objects whose behaviors and routines need modification, rather than as active agents in shaping the transition. Although, the document on page 63 states beforehand in a rather appeasing way that:

"*The success of this task [mobility transition], which will require the buy-in of and will affect society as a whole, depends on the acceptance and willingness of everyone to change: parliaments, governments, companies and every single person living in Austria. People cannot be ordered to accept change or be talked into it.*"

The objectification of citizens becomes apparent in the frequent use of authoritative language around what "*must*" and "*needs to*" happen, even as the document acknowledges that "*acceptance cannot be ordered*" (page 63). For example, the document articulates the general target on passenger transport on page 21: "*The volume of passenger transport must be kept nearly constant*", which implies that mobility behavior will need to be constrained regardless of personal preferences or individual circumstances. This implies how citizens are positioned as objects whose movement patterns must be regulated by authority rather than as participants in reducing emissions in transport. The document presents this reduction in transport volume as a non-negotiable imperative rather than a collaborative goal, exemplifying how the plan's seemingly participatory rhetoric masks an underlying top-down urban-centric approach. This tension becomes particularly apparent in the document's explanation for communication and dialogue of this extensive mobility transition. It explicitly states, within the same paragraph on page 63, that acceptance must be "*achieved through enlightened, rational discourse*" towards "*changing the daily routines of millions of people and business processes that have become ingrained over decades*". In an interesting way, the authoritative governance of initiating the transition becomes some a disciplinary intervention. This approach overlooks what Taylor and Fujita previously identify as crucial in their framework of consumer acceptance, where awareness, access, approval, and adoption are all necessary components. Their chapter demonstrates that sustainable mobility transitions require addressing behavioral dimensions that this top-down approach fails to consider.

This tension is also visible in the treatment of participation and dialogue, where the institutional arrangements tell a different story of a broad

and democratic dialogue. The creation of the National Forum for Climate-Neutral Mobility (NFKM) exemplifies this contradiction. Though presented as a platform for societal dialogue, the forum's structure reveals significant power imbalances. The Minister (in Vienna) controls member selection, meetings are limited to annual occurrences, and representation categories are predetermined. This institutional design effectively channels and controls discourse while maintaining the appearance of participation. This quote is particularly interesting from a Foucauldian perspective, as Foucault particularly describes the spirit of enlightenment as *"[a] guaranteed a system of rights that were egalitarian in principle [but] was supported by these tiny, every day, physical mechanisms, by all those systems of micro-power that are essentially non-egalitarian and asymmetrical that we call the discipline*" (Foucault, 1995, p. 222). This quote underlines our main point of critique against the use of "enlightened discourse" in the context of mobility and energy transitions to generate acceptance for climate policies. It is, according to Foucault, a disciplining power, where by nature non-egalitarian and asymmetrical systems (e.g. political power of the state) govern the transition upon citizens. However, it must be noted, that also in the Foucauldian understanding the purpose of this analysis is not to denounce energy and mobility transition at all, but to focus on the "*plurality of discourses*" and the "*need to investigate the micro-powers that brought about transformations*" (Hajer, 1995, pp. 47–48).

The discursive construction of the mobility transition itself reveals several supporting narratives within the "Between Vision and Control" storyline. Environmental imperatives present climate goals as non-negotiable ("*The federal government's target of becoming climate-neutral by 2040, which is consistent with the science, meets the requirements of the Paris Agreement*", p. 8), while economic opportunity narratives frame the transition as a source of innovation and jobs ("*New ideas have strengthened Austrian companies' innovative capacity and have had a lasting impact on the economy*" p.5). Social justice considerations emphasize accessibility and affordability, and technological progress narratives focus on electrification and digitalization. These various narratives work together to create a sense of inevitability around the proposed transition pathway while simultaneously downplaying potential conflicts or alternative visions. This approach to building support for transition policies, however sophisticated, reveals several potential challenges for implementation. The urban-centric nature of proposed solutions risks generating resistance in rural areas where such solutions may be less applicable or desirable. Despite rhetorical commitments to participation,

the actual mechanisms for citizen involvement remain tightly controlled and limited. The privilege of technical and administrative expertise over local knowledge and perspectives may limit the effectiveness of implementation efforts, while the maintenance of existing top-down power structures through new institutional arrangements may generate resistance or limit buy-in from affected communities.

In conclusion, Austria's Mobility Concept 2030 represents a sophisticated exercise in applying the power of public institutions to climate and energy transition that combines positive environmental narratives with traditional governance structures. While its ecological modernization framing suggests a more nuanced approach to building support for transition policies, the underlying power structures remain largely unchanged. This raises important questions about how transitions can be effectively governed while maintaining democratic legitimacy. The persistent tension between rhetorical openness and structural control suggests potential limitations in current approaches to transition governance and points to the need for more fundamental reforms of how such transitions are conceptualized and implemented.

5.3 Mobilitätspaket Niederösterreich 2023-2027: Bureaucratic continuity vs. Green modernization

The document by the state government of Lower Austria from 2022 presents an interesting case of institutional resilience in Austrian environmental governance. The administration of infrastructure and transport on the federal level is currently, since the state election in 2023, under the supervision of a FPÖ-led Vice-governor from the Freedom Party of Austria (FPÖ), known for climate-sceptic positions to lay climate goals "ad acta" (Lohninger and Röhrer, 2023). The office of Vice-governor (*Landeshauptmann-Stellvertreter*) in Austria is a significant regional position, serving as the deputy to the Governor (Landeshauptmann) in one of Austria's nine federal states and serving according to the constitution as the highest administration official to formally execute federal law in the states. While they implement federal laws and are technically subordinate to federal ministers, binding federal directives are rare in practice. Governors hold significant formal and informal power, managing provincial competencies such as spatial planning, youth protection, hospital systems, and social welfare. Their role has evolved from traditional "provincial father/mother" figures to crisis managers, though they still maintain considerable influence within their national parties and across the federal system. The Vice-

governor typically comes from a different political party than the Governor as part of Austria's tradition of power-sharing and coalition governance (Karlhofer, 2015).

Despite being administered by the FPÖ Vice-governor, it represents the latest state-level document on mobility and transport. Therefore, as of today it still represents the current guideline of the Lower Austrian administration. It maintains a distinctly administrative and technocratic character that differs markedly from both national climate policy discourse as in the *Mobilitätspaket Niederösterreich 2023–2027* and the FPÖ's political rhetoric. The resilience of the Austrian federal system can be understood in the context of the country's specific federal structure; whereby federal state governments have greater responsibility for administrative and planning matters rather than legislative authority. While the constitution of Austria initially granted broad powers to federal states, subsequent centralizations have resulted in states possessing limited competencies, primarily in planning, zoning, nature protection, and certain aspects of public welfare (Karlhofer, 2015). However, these domains, which may appear to be technical in nature, carry significant practical weight, as state governors e.g. the mentioned Vice-governor of Lower Austria, oversees the implementation of federal administrative law and controls crucial planning and procurement decisions at the regional level. In the case of the analyzed document, this institutional arrangement seems to create a space where technical-administrative discourse can persist somewhat independently of political rhetoric, particularly in environmental and transport planning documents.

This document's most notable discursive feature is its deliberate distancing from the ecological modernization storyline through an administrative style that depoliticizes climate-oriented language. Unlike the environmental and climate-orientated imperative framing of national policies from the federal government or the transformative vision of the Mobility Master Plan 2030, the *Mobilitätspaket* employs neutral bureaucratic language that depoliticizes potentially contentious issues and differentiated needs by treating them as routine planning matters. On page 6 for instance the document outlines the motivation and states: "*The different regional characteristics of Lower Austria, such as centers, axes and rural areas, are taken into account and the strengths of the different means of transport are used in a targeted manner to create regionally adapted transport solutions and mobility services.*" This is particularly evident later in its treatment of rural mobility, which is approached as a standard planning consideration rather than a challenged

region requiring special intervention: "*The founding of Radland GmbH and the initiation of a funding program for high-speed cycle paths and basic cycle networks as well as for rural access cycle paths*" (page 9). This might reveal complex power dynamics between political leadership and administrative structures. The absence of FPÖ's typical anti-climate narratives, despite their formal control over transport administration and planning in the Lower Austrian government, suggests strong institutional resilience in maintaining policy continuity through bureaucratic expertise. Regardless of this observation, this does not mean that anti-climate narratives do not exist at all, but they do not appear on the institutionalized policy and administrative level. We know from historical and institutional research that imperial Austro-Hungarian bureaucracy was known for its efficiency and its persistency to manage the vast diversity of ethnic groups of the *Vielvölkerstaat* (multi-ethnic state) against any changes or reforms in society (Heindl, 2006).

The term *Vielvölkerstaat* is closely associated with the Austro-Hungarian Empire until 1918, which encompassed numerous ethnic groups, languages, religions, and cultural traditions under one imperial administration. To govern this diversity effectively, the Habsburg bureaucracy developed a distinctive administrative system that balanced imperial authority with a degree of ethnic autonomy while resisting destabilizing reforms. This created the idealized image of the apolitical, efficient civil servant (*Beamter*) who made decisions objectively according to law rather than political considerations (Heindl, 2013). This administrative tradition profoundly influenced Austrian governance culture and continues to shape how administrative institutionalizations persist independently of political shifts (Mantl, 2005). The self-contained nature of imperial bureaucracy - operating as an isolated world making decisions seemingly impervious to external intervention - has been memorably captured in literary classics like Franz Kafka's "*The Trial*" and Robert Musil's "*The Man Without Qualities*," both of which portray bureaucratic systems that function according to their own internal logic. We assume that the legacy of bureaucratic administration persists on the lower end of the hierarchy, also in line with Wenz's (2022) assessment of slow Austrian energy governance. This creates a notable separation between political rhetoric and administrative practice.

Most significantly, the document employs strategic ambiguity in handling climate and energy transition themes. While not explicitly rejecting these goals, it reduces their prominence compared to previous iterations. This enables continued environmental action under climate-sceptic political leadership by focusing on practical advantages like

efficiency and accessibility rather than environmental benefits. The document achieves policy continuity through technical practice rather than political narrative, embedding environmental considerations within standard planning procedures. In terms of practicability for the sake of decarbonization policies, it raises the question whether effective depoliticization by narrating the change process as a bureaucratic planning procedure, creates lesser resistance against such measures. Nevertheless, it demonstrates how bureaucratic institutions can maintain environmental policy direction even under potentially hostile political leadership through depoliticization and technical legitimacy. However, this administrative resilience could also raise questions about democratic legitimacy and whether such institutional separation might contribute to the growing disconnect between policy implementation and public discourse on climate action, where bureaucratic continuity neither satisfies climate action advocates demanding faster implementation nor addresses the concerns of climate action opponents altogether, as demonstrated by the FPÖ's electoral success despite continued administrative advancement of climate policies.

5.4 Outlining alternatives: land.mobil:LAB as grounded case for rural mobility feedback

Mobility Labs serve as innovative real-world platforms where mobility solutions transition from theory to practice. Since 2014, Austria has been actively fostering these laboratories, with several established labs in urban areas and, since 2023, new labs focusing on rural mobility challenges. These labs create cooperative frameworks where diverse stakeholders – from technology developers to residents – collaborate as equals in developing and testing mobility innovations. Supported by Austria's Federal Ministry for Climate Action (BMK), they provide both the infrastructure for testing future mobility solutions and facilitate direct engagement with users and decision-makers, ensuring innovations are not just technically sound but also socially accepted and practically viable (BMK, 2024). In contrast to traditional top-down approaches to energy and mobility transitions, real-world labs enable tailored solutions through co-creation that address local needs. The experimental component allows for low-risk testing of innovative approaches, while community involvement leverages local knowledge and strengthens identification with projects. Their flexible structure enables rapid adaptations, and successful approaches can serve as best practice examples.

One of those mobility labs in rural areas is *land.mobil:LAB* (LML), located in *Waldviertel*, Lower Austria. The lab focuses on different innovation projects

with defined thematic priorities, accompanied by scientific monitoring and evaluation. The innovation projects can be initiated top-down, such as demand-responsive public transport (municipalities), bottom-up, such as car-pooling (civil society), or directly by *land.mobil:LAB* itself. The object of analysis for this study is the project description in the funding application submitted by TU Wien to the *Österreichische Forschungsförderungsgesellschaft* (Austrian Research Promotion Agency). That document reveals complex and partially contradictory narratives about rural mobility and participation. Rural areas are typically portrayed through a deficit-oriented narrative – characterized by infrastructural gaps, insufficient public transportation, and high car dependency. However, this perspective can be contrasted with a resource-oriented counter-narrative that emphasizes these communities' self-organization capabilities and innovation potential. One exemplary project is "*Nachbarschaftsauto*" (Neighborhood Car), hosted by a farming family who doesn't need their car every day. Living in the small village Rafings of just 69 inhabitants where they know most residents, they created a simple website where neighbors can book their car when available. The insurance covers all users, while repair costs must be paid by whoever causes the damage. Booking slots are three hours long and cost €6 each - a price calculated based on typical use cases like doctor appointments in the nearest city or visits to hardware stores. A key element of this successful initiative is certainly the personal proximity among village residents. In such small villages or specific neighborhoods within larger municipalities, professional carsharing services aren't economically viable. Therefore, grassroots approaches like the Neighborhood Car represent suitable bottom-up solutions that leverage existing community resources and relationships.

This discursive tension between viewing rural areas as deficit-laden problem zones requiring external intervention versus recognizing them as resourceful innovation spaces with inherent problem-solving capabilities serves to legitimize the intervention of establishing a mobility lab. The institutional architecture of the lab reflects this complexity through its hybrid position between administrative governance and grassroots empowerment. At the institutional level, the state government of Lower Austria maintains significant influence through financial control (co-funding) and administrative integration (especially through its Department of Spatial Planning and Overall Transport Affairs[8]). This

[8] The Department of Spatial Planning and Overall Transport Affairs is responsible for coordinating spatial planning and comprehensive transport affairs, including mobility concepts, public transportation development, and regional development strategies.

creates a hierarchy where innovation must align with administrative objectives to receive support. However, this power structure is not merely top-down. The lab's physical presence in the rural region and its role in supporting civil society initiatives creates an autonomy. These spaces allow for the emergence of counter-power through local knowledge and social capital, particularly evident in the lab's support for self-organized mobility solutions like neighborhood-based car-sharing. Climate and energy transition narratives feature as supporting elements within the lab's framework, embedded in national strategies like the 2030 Mobility Master Plan. While the lab concentrates on enhancing rural mobility through self-organization and co-creation, climate protection exists as one of several sustainability objectives, alongside public services, social inclusion and local economic development. The lab functions as an intermediary, connecting broader climate goals with local needs by positioning climate protection measures as opportunities for autonomous regional development rather than externally mandated requirements. The lab emphasizes rural areas as innovation spaces where existing social networks, local knowledge, and community resources are networked and activated to generate mobility solutions. The focus lies on connecting and mobilizing what is already present in these communities, such as underutilized vehicles, neighborhood relationships, and local problem-solving capacity to create sustainable mobility alternatives through grassroots innovation.

The power dynamics are further shaped by the lab's tripartite structure of strategic, community, and implementation partners. While seemingly democratic, this structure creates informal hierarchies through differential access to resources and decision-making processes. Strategic partners, primarily administrative bodies, maintain the ability to determine which innovations are considered feasible and worthy of support. By including mobility avoidance strategies through initiatives like coworking spaces, the lab expands beyond traditional transport-focused solutions to embrace broader transformative approaches. This suggests a more complex understanding of rural mobility that encompasses not just movement but also its prevention through local infrastructure development. The lab thus emerges as a hybrid institution that mediates between formal administrative structures and informal civil society initiatives.

The lab's role as mediator between different power spheres – administrative, academic, economic, and civil society – creates a space where innovation can emerge within defined but negotiable boundaries. On one

side negotiation takes place at the institutional level, where the tripartite structure of partners negotiates priorities despite strategic partners having financial control. The document shows administrative bodies must engage with community partners who contribute valuable local knowledge. On the other side negotiation is exemplified through research by for example the Neighborhood Car where the innovation process itself becomes a negotiation site between formal structures and grassroots initiatives. The community-created car-sharing system receives lab support while being connected to broader mobility objectives. This dual approach enables the lab to function as a "hybrid institution" where ongoing interactions allow continuous recalibration between top-down policy objectives and bottom-up community needs.

While the lab's institutional embedding within existing power structures could be seen as reproducing traditional center-periphery relations, it creates new spaces for transformation. Through local presence and support for bottom-up initiatives, the lab enables rural communities to shape their mobility futures while providing the stability necessary for lasting change. This shows how institutional structures can be strategically leveraged to empower rural communities in mobility transitions. The research demonstrates how mobility labs serve as "critical intermediary spaces" where dominant policy narratives can be reconstructed, leading to more socially embedded and locally responsive climate action. This approach shares important similarities with the historical transformation processes analyzed by Van der Craats and Van Lierop in Amsterdam's transition away from car dominance. Their research identifies how the convergence of social movements, crisis events, research, and political leadership created conditions for systemic change, comparable to how the LML creates a platform for multiple stakeholders through participatory processes.

A review of earlier analyses of the discourse on Austrian policies in energy and mobility transitions reveals that the state of mobility in "the rural" has been identified as "*deficient*" or trapped in contradictions of the NECPs statement by "*connecting and mobilizing rural areas*" (page 127). Concurrently, the "*principle of avoidance (of non-essential transport) shifting (to efficient modes of transport) and improvement (of the technologies used)*" (page 83), rural mobility labs can delve deeper into ascertaining which means of transport can be avoided, or improved, or shifted, or eventually need to be maintained to generate baseline acceptance for transition agendas. The *Mobilitätspaket Niederösterreich 2023–2027* states that "*the volume of passenger transport must be kept nearly constant*" (page 21), and

the mobility lab can support this agenda point by ascertaining which forms of passenger transport are required to maintain rural livelihoods. This in turn implies generating positive feedback on this changing environment for mobility and transport. It is hypothesized that the concept of rural mobility labs can mitigate backlash and resistance to change in rural areas by addressing the ambiguities of top-down climate policies, as previously analyzed in the documents, and by advancing the *Mobilitätspaket Niederösterreich* agenda to generate acceptance through "*enlightened and rational discourse*", whereas for now the National Forum for Climate-Neutral Mobility (NFKM) serves as the sole point to voice feedback about its policies.

6. Results and discussion

Based on the discourse analysis of Austria's rural mobility transformation policies, several key conclusions emerge. Our research confirms the presumed urban-rural divide in how mobility transitions are conceived and implemented across different administrative levels, while revealing additional insights into the mechanisms through which this divide operates. National policy documents like the NECP and Mobility Master Plan 2030 demonstrate an urban-centric bias, with rural areas primarily framed through deficit-oriented narratives within the urban-rural divide storyline and treated as objects of intervention rather than spaces of innovation. This discursive construction of rurality through deficiency – characterized as demographically declining, economically challenged, and mobility-deprived – reinforces power asymmetries that position urban centers as progressive drivers of transition while marginalizing rural perspectives and knowledge. The analysis exposes sophisticated power mechanisms operating through technical expertise and bureaucratic structures. While higher-level policies employ ecological modernization narratives and emphasize participation, the actual governance mechanisms maintain traditional top-down control. This is particularly evident in the National Forum for Climate-Neutral Mobility, where participation is carefully channeled and controlled. The NECP's extensive use of scientific and technical language serves to depoliticize fundamentally political choices, presenting decarbonization as a primarily technical challenge while obscuring underlying value conflicts and distributional impacts. Similarly, the Mobility Master Plan 2030's rhetoric of

inclusivity masks its authoritative governance structure, where citizens are positioned as objects of intervention rather than co-creators of mobility futures.

The contrast between document rhetoric and institutional design is especially notable in the divergence between stated commitments to rural mobility and the ambiguity surrounding implementation mechanisms. While the NECP articulates objectives of "connecting and mobilizing rural areas," it simultaneously advocates for transport "avoidance" without reconciling this apparent contradiction or offering mobility alternatives that are viable in rural communities. This strategic ambiguity allows policy-makers to maintain the appearance of comprehensive climate action while avoiding politically sensitive discussions about the potential trade-offs between emission reduction targets and rural mobility needs. Furthermore, the document reveals a conflicting narration about Austria's energy transition in mobility. The dominant economic modernization storyline frames decarbonization as an opportunity, positioning Austria as a technological pioneer in electromobility and public transport expansion. However, these narrative struggles to incorporate rural contexts where neither electromobility nor conventional public transport present viable alternatives to the private car given current infrastructure and settlement patterns. The result is a transition vision that implicitly prioritizes urban contexts while leaving rural communities without clear pathways toward low-carbon mobility that meets their specific needs.

However, the research also identifies potential pathways for more inclusive transition governance. The LML case demonstrates how hybrid institutions can mediate between administrative requirements and local needs. By creating spaces for negotiation between different power spheres, such labs enable rural communities to actively shape mobility solutions while maintaining necessary institutional stability. The lab's support for initiatives like "*Nachbarschaftsauto Rafings*" illustrates how community-based innovations can emerge when local knowledge is valued and external support is provided without imposing predetermined solutions. These intermediary spaces allow for adaptations of transition pathways that respect rural specificity while still advancing broader climate objectives.

The persistence of bureaucratic resilience, as seen in Lower Austria's *Mobilitätspaket*, suggests that administrative structures can maintain environmental policy direction even under politically contested conditions. The document's depoliticized, matter-of-fact treatment of mobility planning represents a striking contrast to the ideologically charged rhetoric of the

FPÖ Vice-governor officially responsible for its implementation. This separation between administrative practice and political discourse demonstrates how bureaucratic institutions can provide continuity in climate policy implementation despite shifting political winds. Yet this same resilience raises questions about democratic legitimacy and the growing disconnect between policy implementation and public discourse on climate action. The fragmentation of responsibilities across administrative levels also creates coordination challenges. While federal strategies like the Mobility Master Plan 2030 set ambitious targets for rural accessibility, implementation authority rests primarily with state and local governments, creating potential imbalances between vision and execution.

The discourse analysis also reveals how language choices and narrative framing serve to either enable or constrain rural agency in the transition process. The technocratic language prevalent in federal documents positions rural communities as passive recipients of expertise and support rather than as knowledge-holders and innovators in their own right. This contrasts sharply with the LML's discursive framing, which acknowledges rural deficits while simultaneously recognizing rural resources and potential. By framing rural communities as capable of co-producing solutions rather than merely implementing externally designed interventions, the lab creates space for more equitable power relations in the transition process. Looking forward, Austria's administrative system will likely continue to provide stability for transition processes while potentially limiting the pace of change. The challenge for future policy development will be finding ways to harness the continuity advantages of bureaucratic inertia while creating institutional mechanisms that can accelerate transformation where needed, particularly in addressing the specific mobility challenges of rural regions. This will require rethinking dominant discursive constructions of rurality to recognize the diversity of rural contexts and their potential contributions to innovative transition pathways.

These findings demonstrate how participatory approaches can help overcome traditional barriers to climate policy implementation by creating positive feedback loops between local needs and policy development, ultimately leading to more effective and socially embedded transition pathways addressing the institutional constraints that often limit ambitious climate action in democratic contexts (Blühdorn et al., 2019; Hausknost, 2020). This conclusion connects with, and reinforces, insights from across previous chapters: Isaksson, Ryan, and Trygg's analysis of planning organizations demonstrates how path dependencies constrain transformation

but can be overcome through new institutional arrangements; Van der Craats and Van Lierop's historical study shows the importance of multiple converging factors in challenging car-centric mobility paradigms; Khan and Johansson reveal how policy mixes must address social norms and institutional barriers to be effective; and Taylor and Fujita emphasize the critical role of behavioral factors in acceptance of new mobility solutions. Collectively, these perspectives complement our finding that effective rural mobility transitions require disrupting urban-centric power dynamics through hybrid institutions that legitimize local knowledge while maintaining necessary connections to formal governance structures.

Going back to the initial question, whether rural communities, local companies and civil society can become active participants in transport energy transitions rather than passive subjects of climate and energy transition policies, or even disruptive opponents of democratic governance, the answer to conclude this chapter can give some optimistic possibility. Despite recent backlashes and the rise of climate-sceptic politics, there are indicators for positive developments that should be further built upon. The level of renewable energy in public transport has never been higher in Austria's and European context. The institutionalization of climate action and energy transition in administrative bodies is advancing the (slow) implementation of its policies and shows remarkable resilience against politically hostile environments. The agonistic and even disruptive resistance against transitions can indeed serve as a "*political (re)source*" (Machin, 2020) to identify blind spots in energy transitions and strengthen policies by addressing what and who have been left out. Rather than dismissing rural opposition to urban-centric transition visions as mere climate skepticism, policymakers should recognize this resistance as valuable feedback that highlights the need for more contextually appropriate approaches. The discursive construction of rural areas in national policy documents as primarily deficient or problematic must give way to more balanced framings that recognize rural communities' legitimate mobility needs, innovative potential, and crucial role in the broader transition process.

As we exemplify by the *land.mobil:LAB* (LML), bottom-up approaches can help to capture and configure transition pathways that achieve broader social acceptance by challenging deeply entrenched behavioral patterns in mobility while still respecting rural realities. By creating spaces where rural communities can participate as knowledge producers rather than mere knowledge recipients, such intermediary institutions facilitate the development of socially embedded transition pathways that align climate objectives

with local needs, capabilities and opportunities. This approach offers a promising alternative to top-down governance models leading the transition and risking generating backlash and entrenching urban-rural divides in the transition process. Therefore, we conclude this chapter with the remark: we are on the right track, but the entire route is still under construction.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used the LLM Claude and DeepL in order to improve readability and language. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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CHAPTER SIX

How crises and social movements can build momentum for alternative mobility visions

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Abstract

The need for alternative mobility visions is critical, as current systems in many regions remain environmentally and socially unsustainable, heavily reliant on fossil fuels, and significant contributors to greenhouse gas emissions. These systems exacerbate air and noise pollution, accelerate global warming, increase traffic collisions, and deepen social inequalities. While the urgency to decarbonize mobility systems and transition to post-fossil fuel solutions is widely recognized, a persistent 'lock-in' limits the ability to imagine viable alternatives. Although scholars increasingly call for alternative mobility visions, the challenge lies in understanding how such visions can be implemented in practice.

In this chapter, we use the conceptual framework of punctuated equilibrium theory to understand how complex social systems change. The theory posits that most social systems exist in an extended period of stasis, punctuated by sudden shifts – such as crises – that lead to radical change. We use this framework to show how the convergence of social movements, research, and political will has historically laid the foundation for alternative mobility narratives, ultimately influencing policy decisions. We demonstrate that these elements must be in place for moments of disruption to translate into lasting institutional and policy change.

Drawing on archival research and case studies from the Netherlands, we explore how activism—when aligned with research, political will, and crises—has facilitated transitions toward sustainable, non-fossil-fuel transport modes. By reviewing historical examples, we identify the conditions necessary for systemic change and propose strategies for leveraging future crises to advance equitable and sustainable mobility systems.

1. Introduction

"Shift to sustainable mobility", "transform the transport system", "transition to sustainable mobility" – these frequently used phrases in contemporary transport planning discourse underscore the need to decarbonize and reimagine how we move through the world. While the need to (re)imagine our transport system is widely acknowledged, Brömmelstroet et al. (2022) argue that mainstream mobility thinking – and many proposed alternatives – remain narrowly framed. According to these authors, mainstream mobility thinking emphasizes the role of transportation in economic and urban growth, individual speed, and system efficiency, while "obscuring its contribution to inequality and unsustainable development on a global scale". This dominant narrative also downplays the increasingly problematic societal and environmental externalities of mobility, such as its significant role in climate change, air pollution, social exclusion, traffic fatalities, public health issues, and landscape degradation (Brömmelstroet et al., 2022; Von Schönfeld and Ferreira, 2022). Breaking free from this "lock-in" vision requires more than technical solutions—it demands cultural and narrative shifts. Ruhrort (2022) highlights the power of competing narratives to shape

political will, noting: "Competing narratives of change may play a central role in deciding which version of a future mobility system will gain broad political support and become reality" (p. 135).

Despite growing interest in (re)imagining future mobility and supporting alternative narratives, there is—aside from a few exceptions (e.g., Bruno et al., 2021)—limited reflection on how past mobility systems have been challenged, replaced or transformed. Meanwhile, scholars like Sandercock (2003, pp. 150–151) emphasize the value of historical perspective: "To imagine the future differently, we need to start with history, with a reconsideration of the stories we tell ourselves about the role of planning in the modern and postmodern city. In telling new stories about our past, our intention is to reshape our future." To contribute to a deeper understanding of the historical dimensions shaping urban form and mobility systems, this chapter examines the case of Amsterdam through both historical accounts and theoretical framing, illustrating how the city navigated and moved away from its entrenched mobility paradigms.

Amsterdam's history offers valuable insight into how entrenched mobility systems can be challenged and reimagined—ultimately contributing to future energy transitions, which are closely interconnected to urban mobility systems. The city's transformation over the past century shows that alternative mobility futures are not only possible but achievable when activism, research, political will, and crises converge to disrupt dominant narratives and generate momentum for change (Bruno et al., 2021). To grasp the extent to which mobility systems have changed, consider this early 20th-century account from Amsterdam:

'If there is one category of people who still need to be educated on matters of traffic, then those are the pedestrians. Not conscious that they are in a busy traffic corridor, nor taking account all that is moving around them, they go on their way with their heads in the clouds. They ignore sidewalks, preferring the middle of the street. Yes indeed! They cross without looking… Entire families socialize on the street" (as cited in Jordan, 2013, p. 30),

This 1906 account reflects an era when human-powered mobility dominated urban life. Streets were shared by pedestrians, pushcarts, bicycles, horses, and trams—free from the emissions and environmental consequences of motorized vehicles. Fast forward a century, and the contrast is stark. In a 2023 local newspaper, a modern-day Amsterdammer[1] expresses his frustration:

[1] An 'Amsterdammer' is a resident of the municipality of Amsterdam.

"For years, I've been infuriated by the excessive number of cars that flow through the city like a constant stream of roaring ants, while I cycle across all parts of the city daily" (Fahrenfort, 2023, translated from Dutch by the authors).

This quote captures the dramatic transformation of Amsterdam's urban mobility. Once thriving without fossil-fuel-powered transportation, the city—like many others—was reshaped by the rise of the automobile. Fig. 1 illustrates the 2019 modal split of Amsterdam.

Initially celebrated as a symbol of progress and modernity (Brownell, 1972), the car came to dominate both physical infrastructure and cultural narratives. Innovations such as Fordist conveyor belt production lines made cars increasingly affordable, particularly in industrialized nations (Sheller and Urry, 2000), and urban planning evolved accordingly. In Amsterdam, as elsewhere, planners made way for the car by prioritizing wide roads, parking, and streamlined corridors—often at the expense of public space and non-motorized modes of travel.

The car's ascendancy was not purely organic; in the Netherlands, as in many other countries around the globe, it was actively promoted by a coalition of stakeholders—including the oil industry, car importers, and pro-road associations (Mattioli et al., 2020). Lobby groups such as *Stichting Weg* (Road Foundation), supported by international organizations like the International Road Federation (IRF), played influential roles in shaping a car-centric agenda (Verkade, 2020a; Eskes, 2020). This transformation produced numerous harmful externalities. Globally, transportation today accounts for around 22 % of CO_2 emissions, with road passenger vehicles responsible for 40 % of that total (Nykvist and Whitmarsh, 2008; Ritchie, 2020). As shown in Fig. 2, car ownership in the Netherlands rose rapidly from the 1930s onward, paralleled by increased fossil fuel consumption between 1965 and 2023.

These trends in car ownership and fossil fuel use in the Netherlands demonstrate the interdependence of mobility and energy systems, specifically fuel consumption, over the past century.[2] Beyond its environmental toll, car-centric planning has led to a host of challenges—traffic fatalities,

[2] Notably, fossil fuel consumption stagnated and declined during the COVID-19 pandemic, reflecting reduced mobility during lockdowns and shifts in travel behavior. Additionally, the introduction of subsidies for electric vehicles in 2020 (Ministerie van Infrastructuur en Waterstaat, 2020) may contribute to a longer-term decrease in fossil fuel dependency in the Netherlands, depending on the source of the used electricity.

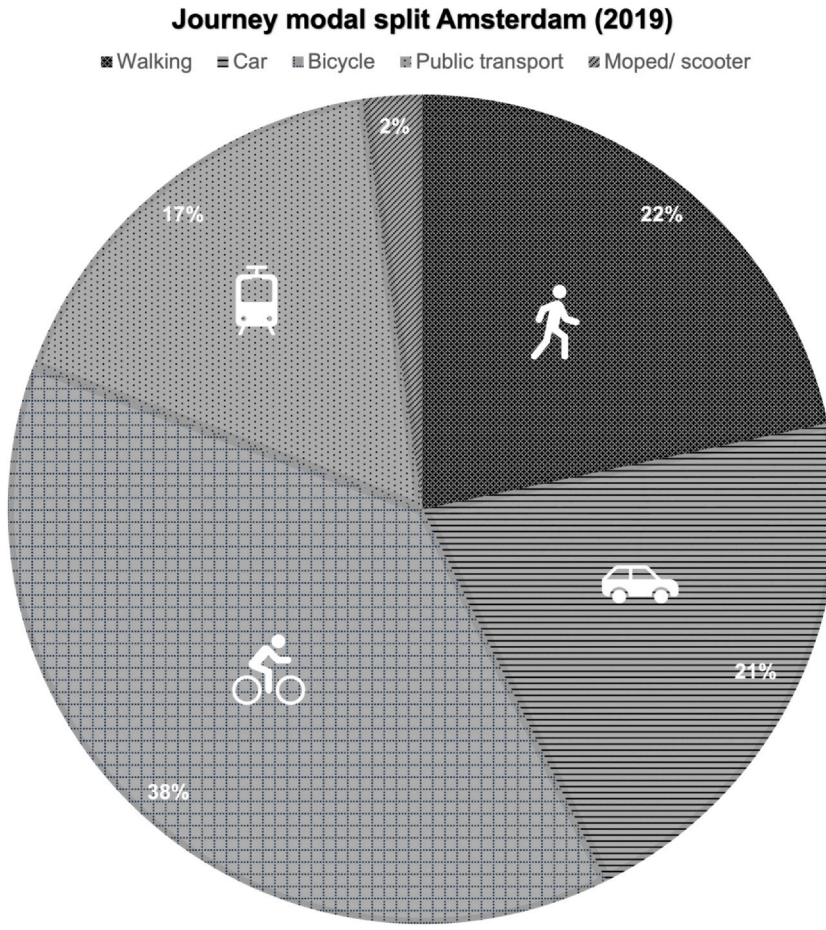

Fig. 1 Modal split of trips to, from, and within Amsterdam (by residents and visitors, excluding tourists) (Gemeente Amsterdam, 2021). Gemeente Amsterdam (2021) *Amsterdamse Thermometer Bereikbaarheid 2021 ATB*. https://openresearch.amsterdam/nl/page/74100/amsterdamse-thermometer-bereikbaarheid-2021-atb#:~:text=Met%20at%202021%20zijn%20recente,van%20mobiliteit%20inzichtelijk%20te%20maken. (Accessed 7 February 2025).

noise pollution, social exclusion, and reduced walkability. As Sheller and Urry (2000) observe, the automobile transformed urban landscapes, replacing pedestrian-oriented environments with wide roads, strip malls, and billboards.

However, the rise of car-centric planning also provoked backlash. Coalitions of grassroots activists, political actors, and researchers began to

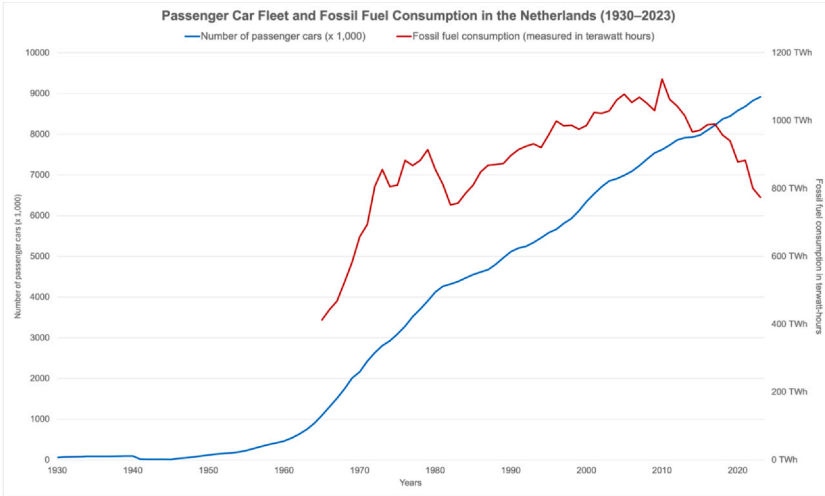

Fig. 2 The rise of car ownership and fossil fuel consumption in the Netherlands (1927–2023). Statistics Netherlands (2019) *Over 200 times more passenger cars than in 1927.* https://www.cbs.nl/en-gb/news/2019/51/over-200-times-more-passenger-cars-than-in-1927 (Accessed 28 January, 2025). Statistics Netherlands (2025) Hoeveel personenauto's zijn er in Nederland? https://www.cbs.nl/nl-nl/visualisaties/verkeer-en-vervoer/vervoermiddelen-en-infrastructuur/personenautos (Accessed 28 January, 2025). Our World In Data (2024) Fossil fuel consumption. https://ourworldindata.org/grapher/fossil-fuel-primary-energy?tab=chart&country=~NLD (Accessed 28 January, 2025).

challenge this narrative in Amsterdam. As Bruno et al. (2021) argue, competing narratives alone are not enough. Empowering a new mobility vision requires grassroots mobilization and political support to generate momentum and broad public backing. Local activists often play a pivotal role in advancing alternative mobility narratives and driving modal shifts. Understanding how activism and crises interact is particularly important in identifying pathways to systemic transformation.

This aligns with the concept of the punctuated equilibrium, a social theory that helps explain how change occurs in complex systems. This theory posits that most social systems experience long periods of stasis, interrupted by sudden shifts that lead to radical transformation (Baumgartner and Jones, 1993). In what follows, we use this conceptual framework to explore how activism, political will, and research laid the foundation in Amsterdam to enable modal shifts and supported the broader energy transition. We show how the convergence of social movements, research, and crises has historically generated momentum for alternative mobility narratives during moments of

disruption, ultimately influencing policies and political decisions. The core question that this chapter explores is: What lessons can be drawn from past instances where social movements and crises intersected, and how did these interactions enable the adoption of an alternative mobility system?

Our analysis reveals three overlapping phases in Amsterdam's response to the car-centric planning paradigm (1930–1967) (see Fig. 3). During the post-war period, the city embraced car-centric urban development, restructuring its infrastructure to prioritize vehicular traffic. Traditional small-scale residential buildings in the city center were replaced by office buildings, department stores, banks, hotels, and cultural complexes. However, by the mid-1960s, the negative consequences of car dominance—rising fatalities, worsening air pollution, and the erosion of public space—sparked growing resistance.

The first of resistance phase saw the rise of *ludiek verzet* (playfully engaged protest) and civil disobedience (1960s–early 1970s), as grassroots movements began contesting the growing car dominance. The second phase was marked by a moment of disruption, particularly the 1973 Oil Crisis, which accelerated momentum and expanded social support for alternative mobility policies (1973–1977). In the third phase, characterized by research and institutionalization (1974–1990), activists and academics transitioned into policymaking roles, formalizing new mobility strategies. These phases, while distinct, were deeply interconnected. Protest continued throughout the institutionalization period, and research played a critical role in shaping long-term urban planning and transport policies.

This chapter demonstrates how the presence of research, activism, and political will is vital to unlocking entrenched mobility paradigms and reimagining urban transport systems that are environmentally, socially, and economically viable. Drawing on archival research, it traces key moments in Amsterdam's mobility history—from the initial embrace of fossil fuel-driven

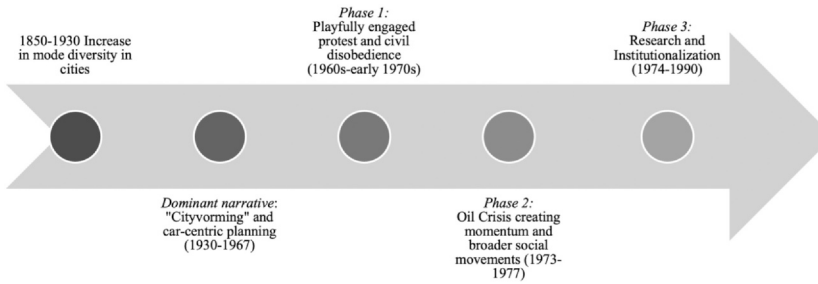

Fig. 3 Timeline of phases influencing the adoption of alternative mobility narratives and modal shifts towards post-fossil fuel transportation.

cars to grassroots resistance and eventual systemic change. The Amsterdam case underscores the potential of activism and crisis to act as catalysts for transformative shifts in urban mobility, offering critical lessons for navigating the global transition toward a post-fossil fuel transport future.

2. Dominant narrative: The rise of car-centric urban planning and *cityvorming*

Before examining the three phases that challenged the dominant mobility narrative of *cityvorming* (city-making) and car-centric planning reliant on fossil fuels, it is important to understand how this narrative developed. This section explores how Amsterdam's historical embrace of *cityvorming* facilitated the rise of automobiles, reshaping the city's urban fabric and mobility systems within an international context.

2.1 Amsterdam's urban transport history in an international perspective

Amsterdam (Fig. 4)—the capital of the Netherlands, with a population exceeding 931,748—is projected to reach 1.2 million residents by 2050 (Gemeente Amsterdam, 2025). Known for its rich cultural heritage, vibrant urban life, and human-centered design (Yeager, 2024), Amsterdam is internationally celebrated as one of the world's most bicycle-friendly cities, supported by extensive cycling infrastructure, progressive planning, and significant public funding aimed at facilitating and promoting active travel infrastructure, such as dedicated bike lanes, traffic-calming measures, and safe intersections (Van Der Zee, 2015). However, this has not always been the case; historically, the city's transport system was markedly different.

In the early 19th century, Amsterdam—like many major European cities—was in economic and social decline (Kahn and Van Der Plas, 1999). Between 1795 and 1815, the city's population dropped from 217,000 to 180,000. Its infrastructure deteriorated: canals became stagnant and unsanitary, filled with waste and debris, while bridges crumbled (Visser and Van Engelen, 2024). The French occupation, beginning in 1795, led to the fall of the Dutch Republic and the imposition of centralized rule, weakening Amsterdam's autonomy and exacerbating its economic hardship. After the French withdrew in 1813, Amsterdam remained financially strained and, unlike other European capitals, received little national assistance for recovery (Wagenaar, 2024; Koops, 2024).

Fig. 4 Historical evolution of Amsterdam. Gemeente Amsterdam (2024) *Maps data*. https://maps.amsterdam.nl/open_geodata/ (Accessed 8 February 2025).

Though the early 19th century saw limited advances in land transportation, the arrival of railways changed everything. Railways shrank distances, enhanced comfort, and redefined urban space. By the 1890s, passenger trains exceeded 100 km/h in some regions (Smil, 2017). The first passenger steam train began operating between Manchester and Liverpool in 1830, marking a new era in mobility. The Netherlands opened its first railway line between Amsterdam and Haarlem in 1839. Located approximately 20 kilometers west of Amsterdam, Haarlem was an integral part of the Amsterdam metropolitan area (van Melle and Wisman, 2011). By 1900, rail had become the Netherlands' most important mode of transport, mirroring trends in other industrialized nations. The growing railway network enhanced mobility, stimulated economic growth, and strengthened national cohesion (Canon van Nederland no date). Amsterdam began recovering from its prolonged decline. Population growth and ambitious infrastructure projects—such as the North Sea Canal and Central Station—reconnected the city to international trade and revitalized its economy (Kahn and Van Der Plas, 1999; Van Engelen, 2024). This period of modernization paralleled global shifts.

Nevertheless, Amsterdam's urban mobility—just like that of other cities—was facing a crisis: mobility still relied heavily on horse-drawn transport, with alternatives seemingly unthinkable. Consequently, horse manure overwhelmed the streets, creating unbearable stench and unsanitary conditions. In 1875, the *Amsterdamsche Omnibus Maatschappij* (AOM)[3] inaugurated its first horse-drawn tramline, connecting the Plantage district (POI 3) with het Leidseplein (POI 2), a prominent cultural square (Gemeente Amsterdam, 2024). By 1894, *The Times* predicted, "In 50 years, every street in London will be buried under nine feet of manure." This became known as the "Great Manure Crisis of 1894″ (Johnson, 2023; Versteeg, 2019). By 1900, the municipality had acquired AOM and established the *Gemeentetram Amsterdam* (GTA).[4] This marked the city's first major energy transition in public transportation. Between 1900 and 1906, nearly all tramlines were electrified, replacing horse-drawn carriages with electric trams, significantly improving efficiency, connectivity, and public health outcomes (Wietsma, 2008). Additionally, bicycles—introduced around 1880—and cars, which first appeared in Amsterdam in 1896, reshaped mobility and further influenced urban planning (Baar, 1992). Like today, electric mobility and the bicycle were seen as clean alternatives to outdated modes. These modal shifts—including human-powered modes as well as collective transportation—echoed earlier responses to urban challenges.

2.2 The rise of cityvorming

However, the rise of trams and buses proved temporary. After World War II, a new era began: that of the private automobile. In many countries—starting with the United States in the 1920s—car manufacturing became a leading industry, and later Germany and Japan dominated global exports (Smil, 2017). The Netherlands, however, had no major domestic car industry. Still, car use supported entire sectors—steel, rubber, glass, plastics, and oil—and required massive public investment, and employed many people. The Netherlands was home to a powerful fossil fuel sector, anchored by Shell. Formed in 1907 through a merger between Royal Dutch Petroleum and the British "Shell" Transport and Trading Company, Shell became a key driver of oil-based transport and energy systems (Boon, 2014). Due to these vested interests, a strong lobbying effort emerged. Dutch engineers were invited to

[3] Amsterdam Omnibus Company, this was a 19th-century private transport company that operated horse-drawn omnibuses and later early trams.

[4] Municipal Tramway of Amsterdam.

the U.S.A. to study car-oriented planning, such as road design and sub-urbanization, and campaigns promoted the car as a symbol of personal freedom. Through the Marshall Plan (1947 onward), this ideology spread to the Netherlands (Verkade and Brömmelstroet, 2020). Dutch engineers joined international road lobby groups and attended conferences of the IRF,[5] funded by the U.S.A. during the Marshall Plan era. These networks helped normalize car-centric planning in the Netherlands (Eskes, 2020), shifting Amsterdam's modal split toward car dependency and reshaping its urban planning.

Influenced by modernist architects like Le Corbusier and designers such as Norman Bel Geddes, who linked cars to prosperity, urban planners reimagined cities for speed and efficiency of movement. Suburbs, shopping malls, and business parks sprang up—all built around the car (Versteeg, 2019). As a consequence, a process known as *cityvorming* (city-making) took root across Europe. This involved transforming city centers to prioritize economic functions over residential ones (Jong, 2016; Visser and Van Engelen, 2024). In Amsterdam, the idea of *cityvorming* coincided with economic resurgence. Infrastructure projects catalyzed this shift as the canal ring and historic center transitioned from residential areas to commercial hubs (Wagenaar, 2024; Duivenvoorden, 2018). Many small-scale residential buildings were replaced by offices, banks, insurance companies, department stores, and cultural venues. Iconic modernist structures like De Bijenkorf—a luxury department store at Dam Square, an important public square in the historic city center of Amsterdam (POI 1)—became symbols of Amsterdam's new commercial identity (Jong, 2016).

2.3 Growing influence of cars on (urban) planning

In the late 1890s the car was a luxury only accessible to the elite. Yet, its introduction onto city streets would soon profoundly impact the planning of the Netherlands (Lintsen et al., 2003; Gemeente Amsterdam, 2020a; Ons Amsterdam, 2019). By 1899, just three years after the first car arrived in Amsterdam, politicians like Cornelis Lely were already envisioning a future in which cars would play a pivotal role in long-distance travel. At that time, fewer than 1500 people across the Netherlands owned a car, predominantly from the wealthiest strata of society. Nevertheless, Lely anticipated that the car would evolve from an exclusive possession into a

[5] International Road Federation, a lobbying organization of oil companies, automobile manufacturers, and tire makers.

mass-produced, efficient mode of transport. His vision included the need for new highways, a separation of traffic types, and the elimination of obstacles to free-flowing traffic (Wilschut, 2009).

Lely foresaw that the car would have profound spatial implications for both cities and rural areas, shaping how these spaces were developed (Autosnelwegen, 2025a). However, while bicycles were financially accessible to many Amsterdammers around the time of the First World War (1914–1918), cars remained largely confined to the elite. By the 1930s, there were already 200,000 bicycles in the city, and bicycles accounted for one-third of all traffic. In contrast, cars made up only 5 % of traffic at the time (Ons Amsterdam, 2019).

To address the growing demand for traffic solutions, urban planners in Amsterdam began considering structural changes to the city (Voogd, 2022). During the 1950s and 1960s, planners turned again to *cityvorming* and modernist urban planning concepts that emphasized *functiescheiding* (the separation of functions): the division of urban areas into distinct zones for living, working, traffic, and recreation (Gramberg and Truijens, 1993; Harbers, 2009). This marked a shift from the *Algemeen Uitbreidingsplan*[6] (Van Eesteren, 1935), which, despite being developed a century earlier, integrated many elements associated with today's "15-minute city" ideals. Rooted in Garden City principes, the AUP emphasized green spaces, recreational areas, and notably, cycling infrastructure. Maps included detailed cycling times from expansion areas to the city center, with most routes falling within 20 minutes (Feddes, 2025, p. 266). While the AUP did not explicitly promote car dominance, it accommodated the growing presence of automobiles without losing sight of human-scaled mobility (Krombeen, 2017).

After World War II, however, Amsterdam's urban planning embraced a car-centric perspective -as did many other cities in industrialized western regions- prioritizing car traffic and the reorganization of the city to accommodate it. These planning initiatives were also assisted by the invention of Ford's mass-produced car, which, for example, motivate and largely enabled suburban development such as Levittown, Long Island, New York. In Amsterdam, motorways were gradually replacing the role of the tram (Kahn and Van Der Plas, 1999) The post-war era saw the ideal of

[6] The General Extension Plan for Amsterdam (*Algemeen Uitbreidingsplan*, or AUP) was an urban expansion blueprint grounded in modernist planning principles, emphasizing the separation of residential areas, workplaces, traffic, and recreational spaces.

progress embodied by wide boulevards, parking garages, and efficient traffic corridors. Planners envisioned Amsterdam as a functional space optimized for car traffic, often at the expense of pedestrian and cyclist-friendly environments. Cars became symbols of modernity, shaping infrastructure and neighborhood designs accordingly (Voogd, 2022).

Yet even in this early phase, opposition to car-dominated planning began to emerge. As early as 1955, the heritage organization *Vereniging Heemschut*, with figures such as Geurt Brinkgreve (1917–2005) at the forefront, raised objections to the demolition of historic streetscapes in central Amsterdam (Eggenkamp, 2005). Brinkgreve, who briefly served on the Amsterdam city council from 1958 to 1966, became a key voice in resisting redevelopment projects that prioritized modernist architecture and car accessibility over historical preservation. One prominent example was the construction of the ABN Bank building on the Vijzelstraat—a large office complex that replaced a row of historic canal houses and required the street to be widened to accommodate growing traffic volumes (van Melle and Wisman, 2011). Although resistance to the project was ultimately unsuccessful in the late 1960s, it was broadly supported and helped bring preservation concerns into public and political focus. Brinkgreve's continued activism played a decisive role in halting later traffic-related demolition plans. While mass protests would not erupt until the 1970s, these early preservationist efforts laid the groundwork for a broader shift in how urban modernity and mobility were contested in Amsterdam.

2.4 The Jokinen report: A radical vision for Amsterdam's future

A particularly illustrative example of this car-centric approach is the Jokinen Report (1962–1967), authored by American traffic expert Prof. David A. Jokinen. Jokinen was invited by the car lobby group *Stichting Weg* (Road Foundation) as an expert in car-centric city design to promote and facilitate car use (Eskes, 2020). In his report *Geef de Stad een Kans* (Give the City a Chance), Jokinen proposed a radical reimagining of Amsterdam's urban landscape. His vision included expressways, multi-level interchanges, and large-scale parking garages that would require the demolition of historic neighborhoods such as Kattenburg, De Nieuwmarktbuurt, De Dapperbuurt, and De Jordaan. Jokinen emphasized the separation of transportation modes—cars, bicycles, and pedestrians—for maximum efficiency. Innovative ideas, such as pedestrian bridges and traffic-free shopping streets, were central to his proposals (see Fig. 5).

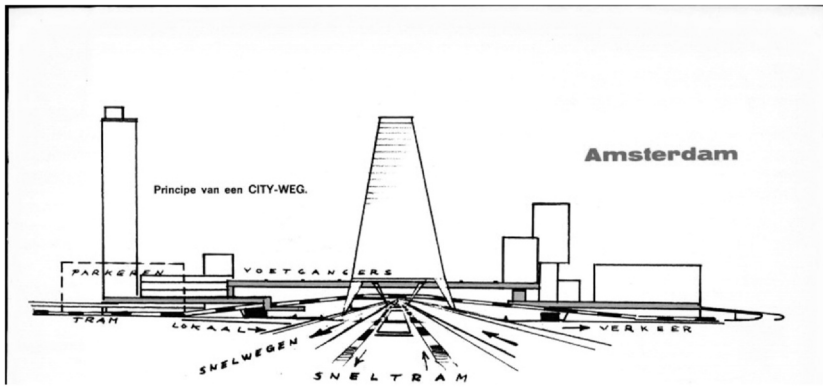

Fig. 5 The principles of a *CITY-WEG* (City road) from Jokinen's plan. Das (1967) *Principe van een CITY-WEG*. [Illustration] In: Jokinen, D.A. 1967. *Geef de stad een kans, SWOV: Institute for Road Safety Research*, p. 55. 's-Gravenhage, Netherlands: Stichting Weg. https://swov.nl/sites/default/files/bestanden/downloads/A%20887.pdf.

The Jokinen Report underscored the tension between modernization and preservation. On one hand, it sought to solve traffic congestion and accommodate growing car ownership; on the other, it threatened Amsterdam's historic fabric. Jokinen himself acknowledged the complexities of urban planning, writing: 'For every traffic and urban design problem, multiple solutions are possible. The choice ultimately depends on the priorities policymakers assign to various considerations, transforming a technical problem into a policy issue—or even a political one' (Jokinen, 1967, p. 107, translated from Dutch by the authors).

The report also highlighted the need for interdisciplinary collaboration in urban planning, emphasizing the importance of combining scientific expertise with creativity and boldness: 'To restore a square's original function and beauty after imposing a new function, such as a parking lot, requires a collaboration between traffic specialists, urban planners, sociologists, and social psychologists—a synergy where scientific insight meets imagination and courage' (Jokinen, 1967, p. 109, translated from Dutch by the authors).

These plans reflect the mid-20th century's fascination with cars as symbols of progress and the belief that urban design should cater primarily to their needs. Illustrations from the Jokinen Report depict a transformed Amsterdam with eight-lane highways cutting through the city center, replacing historic streets and neighborhoods with skyscrapers, parks,

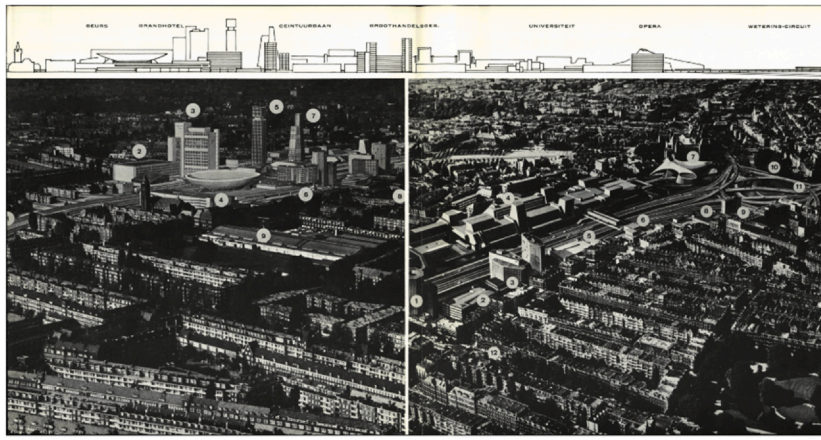

Fig. 6 Visualization of Jokinen's proposed plan. Perlot (1967) *Zuidelijke CITYWEG*. [Technical Drawing]. In: Jokinen, D.A. 1967. *Geef de stad een kans, SWOV: Institute for Road Safety Research*, pp. 86–88. 's-Gravenhage, Netherlands: Stichting Weg. https://swov.nl/sites/default/files/bestanden/downloads/A%20887.pdf.

parking garages, and office complexes (see Fig. 6). While many of these ideas were never fully realized, they highlight the far-reaching influence of car-centric urban planning on Amsterdam's development during this era.

The right page highlights point 7, a proposed opera house located next to the Rijksmuseum, the national museum of the Netherlands dedicated to Dutch arts and history. Both are situated at Museumplein, a prominent public square that hosts several of Amsterdam's key cultural institutions (see POI 9 on the map in Fig. 4) The plan also includes a highway (point 10) connecting major destinations, including cultural landmarks such as the opera house and the Rijksmuseum – a proposal that was never realized (Perlot, 1967, pp. 86–88). Additional elements from the plan illustrate the modernist urban vision of the time, emphasizing functional zoning and car accessibility. On the left page, point 2 marks a proposed conference center with a large parking garage; point 5 indicated a hotel integrated into a business complex; and point 7 shows the main building of a new university. On the righthand image, point 8 denotes another parking garage, while point 9 refers to planned student housing.

2.5 The start of urban renewal and the demolition of working-class neighborhoods

Following Prof. David A. Jokinen's proposals, the city of Amsterdam began implementing plans that prioritized wide streets, parking garages, and

vehicle accessibility. Entire neighborhoods, such as Kattenburg (see POI 4 on the map in Fig. 4), were demolished to make way for modernist housing developments aligned with *cityvorming* principles (Gramberg and Truijens, 1993; Harbers, 2009). Between 1962 and 1968, hundreds of homes in Kattenburg were razed, historic street patterns were erased, and long-standing communities were displaced (Duivenvoorden, 2018; Van Engelen, 2024). Streets like De Grote Kattenburgerstraat were widened from approximately 8 to 38 m, to accommodate car traffic (see Fig. 7). While some displaced residents returned to newly constructed housing complexes, many were permanently relocated (Heddema, 1973, p. 6).

These urban renewal projects reflected the *functiescheiding* (the separation of functions) ideals of the era. This approach prioritized broad streets, parking infrastructure, and car-friendly designs over the preservation of historical neighborhoods or pedestrian-friendly spaces (Voogd, 2022). Historic neighborhoods, built before 1860 and between 1860 and 1919, were similarly targeted for transformation, reinforcing the idea of the city center as a space for offices and large-scale facilities rather than residential living (Van Engelen, 2024, p. 202).

Although these projects were presented as embodiments of modernization and economic progress, they generated significant dissatisfaction among

Fig. 7 Photo of the beginning of the demolition and construction of Grote Kattenburgerstraat. Stadsarchief Amsterdam (1967 ca.) *Kattenburg, links begin Grote Kattenburgerstraat. Sloop, Gemeente Amsterdam Stadsarchief*. [Photo]. https://archief.amsterdam/beeldbank/detail/c85ff8e5–5ddf-68c4–45f0-dae550c548aa.

residents. The demolition of the neighborhood Kattenburg, in particular, became a focal point, exposing the social costs of urban renewal and the displacement of working-class communities (Heddema, 1973; Van Engelen, 2024). The combination of rising car ownership and the implementation of *cityvorming* principles ignited widespread discontent. This resistance played a key role in halting similar redevelopment plans in other neighborhoods.

Amsterdam's mid 20th century urban renewal efforts, which prioritized car traffic and economic growth, came to symbolize the tension between modernization and community preservation. Plans like those for Kattenburg represented the dominant vision of urban transformation but also highlighted the growing backlash from citizens dissatisfied with the social and cultural costs of these changes. This dissatisfaction would lay the groundwork for significant protests and shifts in urban policy in the decades to come (Verkade, 2020a).

2.6 *Phase one*: "Ludiek verzet" (playfully engaged protest) and civil disobedience

The first phase of "*ludiek verzet*" (playfully engaged protest) and civil disobedience (1960s–early 1970s) emerged in response to the rapid increase in car ownership and the growing dominance of cars in Dutch cities and urban planning. In 1960, the Netherlands had only 45 cars per 1000 inhabitants –significantly lower than neighboring countries like Belgium (82) and Switzerland (89) (Bruno et al., 2021). However, by 1970, Dutch car ownership had surged to approximately 200 cars per 1000 inhabitants, aligning with levels in Belgium and Switzerland (Filarski and Mom, 2011; Wolf, 2010). In Amsterdam alone, private car ownership exceeded 100,000 by 1964, doubling within just five years (Gemeente Amsterdam, 2020b). At the same time, bicycle use declined as urban infrastructure was increasingly redesigned to prioritize motorized traffic. As cars became the dominant mode of transport, road safety deteriorated, with a significant rise in traffic accidents and fatalities, particularly among cyclists and pedestrians (Voogd, 2022; Bruno et al., 2021). The growing concerns over these negative consequences fueled public discontent and laid the groundwork for early forms of resistance against car-centric urban planning (Bruno et al., 2021).

2.7 Early critique: Valderpoort's perspective

While car use and car ownership became increasing popular and even normalized, not everyone welcomed the car-centric city planning paradigm that grew out of this narrative. For example, civil engineer Willem

Valderpoort was one of the first to openly criticize the dominance of cars in urban spaces. In his 1953 booklet *De Zelfzuchtige Personenauto* (The Selfish Car), he described private car use as a "parasitic phenomenon" in which the societal cost far outweighed its economic benefits. Valderpoort challenged the notion that society should 'learn to live with the car,' asking whether this meant accepting pollution, carbon monoxide, and the loss of livable public spaces (Das et al., 1966, p. 82).

Initially, Valderpoort framed car ownership as a luxury enjoyed by a privileged elite, with the burdens—pollution, congestion, and infrastructure costs—falling on the broader population. However, by the late 1950s, increasing affordability and the rise of the used car market had made cars accessible to a broader segment of society. This democratization of car ownership amplified the societal burdens, lending further urgency to Valderpoort's warnings. While car ownership was no longer confined to the elite, the consequences of widespread motorization—environmental degradation, congestion, and social disruption—became impossible to ignore (Lintsen et al., 2003).

2.8 *"Ludiek verzet"* and happenings: Provo

The Provo movement (1965–1967) emerged as a countercultural force in Amsterdam, challenging authority and the status quo through satire and public "happenings"[7] (Gemeente Amsterdam Stadsarchief, 2019). Provo was a pacifist organization which sought to provoke societal reflection on the perceived complacency of a materialistic welfare state, which they argued had dulled the rebellious potential of the population. The movement addressed a wide array of emerging social issues, including free love, environmentalism, urban emancipation, art innovation, the dismantling of authority, and the democratization of society (Kennedy, 2016; Koops, 2019). Yet, Provo's significance extended beyond its critique of existing norms. Its members envisioned alternative solutions to the injustices and societal problems they identified, often proposing innovative and, at times, utopian ideas. While the movement's immediate and lasting success lay in challenging and dismantling traditional forms of authority in the Netherlands, its broader aim was to experiment with imaginative solutions to structural inequities and environmental concerns (Van Duyn, 1985; Koops, 2019). The movement's playful yet pointed critique, often referred to as "*ludiek verzet*" (playfully engaged protest),

[7] A happening is a spectacular public event that appears spontaneous but is actually pre-planned, intended to disrupt public order in a playful manner, thereby shocking people and ridiculing ideas perceived as rigid and outdated (Beeren, 1979).

became a defining feature of Provo's activism. Their creative and unconventional approaches not only captured public attention but also ignited widespread debates about urban mobility, environmental degradation, and societal progress (Furness, 2005; Bruno et al., 2021).

Provo activists were among the first to challenge the rapid motorization of Amsterdam (Furness, 2005). Coining the term *asfaltterreur* (asphalt terror), they critiqued cars for their monopolization of public space, air pollution, and the dangers they posed to pedestrians and cyclists (Van Duyn, 1985). Moreover, the construction of many highways and the high number of traffic fatalities also sparked the rage of Provo activists (Koops, 2022). The movement described cars as "authoritarian monsters" that symbolized capitalist excess and environmental harm. Playful yet provocative tactics became a cornerstone of Provo's resistance. Activists staged imaginative protests, such as physically lifting cars parked on sidewalks and *jonas*[8] them to demonstrate frustration with the encroachment of cars on public spaces (Van Duyn, 1985, p. 85). These acts captured public attention and highlighted growing tensions between cars and other urban users (Koops, 2022). Consequently, Provo resonated not only with youngsters but also provoked strong societal resistance. Newspapers such as *De Telegraaf* labelled the activist as "long-haired, work-shy scum", describing them as unhygienic, animalistic, maladjusted, and antisocial (De Telegraaf, 1967).

Provo was also action-oriented in influencing the way Amsterdammers travelled; their most influential contribution was *Het Witte fietsenplan* (White Bicycle Plan), introduced in 1965 as an alternative to car-centric mobility (Furness, 2005). The plan proposed a fleet of 20,000 publicly accessible, white-painted bicycles available throughout the city as an extension of public transport. It is regarded as the first shared bicycle initiative (Ploeger and Oldenziel, 2020). These bicycles would be free to use, offering a sustainable, non-polluting alternative to private car ownership. As described in *PROVO* (Issue 5), a countercultural magazine published by the Provo movement in the 1960s, the plan served as an anarchistic critique of capitalist private ownership, symbolizing simplicity and cleanliness in stark contrast to the excesses and pollution of cars (Van Duyn, 1985, p. 85; Koops, 2022). Nevertheless, the plan received only one supporting vote in the municipal council. Reflecting on this, Provo activist Luud Schimmelpennink explained, "The bicycle was passé for those

[8] "Jonassen" is Dutch for tossing something in the air/rocking.

council members—associated with *De Hongerwinter* (the Dutch Famine).[9] It was a symbol of times we had moved beyond. The future belonged to the car; the bicycle was truly outdated" (Jacobs, 1999).

However, in 1967, Luud Schimmelpennink was elected to the Amsterdam municipal council, where he sought to formally introduce the plan to promote cycling in the city. His proposal outlined three key components: the city center should become car-free, public transportation should be expanded, and the municipality of Amsterdam should purchase 2000 white bicycles to complement the public transport system (Jordan, 2013). Schimmelpennink's goal was to reduce car traffic, air pollution, and parking issues in the city. While the local government ultimately rejected the plan, it sparked a broader conversation about urban mobility (Furness, 2005).

Undeterred, Schimmelpennink introduced *Het Witkarplan* (White Car Plan), a proposal for a shared three-wheeled electric vehicles system in 1968 (Algemeen Handelsblad, 1968). He continued to advocate for car-free city centers, expanded public transportation, and improved cycling infrastructure (Jordan, 2013). *De Witkar* was a two-seat, three-wheeled electric moped car (similar to a modern golf cart) designed as a collective transportation solution for Amsterdam's city center (see Fig. 8) (Algemeen Handelsblad, 1968).

On March 21, 1974, the first *Witkar Station* (see Fig. 9) opened at Amstelveld (see POI 8 on the map in Fig. 4), marking the beginning of the system's operation with 25 moped cars and four stations: Het Amstelveld, De Elandsgracht, De Nieuwmarkt, De Oude Brugsteeg, and later, Het Spui (Historiek, 2024a). However, on October 27, 1986, the initiative was dissolved after failing to meet its goal of establishing 25 stations and 125 moped cars. The founders attributed this lack of success to resistance from the municipality of Amsterdam, which had been obstructive in granting permits, according to *De Witkar* collective (Leeuwarder Courant, 1988, p. 21). This resistance stemmed partly from political reluctance to reallocate scarce public space for new stations and from the city's sluggish, bureaucratic permitting process (Historiek, 2024a).

[9] De Hongerwinter (the Dutch Famine) refers to the famine that occurred in the occupied Netherlands during the winter of 1944–1945, particularly affecting urban areas like Amsterdam. Food shortages, freezing temperatures, and German blockades on food transport led to the deaths of approximately 22,000 to 25,000 people (NOS, 2015). During this period, bicycles played a crucial role in survival. Many people—especially women—cycled or walked long distances to rural areas in the north and east of the country to obtain food. These desperate journeys came to be known as *hongertochten* ("hunger treks"). As a result, the bicycle became associated in the postwar years with hardship and deprivation, reinforcing the perception among some postwar city officials that it symbolized a past best left behind (Verzetsmuseum, no date).

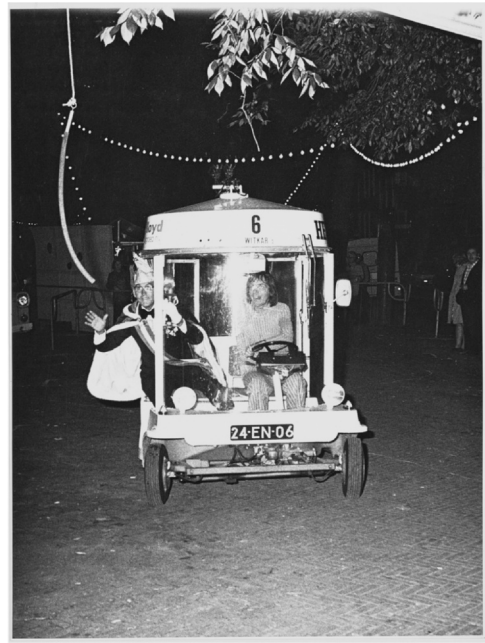

Fig. 8 The Witkar in use. Stadsarchief Amsterdam (no date) *Witkar, het alternatieve vervoersmiddel in de jaren zestig die het niet gered heeft.* [Photo]. https://archief.amsterdam/beeldbank/detail/da23c141-02ea-1861-937d-c4a59209a52c.

Fig. 9 Witkar sation. Stadsarchief Amsterdam and Arsath Ro'is, J.M. (1976) *Amstelveld: "Witkarstation", links N.H. Amstelkerk.* [Photo]. https://archief.amsterdam/beeldbank/detail/95d2a72d-bdcf-0b80-c62970f9d30b7213.

The playfully engaged actions and happenings of Provo, along with similar movements, sparked a public debate about the role of cars and the negative consequences of the shift toward fossil-fuel-powered motorization (Furness, 2005). According to Geels (2007), these social movements played a crucial role in shaping the Dutch transport system around 1970. Due to high visibility and public engagement, they led to institutional changes that granted citizens and societal groups greater influence in decision-making processes, contributing to a shift in the modal share. Provo's early critique of car-centric culture laid the foundation for more radical forms of resistance, especially as traffic-related fatalities began to rise, underscoring the urgent need for change.

2.9 Turning point: Radical protest and civil disobedience

The playfully engaged activism and happenings of the Provo movement sparked a wave of resistance among some Amsterdammers. By the early 1970s, protest groups such as *Amsterdam Autovrij* (Car-Free Amsterdam) and *Maskers af* (Masks off) emerged to confront the growing dominance of cars in Dutch cities. Extending the playfully engaged tactics of Provo, these groups adopted more confrontational approaches as the consequences of motorization became impossible to ignore.

In 1971, the group *Maskers Af* introduced the slogan *'Lazer op met je uitlaatgassen'* ('Get lost with your exhaust fumes'), calling for immediate measures to address air pollution caused by car emissions. Their petition to Amsterdam's mayor highlighted the urgent need for better public transport, restrictions on parking facilities in the city center, and the introduction of unleaded fuel for essential vehicles such ambulances and cars for people with a physical disability (NRC Handelsblad, 1971). This movement emerged 'from the awareness that Amsterdam will become unlivable within a short time if no action is taken'. While *Maskers Af* sought change through petitions and public awareness, other groups, like *Amsterdam Autovrij*, turned to more dramatic street protests to challenge car dominance directly.

The following year, in 1972, *Amsterdam Autovrij* staged a striking and historically important demonstration, blocking busy streets with wrecked cars to advocate for a car-free city. Protesters used the slogan '*Wij zijn blij met autovrij*!' ('We are happy with car-free!') and emphasized the importance of improving public transportation and implementing bike-friendly policies. These bold actions disrupted traffic and symbolized public frustration with the growing environmental and social costs of car-centric planning (Fig. 10).

Fig. 10 Protesters from Amsterdam Autovrij blocking de Ferdinand Bolstraat with wrecked cars to campaign for a car-free city. Nationaal archief/ Anefo (1974) Ferdinand Bolstraat 11–15. [Photo]. http://hdl.handle.net/10648/ac40af92-d0b4-102d-bcf8-003048976d84.

These movements also emerged in the context of rising traffic fatalities: between 1950 and 1970, the number of children under the age of 14 years old who were injured or killed in a collision involving a car nearly doubled, increasing from 278 to 460 annually. Similarly, cyclist fatalities rose significantly, from 332 in 1950 to 512 in 1970. By 1972, traffic deaths in the Netherlands reached a record high of 3264, making the dangers of motorization on city streets painfully clear (Bruno et al., 2021). The devastating toll on children became a particularly galvanizing issue, prompting the formation of *Stop de Kindermoord* (Stop the Child Murder) in 1972 in Eindhoven (Voogd, 2022).

The direct cause for its founding was an article written as a cry for help by Vic Langenhoff, who had lost a child in a traffic accident and could no longer accept that the street had become a place where children could be killed

without consequence. *Stop de Kindermoord* became the most vocal opponent of automobilism in the 1970s, using pamphlets, demonstrations, and striking posters that hit hard (Verkade, 2020b). Langenhoff's pressure group quickly grew into a nationwide organization with a large and active grassroots base. According to the group, the street should be a place where children could play and live freely and safely, as it had been before the rise of cars and other motorized traffic. *Stop de Kindermoord* organized numerous direct actions, such as occupying dangerous roads and intersections. Langenhoff also waged a fierce battle with *Veilig Verkeer Nederland* (Safe Traffic Netherlands), which he believed held children and their parents responsible for their own safety. In his view, traffic danger could only be addressed at its root (Visser, 2022).

Building on public outrage, *Stop de Kindermoord* advocated for streets as spaces where children could play safely, free from the dangers of cars (Fig. 11). The group argued that urban spaces needed to prioritize safety, livability, and community well-being over the convenience of car traffic (Verkade, 2020a). Their efforts marked a shift from playfully engaged protest to focused civil disobedience and policy advocacy, reflecting escalating frustration with the prioritization of cars in urban planning (Bruno et al., 2021).

The protest resonated immediately with politicians. Several expressed their support, and in 1973, the newly appointed Minister of Transport and Water Management, Tjerk Westerterp—who had also lost a child in a traffic accident—placed traffic safety at the center of his policy agenda (Smits, 2022). Most measures that made streets safer were implemented at the local level, under pressure from protest organizations like *Stop de Kindermoord*, which increasingly participated in municipal discussions across the Netherlands. *Woonerven*[10] (residential streets designed for shared use) were introduced, and many cities began implementing separated bike lanes and traffic-calming measures such as speed bumps and road narrowing's. For example, in Rotterdam, a "*hobbelpot*" (speed bump fund) of one million guilders[11] was created, allowing citizens to request a speed bump in front of their home (Verkade, 2020b).

[10] *Woonerf* has since become emblematic of Dutch street design and has been exported to other regions as a model of pedestrian-friendly planning. In a *woonerf*, pedestrians may use the full width of the street to walk and play. Motor vehicles are limited to a maximum speed of 15 km/h, and parking is only allowed in designated areas.

[11] The guilder (*f*) (Dutch: *gulden*) was the official currency of the Netherlands before the adoption of the euro (€) in 2002.

Fig. 11 Protesters from *Stop de Kindermoord* occupy an intersection near the Albert Cuyp Market in Amsterdam to raise awareness about traffic fatalities, particularly those involving children. Nationaal Archief/ Mieremet, R. (1972) *Aktiegroep Stop de Kindermoord bezet kruispunt bij AlbertCuypstraat te Amsterdam.* [Photo]. http://hdl.handle.net/10648/ac20324e-d0b4-102d-bcf8-003048976d84.

3. *Phase two* – momentum for change: The oil crisis and broader social movements

Amidst growing public concern over traffic fatalities and increasing resistance to car-centric urban planning, a major external shock—the 1973 Oil Crisis—disrupted established energy systems and accelerated political momentum for alternative mobility policies. Beyond its environmental toll, car-centric urban planning exacerbated numerous interconnected challenges, including traffic accidents, noise pollution, reduced accessibility, and the depletion of finite natural resources (Nykvist and Whitmarsh, 2008; Ritchie, 2020). What had started as localized protests against urban renewal and dangerous streets now gained broader significance, as national governments were forced to reconsider their reliance on cars and oil-based infrastructure and mobility options. The crisis created momentum for political change, reinforcing the urgency of reducing fossil fuel dependence and accelerating policies that promoted human-centric urban mobility over car-dominated urban planning (Bruno et al., 2021).

3.1 The oil crisis and growing awareness: The shock and the Club of Rome

The 1960s were marked by economic prosperity and the expansion of the welfare state in the Netherlands. Rising incomes, large-scale housing

developments, and the growth of suburban areas led to an increasing reliance on commuting, with daily travel patterns becoming more dependent on the road network (Verlaan, 2019). The continuous expansion of the economy, urban infrastructure, and car traffic fueled growing concerns about resource consumption and environmental sustainability. These concerns were reflected in the emergence of movements like the Club of Rome, a group of international politicians, business leaders, and scientists who gathered for the first time in 1968 with the aim of studying global challenges and warning policymakers of potential crises (Mihailov and Sakelarieva, 2016). In 1972, the Club of Rome published *The Limits to Growth*, a report that presented a dire scenario in which the depletion of natural resources would lead to major societal upheavals (Meadows et al., 1972). While some critics argued that the report's early projections were overly pessimistic or imprecise, many of its scenarios were intended to illustrate long-term outcomes extending well into the 21st century. Nevertheless, the report played a crucial role in bringing environmental issues—particularly those related to transportation and infrastructure—on the political agenda (Gardner, 2004).

The fear of resource scarcity was not unfounded. As global oil consumption continued to rise, oil-producing nations within the Organization of the Petroleum Exporting Countries (OPEC) recognized their growing influence and sought to manipulate oil prices (Adelman, 1973). The opportunity to exert such influence arose in October 1973, when the Yom Kippur War broke out. Egypt and Syria launched a surprise attack on Israel, prompting swift military support from Western nations. In response, several Arab OPEC members imposed an oil embargo on countries supporting Israel, including the United States and the Netherlands (CBS, 2024; Historiek, 2024b). The embargo was not only politically motivated but also served economic interests, as oil-producing nations sought to maximize their profits by restricting supply. Within weeks, the price of crude oil skyrocketed by 70 %, leading to severe fuel shortages and economic instability across the Western world (Rapid Transition Alliance, 2019).

As a result of the Oil Crisis, fuel shortages forced the Dutch government to implement emergency measures. In a televised speech, Prime Minister Joop den Uyl stated in December 1973:

"We must realize that we cannot continue consuming limited fuel and resources at the same pace as we have over the last 25 years. The world before the Oil Crisis will not return. We will have to adjust to a more resource-conscious way of life, and this will change our existence: (Ubels, 2013, translated from Dutch by the authors).

According to Mogridge (1978), the 1973 Oil Crisis sparked a wave of studies across various countries, many of which confirmed the impact of rising petrol prices on traffic flow and mobility choices. Fig. 12 overlays historical oil price trends – both the nominal oil price and its inflation-adjusted equivalent in 2024 prices – with changes in the modal share of transport in the Netherlands from 1970 to 2022. The inflation-adjusted prices provide a cleared understanding of real cost dynamics over time,

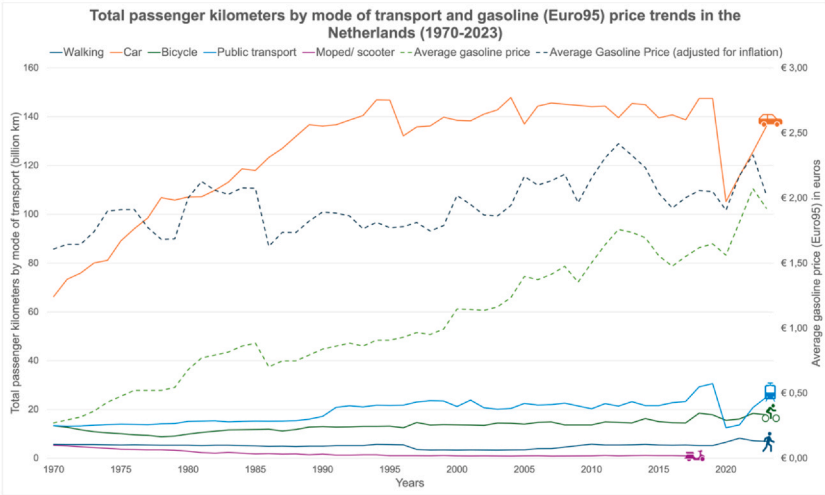

Fig. 12 Graph of oil costs and mode share. This graph illustrates the relationship between oil prices and the share of different transportation modes. it shows how fluctuations in oil prices and availability influence transportation choices during the Oil Crisis in the Netherlands. CBS (2013) *Mobiliteit Nederlandse bevolking, motief, vervoerwijze, 1985–2007*. https://opendata.cbs.nl/statline/#/CBS/nl/dataset/37338/table (Accessed 6 February 2025). CBS (2015) *Totale reizigerskilometers in Nederland per jaar; 2010–2014*. https://opendata.cbs.nl/statline/#/CBS/nl/dataset/81126ned/table (Accessed 6 February 2025). Statistics Netherlands, 2018 *Totale reizigerskilometers in Nederland; vervoerwijzen, regio's, 2010–2017*. https://opendata.cbs.nl/statline/#/CBS/nl/dataset/83497NED/table?dl=9FFE (Accessed 6 February 2025). CBS (2019) *3. Resultaten: De groei van het Nederlandse personenautopark*. https://www.cbs.nl/nl-nl/longread/statistische-trends/2019/de-groei-van-het-nederlandse-personenautopark/3-resultaten (Accessed 6 February 2025). CBS (2022) *3. reizigerskilometers*. https://www.cbs.nl/nl-nl/longread/rapportages/2022/onderweg-in-nederland–odin—2018-2020/3-reizigerskilometers (Accessed 6 February 2025). Statistics Netherlands (2024a) *3. reizigerskilometers*. https://www.cbs.nl/nl-nl/longread/rapportages/2024/onderweg-in-nederland–odin—2023-plausibiliteitsrapportage/3-reizigerskilometers (Accessed 6 February 2025). Statistics Netherlands (2024b) *Hoeveel reisden inwoners van Nederland en hoe?* https://www.cbs.nl/nl-nl/visualisaties/verkeer-en-vervoer/personen/hoeveel-reisden-inwoners-van-nederland-en-hoe- (Accessed 6 February 2025). CLO (2018)

(Continued)

avoiding the distortion caused by nominal price growth. This graph illustrates how fluctuation in oil price and availability have influenced mobility choices, particularly the balance between private car use, public transport, and active modes such as cycling and walking.

Another inflection point is visible around 1991, following the introduction of the *studentenreisproduct* (student travel card), which allowed students to use public transport for free and contributed to a significant increase in ridership (Het Parool, 2013). Such policy interventions, coupled with energy price shocks, played an important role in shaping the evolution of mobility behavior over the past five decades.

4. Political response: Emergency measures with lasting impact?

In response to the crisis, the Dutch government implemented several urgent policies to reduce oil consumption. One of the most visible measures was the introduction of a*utoloze zondagen* (car-free Sundays), during

Fig. 12—Cont'd *Ontwikkeling mobiliteit, 2005–2016*. https://www.clo.nl/indicatoren/nl214104-ontwikkeling-mobiliteit-2005-2016 (Accessed 6 February 2025). Jong and Annema (2010) *De geschiedenis van de toekomst: Verkeer- en vervoerscenario's geanalyseerd, Kennisinstituut Voor Mobiliteitsbeleid*. 10-A02. Den Haag: Kennisinstituut voor Mobiliteitsbeleid (KiM). https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://www.kimnet.nl/binaries/kimnet/documenten/rapporten/2010/02/17/de-geschiedenis-van-de-toekomst-verkeer–en-vervoerscenarios-geanalyseerd/de-geschiedenis-van-de-toekomst.pdf&ved=2ahUKEwizl-rw9rSLAxWYgP0HHdKuAOUQFnoECBAQAQ&usg=AOvVaw195WGPX0e-XssbowBAgiZm (Accessed 6 February 2025). Ministerie van Verkeer en Waterstaat (1998)) *Eindrapport Masterplan Fiets: Samenvatting, evaluatie en overzicht van de projecten in het kader van het Masterplan Fiets, 1990–1997, Fietsberaad.nl*. Z40-d63. Ministerie van Verkeer en Waterstaat. https://www.fietsberaad.nl/CROWFietsberaad/media/Kennis/Bestanden/Eindrapport%20Masterplan%20Fiets.pdf?ext=.pdf (Accessed 8 February 2025). Ministerie van Verkeer en Waterstaat (2008) *Nationale Mobiliteitsmonitor 2008, Rijkswaterstaat Publicatie Platform*. 375943. Den Haag. https://open.rijkswaterstaat.nl/publish/pages/119980/nationale_mobiliteitsmonitor_2008_compleet.pdf (Accessed 6 February 2025). Okhuijsen (2025) *Ontwikkeling prijs benzine Nederland*. https://datagraver.com/ontwikkeling-prijs-benzine-nederland/#more-43 (Accessed 3 February 2025). Polak (1995) *De bronnen voor mobiliteitsgegevens: Een onderzoek naar consistente historische reeksen, Swov,Nk*. report R-95–50. Leidschendam: Stichting Wetenschappelijk Onderzoek Verkeersveiligheid SWOV, p. 19. https://swov.nl/system/files/publication-downloads/r-95–50.pdf (Accessed 8 February 2025). Tweede Kamer der Staten-Generaal (1983) *Fietsverkeer, repository.overheid.nl*. 17745. Den Haag: Tweede Kamer der Staten-Generaal. https://repository.overheid.nl/frbr/sgd/19821983/0000146649/1/pdf/SGD_19821983_0005626.pdf (Accessed 6 February 2025).

which private car use was temporarily restricted to conserve fuel (Historiek, 2024b). First implemented in November 1973, these Sundays transformed streets across the country as bicycles and pedestrians reclaimed urban space (Leeuwarder Courant, 1973, p.1) (Figs. 13 and 14).

Fig. 13 The Oil Crisis – Car-free Sundays. Cyclists on an empty highway near Amsterdam during a car-free Sunday in November 1973. Nationaal Archief/ Mierement, R. (1973) *Fietsers op een autoweg in de omgeving van Amsterdam tijdens een autoloze zondag*, *Nationaal Archief*. [Photo]. http://hdl.handle.net/10648/af3e0992-d0b4–102d-bcf8–003048976d84.

Fig. 14 A city without cars. The Vijzelstraat in Amsterdam during the second car-free Sunday, showing a rare scene of motionless cars and empty streets. Nationaal Archief (1973a) *Een lege Vijzelstraat*, *Nationaal Archief*. [Photo]. http://hdl.handle.net/10648/ac3c2404-d0b4–102d-bcf8–003048976d84.

Although initially intended as a temporary emergency measure, the success of car-free Sundays reinforced the idea that cities could function without cars, demonstrating the feasibility of a modal shift away from car dependency (Bruno et al., 2021). Public discourse surrounding these Sundays highlighted unexpected benefits, including improved air quality, reduced traffic fatalities, and enhanced urban livability. A letter published in the newspaper on December 1, 1973, emphasized this shift: "Much has been written about fuel rationing and car-free Sundays. What surprises me is that no one has mentioned how much these Sundays have reduced traffic casualties. I believe this positive aspect deserves more attention" (Van Brakel, 1973, p. 2, translated from Dutch by the authors). Another letter echoed similar sentiments: "For once, children can play outside normally. It is also a huge advantage that these car-free days are beneficial for the environment" (Plezier, 1973, p. 2, translated from Dutch by the authors). A third letter reinforced the public's growing preference for urban environments with fewer cars: "Car-free Sundays are a weekly breath of fresh air. Now, let's create more spaces for walking and sports instead of more roads. It almost feels like a fairytale" (Pieters, 1973, p, 2, translated from Dutch by the authors).

Because the Netherlands was affected by an oil embargo that year, there was a strong political push for energy-saving measures. In this context, politicians called on citizens to voluntarily adhere to the new 100 km/h speed limit. National solidarity during the 1973 Oil Crisis was so strong that the public largely complied. People spontaneously began carpooling to reduce consumption (IsGeschiedenis, 2022). Although this restriction was later relaxed (Nederlands Dagblad, 1988, p. 1), the societal acceptance of a voluntary speed limit evaporated as the crisis subsided. The Dutch national government subsequently announced that a mandatory speed limit would be introduced (IsGeschiedenis, 2022). This marked a significant turning point in both highway regulation and energy policy in the Netherlands (Feitsma, 2019).

Government arguments in favor of the speed limit were quickly challenged. Critics argued that the measure was motivated more by the desire to reduce national energy consumption than by concern for road safety. Tensions came to a head with a petition signed by over a hundred angry pastors and professors, who condemned the cabinet's policy. They claimed that The Hague[12] was willing to intervene in traffic matters to lower oil

[12] The Hague (Den Haag in Dutch) is the city in the Netherlands that serves as the seat of the national government, the parliament, the Supreme Court, and the Council of State, though Amsterdam is the official capital.

consumption—but not when it came to protecting lives. The prominent traffic psychologist J.A. Michon also contributed to the debate. In a provocative argument, which lacked scientific evidence, he claimed that the new speed limit would actually reduce safety: "Highways are built for 120 or even 130 km/h," he asserted. "Driving slower is boring, it causes fatigue and drowsiness, and ultimately, drivers may fall asleep. In short, it makes Dutch highways more dangerous" (IsGeschiedenis, 2022). Despite these protests, including the moral objections of the offended clergy, the new policy went ahead. As of February 4, 1974, a maximum speed limit of 100 km/h was enforced on all Dutch highways (Fig. 15).

Nonetheless, a powerful political lobby emerged to reverse the speed limit reductions. While the limit had originally been reduced to 100 km/h as an energy-saving measure, it was raised back to 120 km/h in 1988. The main

Fig. 15 Speed limit as a Crisis response. State secretary of transport, public works, and water management Van Hulten presenting a sticker indicating a new speed limit of 100 km/h. Nationaal Archief (1973b) *Staatssecretaris Van Hulten met een sticker voor snelheidsbeperking tot 100 kilometer per uur, Nationaal Archief*. [Photo]. http://hdl.handle.net/10648/ac3be868-d0b4–102d-bcf8–003048976d84.

arguments were that most highways were designed for 120 km/h, that the 100 km/h limit was widely ignored, and that the higher speed better aligned with public expectations. Eventually, the speed limit rose even further, reaching 130 km/h on many highways in 2012 (Ministerie van Infrastructuur en Mileu, 2015). Left-wing opposition parties objected, citing concerns over traffic safety and environmental impact (Du Pré, 2012).

The Oil Crisis also catalyzed significant investment in research into renewable energy sources, such as solar and wind power, driven by concerns over long-term energy security. Although the shift away from fossil fuels was gradual, the crisis underscored the risks of oil dependence and prompted policymakers to consider more sustainable alternatives (Rapid Transition Alliance, 2019). The oil embargo and car-free Sundays officially ended in January 1974 following negotiations. However, their impact endured, inspiring local environmental movements and reshaping public debates about urban sustainability (Historiek, 2024b). Environmental activists continued advocating for *autoloze zondagen* long after the crisis, emphasizing their role in raising awareness about car-related pollution and promoting alternative mobility options (Traa, 2022).

4.1 Social movements: Using momentum for change

In response to the car-free Sundays and their positive consequences, grassroots activism gained momentum, with increasing participation in *fietsslierten* (mass bicycle rides), see Fig. 16. Activists deliberately chose the bicycle as both a symbol and a tool for protest, positioning it as the direct alternative to the car. The bicycle was not only safer, but it also represented individual mobility and improved environmental quality. According to action groups, a strong cycling culture was essential for creating a more livable Amsterdam (Stadsarchief Amsterdam, 2019).

On May 13, 1974, nearly a thousand cyclists, organized by *Amsterdam Autovrij*, staged a large-scale ride through the city, deliberately blocking major roads to advocate for bicycle-friendly policies. The protest disrupted traffic in multiple locations, aiming to prioritize public transportation and non-motorized mobility. The demonstration, which started and ended at Dam Square, provoked mixed reactions, including frustration from drivers and support from pedestrians. At the end of the ride, activists symbolically handed flowers to police officers who had supervised the event, and organizers announced a follow-up demonstration for June 15 (Het Parool, 1974, p. 5).

Fig. 16 Bicycle protest for a car-free Amsterdam. A procession of cyclist fills the Rokin, carrying signs that read 'Amsterdam Autovrij' and waring face masks to protect themselvss from exchaust fumes. Nationaal Archief/ Verhoeff, B. (1974) *Fietstocht Amsterdam autovrij in Amsterdam; overzicht van de stoet op het Rokin, Nationaal Archief*. [Photo]. http://hdl.handle.net/10648/ac4abab4-d0b4–102d-bcf8–003048976d84.

While the bicycle became a powerful symbol of resistance, many of these protests were also deeply rooted in broader social struggles around housing, displacement, and urban demolition. A key turning point came with the *Nieuwmarkt* riots[13] of March 1975 (see POI 5 on the map in Fig. 4), which erupted in response to the city's plans to extend the metro line and construct a major traffic corridor toward Amsterdam Centraal Station, the city's central rail hub. To make space for this infrastructure, significant parts of the historic *Jodenbreestraat* and *Antoniebreestraat*—streets located in a working-class neighborhood that once formed part of the old Jewish quarter—were slated for demolition, threatening both homes and heritage buildings (NTR, 2015). The *Nieuwmarkt* riots were heavily influenced by the Dutch squatters'

[13] The Nieuwmarkt riots (*Nieuwmarktrellen*) occurred in March and April 1975, when the city of Amsterdam deployed approximately 800 police officers to evict squatters from houses in the Nieuwmarkt neighborhood. The evictions were carried out to make way for the construction of a new metro line, but the clashes represented the culmination of years of growing resistance. On one side stood the municipal government, committed to large-scale redevelopment plans; on the other, a growing coalition of activists who aimed to preserve the city's historical character and advocated for the renovation—rather than demolition—of deteriorated housing. Although the metro was eventually built, the protests forced the city to abandon broader demolition plans, and the events became a turning point in Amsterdam's urban policy (NTR, 2015).

movement,[14] which opposed the shortage of affordable housing and the continued demolition of livable homes (Van Vuuren, 2021).

In reaction, activist and preservationist Geurt Brinkgreve established a foundation to save the *De Pintohuis*, a 17th-century canal house situated directly in the path of the planned road. Brinkgreve's proposal to preserve and restore the building was ultimately approved by the city council. Once the building was transferred to the foundation's care, the traffic artery could no longer fit between the *De Pintohuis* and the nearby *Zuiderkerk*, a prominent 17th-century church, forcing planners to abandon the road segment (Schoonenberg, 2013). Although the riots were sparked primarily by the threat of housing demolition rather than by transportation concerns alone, their impact was far-reaching: from that point forward, demolition in the name of road-building became politically taboo in Amsterdam. In retrospect, completed traffic breakthroughs such as those in Kattenburg and the Nieuwmarkt neighborhod (see POI 4 and 5 on the map in Fig. 4), were exceptions rather than the rule. More extensive plans to build an inner-city ring road, as proposed by Jokinen's plans (see Fig. 6), were never realized. This history underscores how opposition to car dominance was often inseparable from resistance to housing displacement and the destruction of Amsterdam's historic working-class neighborhoods. The failure to implement these plans also had lasting implications for modal shift and the energy transition in Amsterdam: the absence of large-scale car infrastructure enabled the prioritization of cycling, walking, and public transit, helping to ensure that the city never became car-dominated—land use planning simply did not allow for it.

Bicycle demonstrations became increasingly frequent throughout the 1970s. In 1976, multiple organizations decided to join forces. *Stop de Kindermoord*, *Amsterdam Autovrij*, *Milieudefensie* (Environmental Defence), community centers, and the newly established *Enige Echte Eerste Nederlandse Wielrijdersbond* (ENWB) (the first and one and only cycling association) formed a coalition under the name *Amsterdam Fietst!* (Asmterdam Cycles!).

[14] The Dutch squatters' movement (*kraakbeweging*) emerged in the 1960s in response to a severe housing shortage and the widespread vacancy of buildings, often held for speculation. Active from roughly 1964 to 1999, the movement grew particularly strong in the 1970s and 1980s, when young people and activists occupied empty buildings to protest against real estate speculation, urban renewal projects, and the demolition of affordable housing. Squatted buildings often became self-managed hubs for alternative living, political organizing, and cultural activity (Duivenvoorden, 2000). While not a unified movement, squatters frequently clashed with authorities, especially during mass evictions and urban redevelopment efforts, as exemplified by the 1975 Nieuwmarkt riots in Amsterdam.

Fig. 17 National Bicycle demonstration. Protesters lying on the ground at Museumplein to commemorate traffic victims during the *Amsterdam Fietst* demonstration. Nationaal Archief/ Bogaerts, R. (1977) *Landelijke fietsdemonstratie in Amsterdam; fietsers liggen op de grond op Museumplein om verkeersslachtoffers te herdenken, Nationaal Archief.* [Photo]. http://hdl.handle.net/10648/ac9d2646-d0b4–102d-bcf8–003048976d84.

The coalition launched city-wide campaigns, distributing recognizable posters to encourage participation in upcoming demonstrations. The number of participants steadily grew, culminating in a massive demonstration on June 4, 1977, which attracted at least 9000 cyclists (Stadsarchief Amsterdam, 2019) (see Fig. 17).

At precisely 2 p.m. on June 4, 1977, het Museumplein (see POI 9 on the map in Fig. 4) – an important public square with various museums in Amsterdam - was filled with bicycles and cyclists who lay down beside their bikes in a symbolic tribute to traffic accident victims. The demonstration was part of the broader *Amsterdam Fietst!* movement, demanding safer cycling infrastructure and a reallocation of urban space away from cars. The protestors called for an expansion of public transport, the construction of new bike lanes, and the introduction of a 20 km/h speed limit in the city center (Stadsarchief Amsterdam, 2019; Toepoel, 2020).

To reinforce their demands, the demonstrators staged a mass ride through the city. After a few minutes of silence at *Museumplein*, thousands of cyclists stood up, mounted their bikes, and began a coordinated ride towards *Vondelpark* (see POI 10 on the map in Fig. 13), a large public park in the center of the city. They occupied entire streets, refusing to make way for cars. Frustrated motorists honked their horns, leaned out of their

windows, and shouted insults such as: 'Idiots! Tonight, you'll be asking for a ride!'[15] (Toepoel, 2020, translated from Dutch by the authors). The cyclists, undeterred, continued their procession, blocking *De Vijzelstraat* as they rode. Upon reaching *Vondelpark*, the kilometers-long procession gathered for speeches, concluding the event with a final message: 'Keep cycling and don't let yourself be boxed in!'[16] (Toepoel, 2020, translated from Dutch by the authors).

5. *Phase three* – research and institutionalization (1974-1990)

The 1973 Oil Crisis exposed the vulnerabilities of car-dependent societies, reinforcing public demand for alternative mobility planning. Alongside growing environmental awareness and increasing traffic fatalities, these concerns pushed policymakers to rethink urban development (Bruno et al., 2021). Car-centric urban planning was increasingly challenged by a new mobility narrative that called for policies prioritizing public transit, cycling infrastructure, and pedestrian-friendly cities (Verlaan, 2019). What began as playfully engaged protest and happenings aimed at raising awareness gradually evolved into broader social movements. These movements, in turn, laid the groundwork for institutional change, transitioning from grassroots activism to formalized policies at both national and local levels (Bruno et al., 2021).

5.1 Changing national policy

This shift was first institutionalized at the national level in the Netherlands, where concerns over energy security, rising traffic fatalities, and declining urban livability led to government initiatives aimed at reducing car dependency, strengthening public transport, and integrating cycling into urban mobility planning (Tweede Kamer der Staten-Generaal, 1977). This marked a turning point, as former activists, academics, and urban planners who had once opposed *cityvorming* and car dominance began shaping national and municipal policies (Bruno et al., 2021). To curb growing car use, the government prioritized integrated urban planning, expanded public transport, and provided financial support to make transit a more attractive alternative to driving (Autosnelwegen, 2025b). These objectives

[15] '*Rotzakken, vanavond vragen jullie weer een lift!*'
[16] '*Blijf fietsen en laat je niet inblikken!*'

were formalized in SVV-1[17] (*Structuurschema Verkeer en Vervoer*, 1977), the first national traffic and transport plan. The policy limited new road construction, strengthened the rail network, introduced dedicated bus lanes, and promoted the development of separate bicycle infrastructure (Tweede Kamer der Staten-Generaal, 1977). A key focus was reducing "undesirable" mobility through better spatial planning while ensuring public transport remained accessible and well-funded to counterbalance the dominance of private cars (Autosnelwegen, 2025b).

In 1988, SVV-2 (*Structuurschema Verkeer en Vervoer*, 1988) reinforced this approach by further improving alternatives to car travel. It aimed to limit projected traffic growth from 70 % to 35 % by making public transport more efficient and accessible. The plan also provided a government mandate to invest billions into public transit infrastructure, aiming to advance the Netherlands' transition toward a more balanced and multimodal urban mobility system (Tweede Kamer der Staten-Generaal, 1989).

5.2 Research and the rise of the "compacte stad" in Amsterdam

Especially in Amsterdam, former protesters and students who had envisioned alternative mobility narratives began taking positions in local politics to implement their ideas in practice (Van Engelen, 2024). This transition was facilitated by the overlapping roles of formal and informal institutions, where universities, policy networks, and activist movements intersected (Zill et al., 2024). The close interaction between academia, policy, and activism played a key role in shaping new urban mobility strategies. Over time, Amsterdam's policies evolved from protest-driven demands into structured urban planning approaches that prioritized livability, accessibility, and the integration of multiple modes of transport.

Parallel to national policy developments, significant changes were taking place in Amsterdam. The protests of the late 1960s and early 1970s began to formalize, as young activists who had once led demonstrations gradually entered positions of political influence (Van Engelen, 2024). Many of those who had fought against car-centric policies became policymakers, shaping urban planning from within politics and government institutions. Research

[17] The *Structuurschema Verkeer en Vervoer* (SVV) (Structure Plan for Traffic and Transport), was a series of Dutch national traffic and transport policy frameworks introduced from the 1970s onward. These long-term planning documents outlined the government's vision for mobility, emphasizing coordinated development of road, rail, and public transport infrastructure in line with spatial planning goals.

by Zill et al. (2024) highlights how former student activists transitioned into academic, political, and activist roles, strengthening the connections between universities, policy institutions, and grassroots movements.

Throughout the late 1970s and 1980s, criticism of *cityvorming* and *functiescheiding* intensified within academic circles, particularly at the University of Amsterdam (UvA). Students and junior researchers (Zill et al., 2024) increasingly highlighted the negative consequences of large-scale urban renewal and suburbanization, advocating for alternative spatial strategies. The concept of the *compacte stad* (compact city) emerged as a direct response to these challenges, emphasizing high-density, mixed-use developments with safe and accessible pedestrian and cycling infrastructure (Zoon and Goedknegt, 1985; Kok and Boerlage, 1981, pp. 4–5).

Inspired by Jane Jacobs, an urban activist and writer who championed community-based approaches to city planning and opposed large-scale urban renewal projects in New York City, Compact City planners in the Netherlands promoted urban diversity across three dimensions: spatial structure (fine-grained street networks), time (a mix of old and new buildings), and function (mixed-use urban areas). Jacobs argued that organic urban development, rather than large-scale, top-down planning, was essential for fostering economic, social, and cultural vibrancy. Initially, many planners rejected her ideas, but over time, they gained traction as an alternative to car-centric planning and *cityvorming* in the Netherlands (Van Der Maas, 2018; Van Engelen, 2024).

The compact city model also intersected with the then new field of feminist geography, which emerged in the Netherlands during the second feminist wave (±1965–1990) (Zill et al., 2024). Feminist urban planners challenged the assumption that cities should be designed around the nuclear family, where men commuted to work while women remained at home (NIROV, 1985; Van Der Craats et al., 2025b). They argued that traditional urban planning prioritized male mobility patterns while overlooking the needs of women, who were more likely to walk, cycle, or use public transport for daily tasks (e.g., Kok and Boerlage, 1981, pp. 4–5). Feminist geographers advocated for mixed-use neighborhood's, pedestrian-friendly streets, and improved public transport accessibility, all of which became fundamental principles of compact city planning (Kok, 1984).

As the Compact City narrative gained momentum, its principles were increasingly integrated into municipal planning. Academics and activists challenged the long-term effects of car-centric development and the *cityvorming* narrative, paving the way for policy shifts that prioritized dense, multifunctional urban spaces.

5.3 Political influence and policy implementation

The growing influence of research in the Netherlands was closely tied to activism and political engagement. Many former student activists and researchers transitioned into policymaking roles, using their expertise to shape municipal decision-making (Zill et al., 2024). The University of Amsterdam (UvA) played a key role in this shift, serving as a hub for critical urban research and activism. One prominent figure in this transition was Michael van der Vlis, who began as a neighborhood activist in Amsterdam's De Pijp before becoming a city councillor for the *Partij van de Arbeid* (Labour Party)[18] in 1974. During his time as an activist, Van der Vlis worked as a researcher at the UvA (Van Engelen, 2024; Kleijn, 2024). By 1978, he had been appointed as *wethouder* (alderman) for spatial planning, housing, traffic, and transport, where he championed compact city principles, traffic calming, and investments in cycling infrastructure (Spaans, 2018).

Van der Vlis (see Fig. 18) and his colleagues translated the Compact City ideas into concrete policy proposals, such as the 1978 municipal report *Fietsen in Amsterdam* (Cycling in Amsterdam). This document called for better protection for cyclists, a shift away from car dominance, and investments in a citywide cycling network (Vlis, van der, Stoffel and Mug, 1978). In 1978, a new coalition government (PvdA, CDA, CPN, D66, and PPR) formally rejected *cityvorming* in favor of densification, investment in public transport, cycle infrastructure, and pedestrianization (Meershoek, 2022).

Van der Vlis also introduced paid parking, separate tram lanes, and extensive cycling infrastructure, helping transform Amsterdam into a city where non-car mobility was prioritized. Without these policy shifts, the city would likely have remained dominated by cars (Verlaan, 2019). The Compact City became Amsterdam's official urban renewal strategy, marking a departure from large-scale car infrastructure projects (Gemeente Amsterdam, 1984, p. 15). By the late 1970s, the Compact City was adopted in several Dutch cities, marking a clear departure from previous urban planning paradigms. Instead of promoting suburban expansion and strict functional zoning, policymakers sought to reintegrate housing, businesses, and other urban functions within city boundaries. Suburbanization was replaced by re-urbanization, ensuring that new developments complemented rather than replaced existing urban structures (NIROV, 1985; Van Engelen, 2024).

[18] De Partij van de Arbeid (PvdA), or Labour Party, is a Dutch political party with a social-democratic ideology.

Fig. 18 Alderman Michael van der Vlis (Spatial planning 1974–1990) opens the new bridge for pedestrians and cyclists at Heemstedestraat. The sing reads *Amsterdam op de fiets* Amsterdam by bike. Stadsarchief Amsterdam/ Busselman, F. (1987) *Wethouder Michael van der Vlis (Ruimtelijke Ordening 1974–1990) opent de nieuwe brug voor voetgangers en fietsers bij de Heemstedestraat, Stadsarchief Amsterdam.* [Photo]. https://archief.amsterdam/beeldbank/detail/09674e99-0da0-65d3-4e6d-7a9bf0156195.

Importantly, the implementation of Compact City policies also reflected the impact of feminist urban planning, which had emphasized mixed-use neighborhood's, pedestrian-friendly infrastructure, and accessible public transport as essential components of inclusive urban environments. These principles, advanced earlier by feminist geographers, found practical expression in the shift away from car-centric planning toward more equitable and socially responsive urban design.

Alongside Van der Vlis, Jan Schaefer played a key role in shaping Amsterdam's urban renewal trajectory. As a former activist himself, Schaefer had been deeply involved in resisting large-scale demolition plans in De Pijp during the 1960s, where redevelopment projects threatened to replace working-class housing with office towers and a wide boulevard. Schaefer's principle "*bouwen voor de buurt*" ("building for the neighborhood") became a cornerstone of the new urban vision. As alderman in the early 1980s, he was instrumental in shifting policy away from demolition toward renovation and neighborhood-based planning, working closely with residents and emphasizing affordable housing, community input, and incremental street-level improvements. His work, set a new direction for urban renewal that prioritized social cohesion and livability (De Liagre Böhl, 2024).

As a result of these policy shifts, Amsterdam's cycling infrastructure had expanded significantly by the late 1980s. With fewer cars on the road, improved public transport, and dedicated bicycle lanes, the city became a global model for post-fossil fuel urban mobility (Stadsarchief Amsterdam, 2019). Consequently, the modal split in Amsterdam has changed since 1984. Whereas in 1986, 29 % of daily trips were made by car and 21 % by bike, this changed to 21 % by car and 38 % by bike in 2019, see Fig. 19. This change can be attributed to a combination of factors, as outlined in Fig. 3. Activism, including playfully engaged protests and civil disobedience in the 1960s and 1970s, raised public awareness about the need for safer, bike-friendly infrastructure. Additionally, the Oil Crisis heightened the demand for sustainable transport options. Together with broader

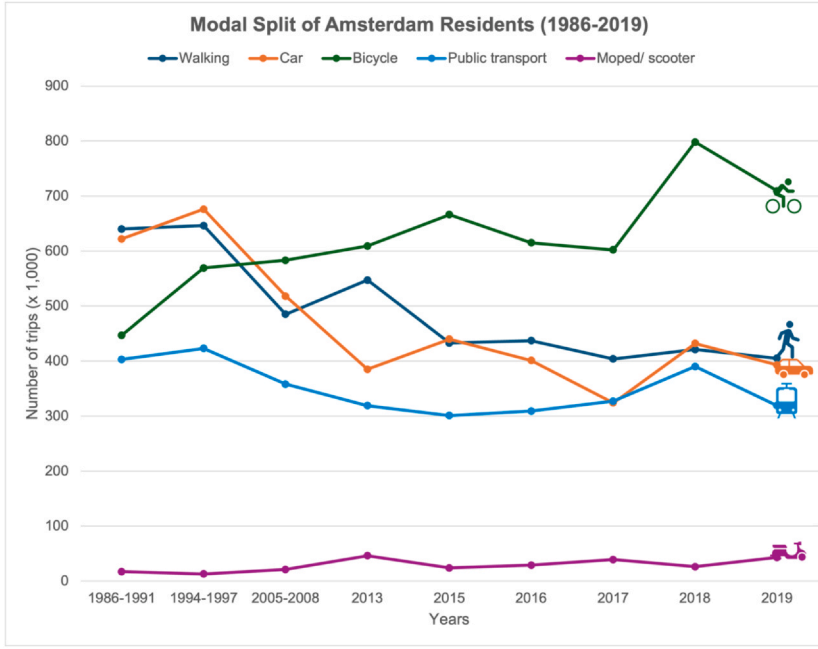

Fig. 19 Modal split in Amsterdam (1986–2014). Number of daily trips to, from, and within Amsterdam by residents, categorized by mode of transport. (Gemeente Amsterdam, 2021) *Amsterdamse Thermometer Bereikbaarheid 2021 ATB.* https://openresearch.amsterdam/nl/page/74100/amsterdamse-thermometer-bereikbaarheid-2021-atb (Accessed 23 January 2025). Ministerie van Infrastructuur en Waterstaat (2017) *Blog: Sterke groei van het fietsgebruik? Ja en nee!* https://www.kimnet.nl/actueel/weblogs/weblog/2017/blog-sterke-groei-van-het-fietsgebruik-ja-en-nee (Accessed 23 January 2025).

social movements focused on environmental sustainability and urban quality of life, these factors contributed to research and institutional support, which ultimately led to the formal integration of cycling into urban planning and policy, driving the changing modal split. These planning choices and policies further discouraged a car-centric lifestyle and contributed to the decline in car usage. Interestingly, while cycling use increased, the share of walking appears to have declined over time. This trend may be linked to factors such the rising convenience of cycling for short urban trip (Nello-Deakin and Nikolaeva, 2020).

6. Periods of punctuation and the necessary elements

Cities did not naturally evolve to accommodate cars and fossil-fuel-dependent transport systems. As we have shown in this chapter, from 1930 to 1967, car-centric urban planning and functional zoning were deliberate policy choices aimed at enabling fast, door-to-door car travel. The integration of cars was guided by a broader vision—*cityvorming*—of how cities should be structured, and the role cars should play within them.

This dominant narrative was not unchallenged. Using the theory of punctuated equilibrium to understand change in complex social systems, we observe that long periods of stasis were interrupted by sudden shifts, leading to radical transformation (Baumgartner and Jones, 1993). The convergence of social movements, academic research, and international crises created momentum for alternative mobility narratives that ultimately influenced public policy and political decision-making. Despite the widespread adoption of fossil-fuel-based transport, this transition was neither seamless nor inevitable. The introduction of cars into urban life required deliberate planning, just as shifting away from car and fossil-fuel dependency today demands intentional policy interventions.

The key question remains: What lessons can be drawn from past instances where social movements and crises intersected, and how did these interactions enable the adoption of an alternative mobility system?

Amsterdam's transition was neither linear nor immediate. Activism spurred political action, crises accelerated policy shifts, and research lent credibility to alternative planning approaches. The shift from grassroots protest to institutionalized policy emerged through sustained interaction among these forces (see Fig. 20). Between the 1960s and 1980s, activism, crises, research, and political leadership combined to challenge Amsterdam's

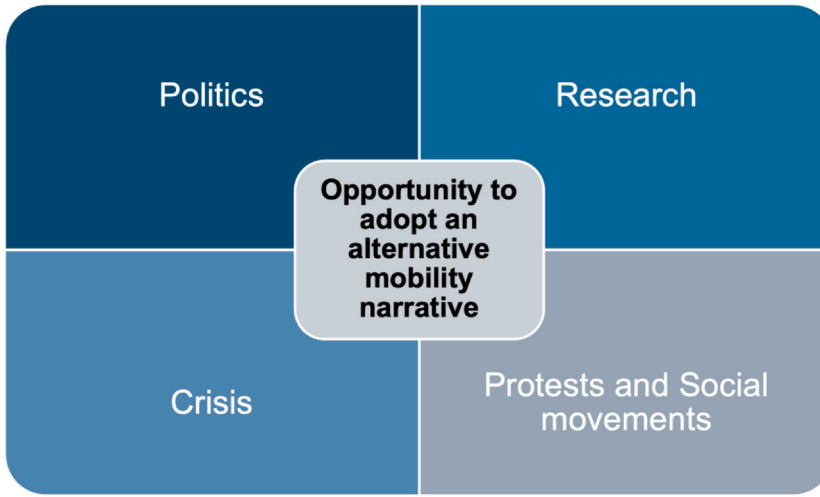

Fig. 20 Elements needed to adopt an alternative mobility paradigm.

car-centric urban model. Grassroots protests and academic critiques-initiated reforms that reshaped the city's mobility landscape. The 1973 Oil Crisis acted as a catalyst, accelerating the transition toward a compact city model that prioritized high-density, mixed-use neighborhood's, efficient public transportation, and cycling infrastructure. These reforms contributed to reduced energy consumption, lower emissions, improved safety, and increased social interaction in public spaces.

A defining feature of this period was the fundamental challenge to the prevailing mobility paradigm. The assumption that cities should be designed around cars was questioned, debated, and ultimately replaced by the Compact City model. The Oil Crisis exposed the vulnerabilities of fossil fuel dependency, prompting exploration of alternative mobility strategies. The convergence of energy shortages, grassroots activism, and environmental awareness laid the groundwork for Amsterdam's now famous and world renown cycling infrastructure and broader urban mobility reforms. These changes influenced broader debates on energy security, climate policy, and urban sustainability—issues that remain urgent today.

6.1 What remains of these sudden shifts?

6.1.1 Phase 1: Playful protest and civil disobedience

Several enduring elements of the 1960s counterculture can still be identified in today's urban landscape. The OV-fiets (public bike rental system

connected to the public transport system) is often regarded as a spiritual successor to the *Witte Fietsenplan* (White Bicycle Plan), one of the earliest experiments in free, shared bicycle use. The OV-fiets, conceptualized in the early 2000s by Ronald Haverman and the Dutch Cyclists' Union (*Fietsersbond*), aimed to simplify last-mile travel from train stations. Renting a bike had previously been slow, bureaucratic, and expensive. Haverman envisioned a faster, cheaper system, stating: "It should take no more than a minute to rent a bike, and 30 s to return it—because people need to catch their train" (OV-Magazine, 2021). The first OV-fietsen were introduced in Delft and Utrecht, quickly expanding nationwide. Meanwhile, car access in city centers continues to be restricted to maintain livability (NTR, 2009).

Another echo from the past is the resurgence of ultra-compact moped cars (*Biro*) in Amsterdam. Decades after the failure of *De Witkar*—an electric shared moped car initiative from the 1970s (see Figs. 8 and 9)—modern, 21st-century versions of these small, lightweight moped cars have regained popularity (see Fig. 21). Many qualify as mopeds, allowing them to be parked

Fig. 21 Microcars parked on the sidewalk in Amsterdam, behind the Dam. Picture taken by J.S. van der Craats on 26 January 2025.

anywhere and, in some cases, driven on bike paths. This has sparked new debates about urban space allocation and the role of small, moped cars in a car-light city like Amsterdam (Kruyswijk, 2024).

The *Stop de Kindermoord* ("Stop the Child Murder") movement, which gained national resonance, also left a lasting legacy. It contributed to the development of safer streets through *woonerven* (residential streets), separate bike lanes, and traffic-calming measures like speed bumps and road narrowing's. Between 1978 and 1988, the length of dedicated bicycle paths in the Netherlands grew from 9300 km to 16,100 km—a 73 % increase—while the road network for cars expanded by just 11 %. This reflected a genuine shift in priorities. As one study summarized: "People are more likely to choose cycling when dedicated infrastructure makes them feel safer and delays are minimized compared to sharing the road with fast-moving cars" (De La Bruhèz and Veraarts, 1999).

A resurgence of playfully engaged activism—reminiscent of the 1960s and 1970s—also emerged. In 2019, Extinction Rebellion, a global environmental movement that uses nonviolent civil disobedience to compel governments to take urgent action on the climate and ecological crisis, staged a symbolic funeral procession in Amsterdam, highlighting the environmental destruction caused by car dependency (Het Parool, 2019). The COVID-19 pandemic (2020–2022) created another episode of disruption, as lockdowns temporarily reduced car usage and emissions. However, unlike the 1973 Oil Crisis, this did not lead to a sustained mobility transition (Muley and Singh, 2024). Although activists urged policymakers to use the pandemic as a springboard for car-free and low-emission urban policies, the momentum largely faded once restrictions were lifted. In some cases, the pandemic even contributed to increased car adoption, as concerns about virus transmission on public transport and a shift toward private mobility led individuals to opt for driving over shared modes (e.g., Anwar et al., 2022). Advocacy groups criticized the lack of long-term structural changes and the failure to capitalize on the temporary drop in car use to implement more ambitious policies (Amsterdammers voor Autoluw NU!, 2020).

6.1.2 Phase 2: The oil crisis and broader social movements

The punctuation—triggered by the 1973 Oil Crisis—illustrates how external shocks can open policy windows for significant change. Although many of the short-term emergency measures were later rolled back, the crisis helped institutionalize a broader shift in thinking. Energy consumption, air quality,

and public health became central to local mobility policymaking. For instance, in Amsterdam, these emergency policies were interpreted and implemented differently than at the national level. Local authorities used the crisis to reinforce emerging urban planning goals that favored public transportation, walking, and cycling over car use.

This tension between national and local policies is echoed in more recent findings. Budnitz et al. (2024) show how policymaking transitions are shaped by institutional structures and power dynamics both horizontally (between cities) and vertically (across levels of government). These transitions are historically and spatially specific, with different cities following different paths toward system lock-in. Cities have varying histories of activism, different models of supporting civic society, and unequal reliance on central government funding. The study by Budnitz et al. (2024) illustrates the ongoing tension between national priorities for electric vehicle (EV) adoption and local ambitions to reduce car usage altogether.

6.2 Phase 3: Research and institutionalization

The third phase was marked not by a sudden crisis, but by the cumulative institutionalization of earlier activist and policy efforts. By the 1980s and 1990s, the *Compacte Stad* model had become a guiding framework for urban planning in Amsterdam. This shift was supported by students and (junior) researchers, who emphasized the need for alternative approaches. They introduced the concept of the *compacte stad* (compact city), which emphasized high-density, mixed-use neighborhoods supported by pedestrian- and bike-friendly infrastructure. Inspired by Jane Jacobs, the compact city approach promoted urban diversity across spatial, temporal, and functional dimensions. Initially dismissed, Jacobs' ideas gradually gained acceptance as viable alternatives to top-down, car-centric planning in the Netherlands.

Recent research increasingly emphasizes urban mobility concepts such as the 15-minute city and shared mobility services, reflecting a renewed interest in reducing car dependency. The 15-minute city model— promoting walkable, mixed-use neighborhoods with essential services located within short distances (Teixeira et al., 2024)—closely aligns with the earlier compact city vision and is being adopted in many European urban contexts. Shared mobility services, including e-bikes, car-sharing, and micromobility platforms, have also expanded, offering alternatives to private car ownership (Van Der Craats et al., 2025a). Fig. 22 illustrates the repetitive nature of urban mobility planning over the past 100 years: from early city models dominated by active travel, such as the garden city and walking

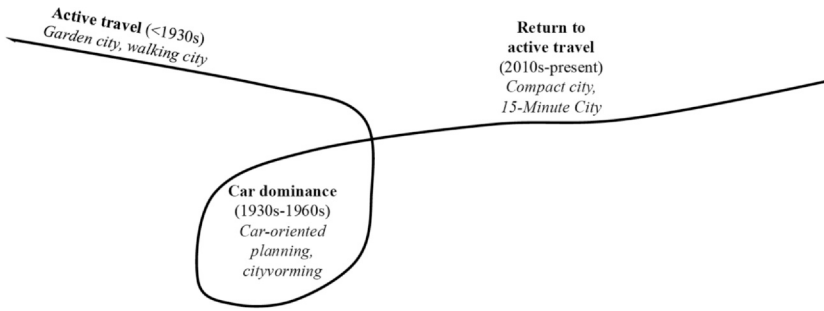

Fig. 22 Looping nature of the mobility planning over the past 100 years.

city, to a car-centric planning paradigm shaped by car-oriented *cityvorming*, and more recently, back toward active-travel oriented approached like the compact city and 15-minute city.

Simultaneously, Amsterdam is doubling down on its ambitions for a car-light city. As city officials stated: "The time when everyone could drive into the city is over. If we do not act now, the city will literally grind to a halt" (Hielkema and Kruyswijk, 2024). By 2050, Amsterdam is expected to have nearly 1.2 million residents. Without intervention, car traffic is projected to increase by 30 %. The city continues to grow, but the available space does not. To address this, Amsterdam has set an ambitious goal: petrol and diesel vehicles will no longer be permitted in the city by 2030. The municipality plans to achieve emission-free transport by expanding environmental zones and introducing zero-emission areas (NOS, 2019). However, it is important to note that while fossil fuel vehicles will be banned, electric vehicles (EVs) will still be allowed. This shift to EVs, though crucial for emissions reduction, does not necessarily represent a broader transition away from car-centric mobility. In 2023, Amsterdam officially lowered the citywide speed limit to 30 km/h (Klein, 2023)—fulfilling a demand that activists had been making since the 1970s.

6.3 Lessons from the past

Looking back at the three phases in Amsterdam's transport history we see that mobility transitions are complex, contested, and shaped by the interplay of actors, narratives, and events. While the path was not linear, each moment of disruption opened new possibilities for imagining and enacting a different kind of city. These historical lessons matter today. As cities around the world confront the climate crisis, energy insecurity, and growing demands for inclusive public space, Amsterdam's experience offers

a valuable reminder: mobility systems are not fixed. They are always dynamic and the product of political choices, social struggles, and contingent events. Change is possible—but it requires vision, persistence, and the ability to seize critical moments when they arise. This case shows that moments of disruption only lead to meaningful change when the foundational elements –social movements, research, and political will– are already in place. Crises act as punctuation marks –but only when those foundational elements are present can they trigger real change. Three key lessons emerge from this chapter:

First, synergy between grassroots activism and policymaking is essential for lasting change. Social movements bring attention to pressing urban issues—such as traffic safety, air pollution, and the need for alternative transport options—while political institutions must translate these concerns into concrete policies. The rapid transition away from car dominance in Amsterdam shows how the alignment of advocacy, research, and political will can drive systemic change. When the right conditions are met, societies can reorganize mobility systems remarkably quickly—but only when institutional structures are prepared to act on public demands.

Second, crises serve as catalysts but are not guarantees of transformation. While the 1973 Oil Crisis accelerated Amsterdam's transition toward alternative mobility, the COVID-19 pandemic—despite temporarily reducing car dependency and emissions—failed to produce comparable long-term shifts. This contrast highlights that crises alone do not create change unless they coincide with strong advocacy, clear policy frameworks, and institutional readiness. For mobility transitions to be widely accepted and effectively implemented, policies must focus on ensuring fairness, accessibility, and tangible benefits that are widely perceived among the general public.

Finally, policymakers and activists must be prepared to strategically leverage future disruptions—whether economic, environmental, or public health-related—to advance alternative mobility visions. This entails recognizing early signals of disruption, coordinating responses across institutions, and framing these moments as opportunities for systemic change. Governments should proactively support and incentivize policies that promote resilient, human-centered urban mobility, rather than waiting for crises to force abrupt adjustments. The interplay between activism, research, and governance is crucial in maintaining momentum and ensuring that moments of disruption lead to meaningful and lasting urban transformation.

While this chapter focuses on Amsterdam, the patterns discussed are likely applicable to other democratic regions facing similar social, spatial and ecological challenges. Amsterdam's shift from a car-centric city to a leader in multimodal transport was not inevitable; it resulted from a confluence of activism, external shocks, and timely policy changes. This transformation underscores the importance of seizing critical moments to implement lasting change. As urban congestion, air pollution, and climate change intensify globally, the lessons from Amsterdam's experience become even more relevant. The urgency for adopting an alternative mobility narrative is clear, particularly in the transition to post-fossil fuel transport systems.

The three key elements necessary for adopting an alternative mobility narrative—protests and social movements, research, and political will—can serve as a guiding framework for other regions when they are faced with a punctuation –such as a crisis. These factors play an important role in challenging the dominant narrative and transitioning away from fossil fuel-dependent transport systems. Just as the dominance of cars and their reliance on fossil fuels once seemed inevitable, the current narrative of car-dependence can also be contested. From a historical perspective, this mobility system has only been in place for a brief period, and its continued dominance is anything but guaranteed.

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CHAPTER SEVEN

Conclusion

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Contents

Abstract

This concluding chapter offers perspective on the complex challenges posed by an energy transition by revisiting the three perspectives on systemic transport change that were articulated in our Introduction. These include: the challenge of path dependencies within large technological systems; the challenge of constructing new discourse that can transform socio-technical imaginaries; and the challenge of adapting institutional structures to facilitate change. These three challenges are reconsidered in light of the findings that have been offered in the intervening chapters. By integrating perspectives on path dependencies, socio-technical imaginaries and evolutionary dynamics of institutions, the chapter draws upon the preceding research contributions to illuminate the need for comprehensive change across governance structures and social practices, recognizing both the barriers to and potentials for systemic transformation. Ultimately, the research posits that while the energy transition is fraught with challenges, it also presents opportunities for radical shifts in mobility paradigms that can be initiated and reinforced both from above and below, and through forces that originate either within or beyond the state's structure.

This volume is being published at a precarious moment in the history of major societal transitions. From the present vantage point, the world appears to be approaching what in retrospect could come to be seen as a watershed between alternative development trajectories. Looking back to the years immediately following the signing of the Paris Agreement in 2015, evidence was pointing towards the build-up of transition momentum. A sign of the times was multinational oil and gas giants like BP and Shell coupling their green rhetoric with investment strategies that appeared to herald a shift from

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fossil fuels to renewable energy (Gentile and Gupta, 2025). Around Europe, new and diverse actor coalitions were forming with an interest in decarbonizing transport (Niskanen et al., 2023; Walk and Stognief, 2022). Administrations in the EU (EC, 2019) and the US (Muratori et al., 2023) followed suit with ambitious policies to fundamentally decarbonize their transport sectors by 2050. Green stocks surged while "sustainable investing" became the favored financial strategy of the day, and for a brief period during the early days of the Covid pandemic, oil futures became negatively priced for the first time in history (Reed and Krauss, 2020). Around European and US cities, grassroots climate movements took to the streets to demand even more, much more, in the way of policies to rapidly phase out fossil fuel dependency (Jernnäs and Lövbrand, 2022).

To some optimistic interpreters of transition theory, these changes to long established trends and understandings all offered evidence of ruptures in the socio-cultural fabric of industrial modernity. To some, these pointed to the approach or even surpassing of "social tipping points", after which a return to the previous, unsustainable equilibrium was no longer possible (Milkoreit, 2023). In hindsight, though, there was nothing inevitable or irreversible about these processes, nor were they in many instances as far-reaching as they initially appeared. After a wave of public backlash to energy transition policies has swept across the EU and the US, landmark policy achievements have been either paused, watered down or reversed, while geopolitical disruption and market uncertainty has undermined the viability of supply chains and industries critical for the energy transition. The green discourse emanating from fossil fuel multinationals appears less a dramatic turn in investment strategies and more as a strategic positioning in which plural development trajectories remain open for them (Christophers, 2022; Yeo, 2025). The collapse of Northvolt in the Swedish north, once touted as the great battery hope of the EU, is indicative of the relative unpreparedness of EU industries to rapidly scale up production to meet the demands of a decarbonized transport sector. EU policymakers are realizing that a comprehensive energy transition requires industrial policy, but they are perhaps two decades behind China in this regard (Stylianou et al., 2025). Official US policy under several administrations gave credence to the observation that the country is stuck in a "fossil fuel trap" (Acemoglu et al., 2023). Since the re-election of Donald J. Trump, US energy policy has pivoted to re-emphasize the use of fossil fuels.

While the post-Paris transition optimism has thus been significantly dampened, a complete dismantling of the policy framework that was

established following the Paris Agreement is unlikely. From a transition theory understanding, accelerations in energy revolutions often exhibit incremental attributes (Radtke and Wurster, 2023), resulting from the "layering" of new rules added onto old ones and thus evolving into what appears as a new policy regime only in historical perspective (Lockwood et al., 2017). Perhaps what today appears as a number of "lost opportunities" for fundamental transport policy reform after Paris and Covid will later be understood as important moments in the disruption accompanying a dynamic policy paradigm shift (Hall, 1993). The extensive build-up of a renewable energy system in China, the world's largest emitter of greenhouse gases, indicates that an energy transition is in fact underway, as do statistics showing Chinese EVs overtaking ICEs in sales of new cars (Hossain, 2024). To the surprise of many, a recent report on EU greenhouse gas emissions revealed it is on course to reach its climate targets for 2030, even while political discussions about the 2040 target are set to become deeply contested (EC, 2025).

Yet, even if we accept the premise that fossil fuel energy is beginning to be displaced as the main energy source powering mobility, the question remains whether this partial and incomplete replacement goes far enough in ensuring a sustainable transport sector. As historian Jean-Baptiste Fressoz (2024) has argued, the very idea of an energy revolution is an historical misnomer. When examined more closely, modern industrial society has never, in fact, experienced an energy displacement, only energy accumulation of a new source layered upon its predecessors. While putting a sobering perspective on transition discourse, this perspective also highlights a crucial question at the heart of transition policymaking. Do public backlash episodes and institutional inertia in the energy transition reveal absolute limits of what can be achieved through policymaking, or are these challenges reflective of limited skill in, and inauspicious contexts for, adapting the existing policy paradigm? That is, could transition policies be designed and implemented more successfully to effectively break the shackles of the old energy regime and thus foster a radically new mobility paradigm? It may be that, as evidenced by multiple dimensions of disruption, society is approaching the level of turbulence where politicians and policy practitioners can take their transition capacity to the next level and attain crisis driven breakthroughs in stalemates that seemed previously intractable.

In various ways, the chapters in this book have contributed to understanding the potential for systemic change by illuminating when

institutional and social resistance to change reinforce existing transition boundaries, and when or how transition policies approach, or exceed, the threshold of systemic transformation. Our contributors have identified challenges and barriers to the energy transition, but they have also highlighted socio-political dynamics capable of precipitating change and thus overcoming those constraints. They suggest approaches, options and styles of governance that can enhance belief and confidence in an alternative energy pathway or reveal costs and risks that discredit and delegitimate business as usual. When examined closely, the change dynamics profiled in these chapters suggest that the conflict manifested in public backlash is only superficially a contest between progressivism and conservatism. From various angles, the chapters probe the more "wicked problem" of imagining and forging strategies for a radically different mobility paradigm that does more than extend business-as-usual through green(er) energy technologies. The extent to which such a vision is needed, desirable and even possible underpins the sustainable mobility discourse as explored in the chapters in this book.

The focus of this concluding chapter will be to revisit the three perspectives on systemic change in transport from the Introduction: A challenge pertaining to path dependencies within large technological systems; a challenge pertaining to discourse and socio-technical imaginaries; and a challenge pertaining to the evolutionary dimension of institutions. We do this by reconsidering concepts identified in the introduction in light of the findings that have been offered in the intervening chapters.

1. Transport as socio-technical systems

Chapters 2, 4, and 5 illuminate the energy transition as a problem that is embedded within large technical systems. Khan and Johansson show that the policy mix in Sweden has been focused on advancing technical strategies for transition to sustainable energy sources and conservation, with significantly less initiative devoted to the problem of reducing overall transport demand. Schojan and Schmidt-Hamburger similarly identify an urban-centric hegemonic discourse that has been adopted in Austria's strategy for transport transition policy that favors electrification and public transport, to the detriment of peripheral regions where low-density rural communities are not favorable to such solutions. Official discourse that ignores the social and economic disadvantage facing rural communities in

an energy transition is shown to trigger political backlash that can undermine policies and plans and precipitate rejection and abandonment of transition efforts.

Isaksson, Ryan and Trygg show that aspirations within one level of government to "think outside of the box" and advance a new paradigm in mobility planning may be stifled by institutional path-dependency in other levels or departments, whose collaboration is needed to advance a transition strategy. These three chapters reveal the challenges inherent in transforming the cross-sectoral attributes of the fossil fuel mobility paradigm, and highlight the risk of transition policies running into "reverse salients" (Hughes, 1987) if they fail to address multiple dimensions of needed change at the same time (Sovacool et al., 2025).

In its detailed mapping of the infrastructure and organizations that sustain mobility paradigms, Taylor and Fujita's chapter offers a distinct perspective on the large technical systems of transport. They demonstrate that large technical systems are not merely sustained by technical functionality but also reinforced by a socio-cultural web of habits, impressions, assumptions and material interests. In their assessment, the American gas station appears as a socio-material "assemblage" that tie together ingrained individual habits of consumption and mobility with the concrete aspect of job creation (Moss et al., 2016). This focus on obtaining fuel is an important insight into the heterogeneity of the various nodes that make up large technical systems, and the challenges involved in displacing them. This chapter points also to the path dependency involved in large technical systems and the tendency of new technical systems to evolve along similar lines as earlier ones – materially, ideologically as well as institutionally (Gökalp, 1992; Van Assche et al., 2024). With the exception of gas stations, electric vehicles seek to mirror the exclusivity and individualism offered by motor vehicles powered by internal combustion engines. While such mimicry may facilitate EV uptake and substitution for ICE powered vehicles, it may also limit the potential for spatial restructuring (e.g, repair of suburban sprawl) that could advance alternative mobilities such as walking, cycling and public transport. Schojan and Schmidt-Hamburger's contribution also illuminates the propensity for policymakers to follow a beaten path and propose "one-size-fits-all" solutions for transport decarbonization based on evidence, or model outputs, that only apply to a subset of the jurisdiction that the policy applies to.

Taylor and Fujita's analysis also speaks to the multi-level perspective by highlighting the interaction between users and the system level regime in

the energy transition. They show how material and institutional provision of decarbonized energy infrastructure is not by itself sufficient to accelerate the energy transition, which requires the active participation of users not only as consumers but as co-creators of the transition strategy (Schot et al., 2016). As EVs play a larger role in automobility, all drivers will need to adapt their behavior, including those who depend on a decreasing number of gas stations to fuel their ICE powered vehicles. Their chapter also raises the question of how an energy transition under way might be derailed through backlash against change in the policy regime. Such resistance to change could arise from within the established regime, motivated by powerful actors' economic stakes in business as usual (e.g., fossil fuel producers and distributors). Or it could come from those who rely upon fossil fuel combustion vehicles and feel threatened by the cost of switching to an EV or different performance characteristics of EV's. ICE drivers could even feel threatened by EVs when they see gas stations closing, or curtailing their hours, because of less demand for petroleum-based fuels.

The two chapters by van der Craats and van Lierop and by Schojan and Schmidt-Hamburger also probe the dynamics of directionality between regime and niche level actions and reactions to energy transition. Both contributions reveal the potential for bottom-up and grassroots initiatives to foster policy innovation. The experience that such regime changing dynamics can arise from both urban social movements in large cities like Amsterdam, and decentralized cooperation at the micro-enterprise scale in Austria's rural villages suggests how the potential for collaborative innovation to shift the policy paradigm in mobility could develop. These findings highlight a tension within transition theorizing regarding the role of grassroots mobilization in systemic change. Such policy initiatives can animate the forces of change balancing between the anarchic and uncontrolled, and the technocratically managed transition paths (Machin, 2021). Schojan and Schmidt-Hamburger's example of policy innovation in Austria is evidently a case of the latter, with transformative experiments in urban governance emerging as a popular model for creating change in policy regimes with official sanction from both national and EU levels. While German, real-life laboratories are less territorially bounded than similar experimental settings in other European countries, as shown by the authors, they still constitute a formalized project under controlled structures. To some scholars of green democratic processes, that would blunt their transformative potential as the balance of political power over the innovation agenda remains unchanged (Mouffe, 2022). However, as

argued by Smith and Ely (2015, p. 118), "the actual process of innovating at the grassroots itself serves to shift the democratic balance and to (re-) position power at the grassroots level." Schojan and Schmidt-Hamburger's chapter ends with an encouraging outlook on the potential for grassroots experimentation to have this effect.

Van der Craats and van Lierop instead look at the potential for transformative change in radical upheavals where global and local disruption coincide to delegitimate the status quo and open possibilities for change. By locating examples in history of social upheavals leading to changes in mobility paradigms, they are able to argue that social forces that are not controlled from above can unleash transformative changes, especially when these movements occur at the same time as international regimes create major economic and geopolitical change, as occurred during the 1973 OPEC oil embargo. The unmanageable and unpredictable aspect of such movements enable punctuating an equilibrium, when they occur alongside or in coincidence with exogenous shocks that destabilize an existing regime.

Thus, two competing but still reconcilable, understandings of transition directionality appear in these contributions. One where the landscape level sets the conditions for policy innovation at the regime level, which in turn feeds into niche-level policy innovation that generates policy feedback to the regime. Another where changes at the niche level reverberate rapidly through the energy system, filling a shortfall in capacity or legitimacy that is caused by some exogenous destabilization, to alter the conditions in the regime and even landscape. It taps into a classical philosophical debate of societal change ongoing since at least the times of the French Revolution, which has underpinned organization (Fornaciari et al., 1993) and transition theorizing (Lawhon and Murphy, 2012) for decades. The cause-effect dynamic actualized by that debate pivots around the issue of idealism and the structuring power of ideas. What comes first: a change of mind or change of matter? In the following section, we discuss how the contributions to the book relate to that question.

2. Transport as socio-technical imaginaries

The concept of socio-technical imaginaries provides a view on the transport system as an intricate web of infrastructures, institutions, cultural norms and ideas about progress. Jasanoff and Kim (2013) emphasize their future-shaping power. More than simply "visions" of the future, they are

manifested in policy and investments plans that have concrete material effects. Several of the contributions illustrate how transport imaginaries provide "institutionally stabilizing" (Jasanoff, 2015, p.4) trajectories for the mobility energy transition in a way that can influence the outcome. Khan and Johansson reveal the Swedish policy mix to be predicated on continuously increasing transport demand, with the resulting gap between transition objectives and increasing traffic to be bridged through energy efficiency measures and low or carbon free energy carriers. The authors identify historical, economic and political path dependencies which are partly nation-specific, and partly universal: car dependency and a culture of individual choice of mobility mode; a strong biofuel- and forest industry, as well as a significant auto manufacturing industry, and; a predominance and broad socio-political acceptance of taxation as a policy instrument. Together, these policy path dependencies can be said to form a socio-technical imaginary that precludes disruption of established mobility patterns and reinforces the car paradigm, albeit in a green guise. The conclusion from that chapter sends echoes of Jacques Ellul's (1964) dystopic vision of the future as one where technology frames problem formulations as well as the solution space for all planning activity. As long as visionary thinking is discursively limited by this paradigm, neither policies nor infrastructure investments will be directed to explore functionally or ethically different avenues for the energy transition.

Similarly, Isaksson, Ryan and Trygg identify an assemblage of formal and informal rules for infrastructure planning that reinforces the car paradigm against attempts to establish an alternative mobility vision. The fact that infrastructure planning is directly tied to state investment into physical infrastructure illustrates how socio-technical imaginaries are at the same time discursive and material, and how institutional norms can manifest in future-shaping planning activities. These two chapters give further support to previous findings of path-dependencies in the future-making activities of Swedish transport planning, and the barriers to disruptive planning that are raised by mutually reinforcing institutional and discursive "conditions of possibility" (Haikola and Anshelm, 2022; Witzell, 2020). They also indirectly raise the issue of power and responsibility in shaping the future for the energy transition, which is especially pertinent in governance systems of vertically and horizontally distributed political agency (Stegmann Mccallion, 2007). As Haikola and Anshelm (2023) have shown, Swedish transport decarbonization policy discourse pivots around a struggle between the central government and the Transport Administration regarding who must assume the responsibility for achieving national

climate targets for the transport sector. While especially pronounced in a country with relatively independent state agencies, the basic problem is universal for mobility energy transition policy. Instances where long-term decarbonization objectives are matched by concrete policies and state investments are few. Accelerating the energy transition in transport thus requires a parallel and comprehensive process of change across instructions, industrial sectors and levels of government (Sovacool et al., 2025). As long as more ambitious transition policies remain the exclusive domain of separate entities within the state apparatus, as is the case in the chapter by Isaksson, Ryan and Trygg, they will not be diffused across society. They will not, as it were, manifest in socio-technical imaginaries.

It is senseless, however, to use the vantage point of the present to pass any definitive verdict on such attempts at reshaping socio-technical imaginaries. It is possible that they initiate small changes on limited scales that will, eventually, translate into wider systemic change, a point also made by Isaksson, Ryan and Trygg. In the two chapters by van der Craats and van Lierop and by Schojan and Schmidt-Hamburger, the potential to shift established socio-technical imaginaries is explored instead from a bottom-up perspectives. Both make the case that politicization of transport policies is likely to emerge most effectively from the grassroots or local level, driven by the immediate concerns of real people rather than nationally established transition policies. They indicate that disconnects between dominant transition discourses and lived realities are one of the most formidable obstacles to the energy transition (Portinson Hylander et al., 2024). They do that, however, using very different examples.

In Schojan and Schmidt-Hamburger's chapter, a center-periphery gap is explored with the conclusion that a comprehensive energy transition is impossible without the support and participation of rural regions where mobility access and needs are very different from those in the urban centers. It shows that energy peripheralization is a persistent problem for energy transition policy, despite being a longstanding feature in transition studies (Golubchikov and O'Sullivan, 2020). More optimistically, it also points to attempts of rectifying the economic and spatial gaps between established socio-technical imaginaries and local realities through democratic innovation. In the chapter by van der Craats and van Lierop, progressive change is instead brought about by democratic outbursts of mass mobilization in urban centers. It reveals the radical political potential of cities, but read in relation to Schojan and Schmidt-Hamburger's chapter, it further indicates the distance between concerns of urban and rural residents as a source of tension in transition policy (Arning and Ziefle, 2020; Van der Ploeg, 2020).

Despite these differences between the chapters, both can be used to draw the same conclusion for energy transition governance. Popular, and sometimes popu*list* (Lockwood, 2018), transition discourse has been acknowledged in the transition literature as founded on claims of injustice (Sovacool et al., 2019). That applies regardless of whether the discourse is premised on conservative (Martin and Islar, 2021) or leftist political claims (Meyer, 2024). Popular and populist mobilization against transition agendas can certainly challenge and stall the energy transition (Förell and Fischer, 2025), but it is also possible to see a progressive political potential in such challenges (Wanvik and Haarstad, 2021). One study by Ćetković and Hagemann (2020) makes the case that polarization in climate policy need not necessarily lead to gridlock but can also energize policy by opening the political action space. On the basis of that insight, the chapters by Schojan and Schmidt-Hamburger and by van der Craats and van Lierop give hope that through expanded space for democratic engagement, the transport energy transition may be greatly accelerated. Whether it be through uncontrolled mass mobilization or relatively controlled local state-civil society experimentation, democratic input can create new political alliances that enable policy paradigm change. In the final section of this concluding chapter, we turn to this dimension of the energy transition in transport.

3. Transport as socio-technical evolution

Paradigms exert an enduring influence over many public policy areas by justifying the pursuit of particular ends, and the use of preferred means, over an extended time period. As in science, policy paradigms rely upon an ongoing belief in the causal connections between actions, objects and outcomes. And when those connections are superseded by different ideas, such as when relativity and quantum mechanics displaced the Newtonian laws of physics, new possibilities for understanding and potentials for problem solving emerge. In public policy, belief in the causal relationships between policy instruments, policy goals, and policy outcomes can also shift from anomalies that discredit those purported relationships. In the transport sector, such beliefs about how the world works, and what role mobility should play in building a better future, exert profound influence through the paradigm that guides contemporary policy.

Reduced to its essential causal mechanism, and at the risk of oversimplification, the contemporary transport paradigm has been guided for

more than a century by the belief that more mobility will always yield better outcomes across a range of economic and social goals. More goods movement is seen to enable economic growth and development through increasing trade. And more passenger travel, both local and longer distance, is seen to expand opportunities for upward social mobility through offering access to a wider range of educational programs, employment options, and cultural experiences. Such beliefs exerted a clear influence on the Swedish Transport Administration's inflexibility about adding road capacity to the infrastructure plan for Tomtebo Strand's development, as explored in Chapter 2 by Isaksson, Ryan and Trygg.

This embedded preference for more mobility in transport policy has become linked to an energy policy paradigm in which fossil fuels, mainly refined from petroleum, are seen to offer the best option to power aircraft, motor vehicles, and ships. As a result, the world's economic growth has been correlated with the expansion of capacity for moving people and goods by transport modes that burn fossil fuels in ever increasing amounts, and with similarly increasing greenhouse gas emissions. Chapter 2 demonstrates how challenging it can be to break out of the norms and standards that entrench such goals into planning and development initiatives.

As the effects of climate change have become more pronounced, and more disruptive, there have been increasing anomalies that challenge the established transport policy paradigm that more mobility will always lead to better outcomes. Extreme weather events, droughts, wildfires, and other ecosystem disruptions have become increasingly impactful and difficult to ignore. Second order impacts from these natural disasters have had destabilizing effects on agriculture, thus reducing food security, and encouraging human and animal migrations away from increasingly hostile habitats. From rising insurance premiums to the growing movement of refugees who are displaced by climate crises, the consequences of climate change create growing evidence that established plans and programs for mobility are not producing the uniform benefits envisioned by the incumbent transport policy paradigm. Thus, options for changing policy receive more attention, at the same time as debates over the efficacy and appropriateness of existing policy intensify. Chapter 6 illustrates an example of past policy disruption, illuminating how the 1973 Oil Embargo triggered national transport policy reforms in the Netherlands. Van der Craats and van Lierop demonstrated how this openness to change at the national level enabled policy entrepreneurs to advance innovations at the local level that have reoriented the urban mobility away from private motor vehicles and toward cycling and pedestrian priorities.

The state is situated at the nexus of policy disruption, and can play a unique role in either advancing a policy paradigm shift or resisting such change. The material and symbolic factors associated with mobility are closely regulated, and often fostered by state policies and practices in the transport sector. State agencies can choose to reinforce these established flows of resources and information in the face of climate-induced socio-economic disruption. Or state actors, from senior public servants to elected officials, can introduce policy alternatives that open transition pathways for the role of mobility in society, and the sources of energy used to power that mobility. In Chapter 4, Khan and Johansson identify how state action on fiscal policy steered Sweden's transport sector toward decarbonization which began advancing transition outcomes until political backlash led to policy retrenchment.

In his seminal article on policy paradigm shift and the state, Hall (1993) identified a correlation between increasing politicization of challenges to an established paradigm and the likelihood that state actors would endorse different goals for a policy sector. He identified the 1980s macroeconomic policy shift from the Keynesian paradigm that focused on adjusting tax and fiscal policy to manage aggregate demand to the monetarist paradigm that focused on controlling the money supply as a better way to manage unemployment and inflation to illustrate how state initiative was needed to enable fundamental changes in policy. He demonstrated how this change emerged from the outcome of political conflict that gave power in governing to actors who adopted policy alternatives.

Governments' inability to remedy the stagflation that followed a global energy shock in 1973 set the stage for neo-conservative political parties to take power starting in 1979, with the Thatcher government's election in the United Kingdom. Neoconservative political victories enabled the establishment of neoliberal policy paradigms by replacing previous policies with deregulation, privatization, and fiscal austerity that are collectively identified as the policy pillars of contemporary neoliberalism. Thus, political realignment through electoral competition enabled change in government's leadership, which then established new goals for economic and social policies pursued by the state. And the trigger for that realignment was the discrediting of the existing policy paradigm through an accumulation of anomalies that discredited the incumbent paradigm as no longer being relevant or capable of solving key problems facing society.

While the current climate emergency may not have yet produced impact levels that reach extremes that are equivalent to those measured on

Okun's (1963) "misery index" of combined inflation and unemployment that were reached during the 1970s stagflation, there are reasons to anticipate such a pain point will arrive during the future. When this occurs, conflict over what needs to be done about climate change and its second order socio-economic effects can be expected to become a focus for mass politics, with realigning elections, or perhaps less democratic forms of regime change, occurring as the miseries inflicted by climate change accumulate. Such triggering of populist protest against transition plans that appear to ignore or disadvantage vulnerable groups could come, for example, from rural communities like those considered by Schojan and Schmidt-Hamburger in Chapter 5.

Such conditions could enable the state to introduce considerable changes in transport policy based on a break with the paradigm guided by a "more equals better" logic that has guided the planning and development of transportation systems as we know them today. In that future, some of the transition possibilities that have been explored in this volume, ranging from energy source substitution and electric vehicle adoption considered by Taylor and Fujita in Chapter 3 to spatial restructuring that enables more active transportation discussed by Van der Craats and van Lierop in Chapter 6, are likely to be embraced and enabled as policy priorities. Some of the pitfalls and path dependencies that have inhibited energy transition to this day will then be overcome and avoided in future mobility developments that embrace the energy transition that remains so speculative and contested at this time.

4. Conclusion and outlooks on the energy transition – a matter of acceleration?

The introduction set out some key socio-political challenges for the energy transition in transport. The chapters have explored them in various ways and also highlighted potentials to use them as levers for accelerating the energy transition in transport. If the energy transition is imagined as an evolutionary process, where do we currently stand, based on the chapters?

In periods of flux, it is common for uncertainty and discontinuity to create evidence that is interpreted in starkly different ways by policy actors and the general population. We appear to be in such a moment, when it comes to the energy transition in transportation, based on the experience that has been assembled in the preceding chapters. There is a 'glass half-

empty' version which says that the chapters starkly reveal barriers to the energy transition. This version becomes even more persuasive when set against the background of massive popular backlash to climate policies around the western world. In this context, it should be noted that most chapters deal with policy failures that have become evident even before the more severe backlash that has occurred over the last two-three years. Those results indicate that western governments and state institutions have so far failed to formulate policies and plans that correspond to the wickedness of the transport decarbonization challenge (Radtke and Wurster, 2023).

But there is also 'glass half-full version' that says that the chapters indicate that the dynamics which could unlock an energy transition have already begun, and that we are in fact at the stage in the Punctuated Equilibrium Theory right before when the transition accelerates. While it is usually only after a new equilibrium has been established that the punctuation which led to it can be fully appreciated, the evidence we have considered demonstrates that we have reached the beginning of the end of the current policy paradigm that has enabled and reinforced the use of nonrenewable carbon-based fuels for transportation. Sooner or later, a new path will become established, and the transition to post carbon energy sources in transportation will be seen to appear increasingly clear and convincing. The chapters provide empirical lessons that show transformative policy change can be driven both from above and from below, from within and from outside of the state apparatus, and that state institutions might be both engines and barriers to transformative change. To conclude, we believe this book strengthens the case for acknowledging the state as the key institutional locus for transformative change and for democratic engagements within the transport energy transition (Machin, 2021).

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