

7 An automobile nation at the crossroads

Reimagining Germany's car society through the electrification of transportation¹

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Introduction

After decades of relative stability within the motor industry and automobile culture, a considerable shift can be observed. The trend is unsteady but relates to fundamental and irreversible developments in the world. In the emerging economies such as China and India, highly populated areas are burgeoning into 'megacities', creating pollution and transportation issues of unprecedented proportions. Industrialized countries have been facing similar problems for decades, while their sporadic efforts to counteract the downsides of mass motorization mostly have come to nothing. By now, increasingly ambitious goals to mitigate climate change and the resulting pressure to modernize and decarbonize all areas of human activity have disrupted this inertia. The transition towards sustainable, decarbonized transportation systems has become an urgent matter around the world.

Policymakers in most countries consider the electrification of transportation with energy from renewable sources key to lowering emissions from transportation (IEA, 2009, 2014), but economic factors are deemed equally important. Leading car manufacturing countries such as the United States, Germany and Japan perceive this looming transformation as a threat to their national business models, but also as an opportunity to get an advantage in an anticipated future economy dominated by 'green' products and services. These countries have already experienced a few unsuccessful attempts to promote electric cars as low-emission alternatives to their conventional counterparts.² In contrast to the previous ill-fated efforts, this time, the technology, economic circumstances and consumer attitudes favour electrification. Even if it is too early to assume that a substantial share of vehicles will be electric anytime soon, the imagination around the 'car of the future' has never been more vivid.

Because of the perceived need to innovate, the image of the car and its design, purpose and meaning have become more contested than in previous times. The automobile's future has opened up and seems more uncertain than ever before. Some engineers, mobility experts and self-proclaimed futurists no longer envision a mere substitution of the internal combustion engine with an electric powertrain. They champion a radical departure towards novel scenarios, in

particular the driverless car, as well as the seamless integration of electric vehicles (EVs) into electrical grids and communications networks (Wentland, 2016). It would not be the first time that changes in infrastructural arrangements and mobility practices would reinforce the course of economic and cultural development in a certain direction. This observation was as true for the formation of the suburban sprawl in the 1950s as it is for today's digitally mediated sharing economy. Both experiences reveal the density and contingency of the sociotechnical imagination around the automobile and how the seemingly mundane technical thing cannot be separated from political interests (Schwedes, Kettner and Tiedtke, 2013) and larger cultural dynamics (Ozaki, Shaw and Dodgson, 2013).

In fact, modernity itself has always been closely intertwined with the automobile. Contemporary social relations would not be possible without a highly sophisticated economy of car manufacturing, road infrastructure and traffic regulations. However, there is much more to it than that. The car has also become synonymous with what Charles Taylor (2004) identifies as the 'modern social imaginary', which emerges from the notions of progress, individualism and access to public life. Perhaps because society's basic fabric is so deeply imbued with the values, dreams and materiality of automobility, the story of the car exhibits few twists over the course of the twentieth century, despite a long-established awareness about its environmental impact. Now the story might be about to change.

In this chapter, I will explore recent changes in the electrification narrative, focusing on the particular case of Germany.³ The country is and has always been an automobile nation in multiple ways. From the early history of mass motorization during the Third Reich to the global success of the German luxury car as a distinct brand and status symbol, the automotive industry has constituted the core of the nation's economy for almost a century. Simultaneously, to the German people, the automobile came to signify wealth, success, family values, pleasure, self-determination and a positive sense of nationhood as part of their collective post-Second World War identity. The conventional car has become part of Germany's national pride and central to its export-driven economic model.

Perhaps because Germany's industry, politics and culture are almost inseparable from the traditional regime of automobility, the electric car has been struggling to gain ground. Unlike in the United States, where within a decade Silicon Valley entrepreneur Elon Musk has built the multi-billion-dollar EV company Tesla Motors from scratch, or even compared to other European countries such as Norway or France, Germany's car manufacturers and consumers have remained sceptical. Against this backdrop, the German government passed one of the internationally most ambitious plans to electrify transportation. The 2009 National Initiative not only dedicated billions to research and development (R&D); it also brought together a heterogeneous alliance of stakeholders from business, politics and science to advance the joint project. Perhaps unintentionally, this questioning of the status quo paved the way for a broad range of imagined mobility futures associated with the EV into the discursive arena. Some of them represent a radical departure from the taken-for-granted notion of automobility.

These developments raise analytical questions with significant normative implications: what are the actor coalitions that co-produce and stabilize these imagined futures across different domains of society? What kind of desirable and obtainable future do they propose? How do they reimagine the car and its associated infrastructures as well as their users and mobility practices?

In this chapter, I argue that the electrification of transportation is more than an intended, manageable sustainability transition, as scholars in innovation studies usually analyse it (Geels, 2012). It also represents a rearticulation of the old promise of an automobile nation. Departing from this premise, I examine the recent attempt to re-envision automobility in Germany through the lens of ‘sociotechnical imaginaries’ (STI), a concept developed and elaborated by Sheila Jasanoff and Sang-Hyun Kim (2009, 2015). This kind of analysis seeks a more nuanced understanding of both technical transitions in the making as well as the institutionally and discursively sedimented habits of mind that highly technologized societies engender. After recapitulating some of the key features of the traditional German imaginary of automobility and its genealogy within its historical context, I will distinguish three major ‘rearticulations’ of future mobility. All of them draw together different assemblages of artefacts, infrastructures and users. They are being championed and stabilized by heterogeneous actor alliances. These coalitions partially overlap but are also competing to establish the dominant narrative in the larger discursive arena of the German energy transition.

Electrification, sociotechnical imagination and the nation state

Much of the recent literature has emphasized the economic momentum and institutional obstacles to a large-scale transition towards sustainable transportation but has only marginally taken into account the values, practices and desires attached to the automobile. Scholars in innovation studies have produced a number of insights on the prototyping and selection dynamics within the R&D of alternative fuels (Bakker, van Lente and Meeus, 2012). They also looked into economic prospects of users adopting EVs (Sierzchula *et al.*, 2014) and policy strategies such as government subsidies (Bakker and Farla, 2015). However, these studies seem limited in scope. They have avoided discussing the historical continuities and discontinuities, the nation-specific idiosyncrasies and the narratives and myths that allow engineers, policymakers and industry stakeholders to constitute and maintain a persistent ‘system of automobility’ (Urry, 2004).

Research from science and technology studies (STS) favour a different kind of perspective, paying closer attention to the interrelations between actor-networks, technical materialities and users. Unfortunately, little work on transportation has been done within STS.⁴ The notable exceptions dealing with the electrification of transportation (Callon, 1980; Brown, 2001; Hård and Knie, 2001) remain analytically compelling but obviously cannot capture the far-reaching implications posed by the very recent developments in this area. In

related disciplines, prominent works done by historians (Sachs, 1992; Volti, 2004; Seiler, 2008) and sociologists (Featherstone, 2004; Urry, 2007; Canzler, 2008) indicate a sustained interest in the history and culture of automobility in society as a whole. However, electric vehicles are usually excluded from the picture or discussed only as an early competitor for the combustion engine at the beginning of the twentieth century (Kirsch, 2000; Mom, 2004).

Other technologies have been studied in greater detail, leading to essential conceptual contributions. The history and sociology of technology have sensitized the social sciences to important aspects such as relevant social groups, interpretative flexibility and closure mechanisms, which enable and shape any given scientific and technological leap (Pinch and Bijker, 1984; Latour, 1986; Rammert, 1997). In particular, the work on large technical systems (Hughes, 1983; Mayntz and Hughes, 1988) and how such infrastructures reflect cultural preferences and historical shifts remains crucial to the understanding of current transitions towards sustainable technologies (van der Vleuten, 2004; Geels, 2007). However, this approach merits an extension. In order to probe the 'seamless web' (Hughes, 1986) that binds together the emerging EV technology and its infrastructures and society, the analysis has to aim attention at the desirable, collective futures that sustain such an interdependent network of materiality and meaning today.

The STI framework (Jasanoff and Kim, 2009, 2013, 2015) builds on the insights from the history and sociology of technology but adds the layer of collective, discursive and institutional co-production. It highlights the 'shared understandings of forms of social life and social order' (Jasanoff, 2015, p. 3) that technology is imbued with, but also stabilizes. This process can be observed particularly well on the level of the nation state. Recent empirical works have demonstrated how technologies contribute to the formation of national identities and how, vice versa, nation-specific cultures shape sociotechnical regimes (Ballo, 2015; Dennis, 2015; Felt, 2015; Felt, Schumann and Schwarz, 2015). These studies pay homage to Benedict Anderson's (1983/2006) influential definition of a nation as an 'imagined community', made possible by emerging technological opportunities. Anderson attributed the formation and stabilization of national imaginaries to the emergence of communication infrastructures all over the country, which allowed the people within a certain territory to develop a shared sense of belonging, even though they would never meet in person. He also reflected on the material manifestations of state power in and through sociotechnical devices of nation-making such as the map, census and museum.

Jasanoff and Kim have emphatically pointed to the state's role 'in defining the purposes of publicly supported science and technology', especially 'what constitutes the public good, which publics should be served by investments in S&T, who should participate in steering science and by what means, and how should controversies be resolved about the pace or direction of research and development' (Jasanoff and Kim, 2009, p. 120). The reciprocal problem of how 'national S&T projects encode and reinforce particular conceptions of what a

nation stands for' deserves similar consideration. Both are two sides of the same coin, which renders the question of which came first meaningless. My analysis of the transportation transition follows the notion that national STI 'can penetrate the very designs and practices of scientific research and technological development' and that the resulting politics 'may shape not only the narrow issues surrounding those specific enterprises but also wider social and political understandings about a nation's past, present and future' (Jasanoff and Kim, 2009, p. 124).

Automobility represents an ideal case study for investigating deeper into a nation's STIs. This observation is particularly true these days, as the taken-for-granted regime around the internal combustion engine is being challenged by a variety of competing mobility futures based on the electrification of transportation. Each proposed mobility future reflects attitudes towards urban space, ownership and self-expression, as well as the technological preferences and materialities within a larger social landscape. Although the recent electrification efforts are to a large extent driven by global trends and transnational corporations, the STI perspective calls attention to the specificity of each nation's socio-technical arrangements and experiences in the innovation process. The framework allows me to focus on the mutual stabilization of social imaginaries, technical artefacts and actor coalitions, within both Germany's historical entanglement with automobility and its current attempt to electrify transportation.

While the STI approach explicitly refrains from black-boxing 'innovation' or 'the state', this principle equally applies to the technopolitics of non-state actors such as corporations, NGOs and organized social groups. In the organizational field related to the competing technological rearticulations around the electrification of transportation, the state is only one actor among many. State politics are not necessarily coherent. In fact, the larger the actor, the more likely it is to occupy several – often contradictory – positions within a given field of imagination, which becomes especially apparent considering the position(s) that car manufacturers have taken. This finding is consistent with the assumption that a nation is not a monolithic entity but is composed of various cultural currents. Some of them are explicit and publicly articulated; some remain implicit or concealed. As a result, actor coalitions may align with different themes and currents within a national STI to advance their cause.

Although STIs appear to be rather stable pillars of the modern social order, the micropolitics, rehearsals and contestations should not be left out of the picture (Rammert, 2002, p. 183). Social imaginaries do not change abruptly, because they signify 'ways people imagine their social existence, how they fit together with others, how things go on between them and their fellows, the expectations that are normally met, and the deeper normative notions and images that underlie these expectations' (Taylor, 2004, p. 23). Technology introduces a disruptive force and dynamism into these seemingly firm collective dispositions. Scholars in STS have been particularly aware of this fact. Innovation can bring about rapid change and uncertainty that opens up seemingly taken-for-granted sociotechnical assemblages to the possibility of change. Emphasizing this point,

Gabrielle Hecht argues in her account of nuclear power in France that 'ideas about national identity do not grow by themselves', since they 'must be actively cultivated in order to persist'. As a consequence, 'articulating and rehearsing these ideas often reformulates them' (Hecht, 2009, p. 12). In the case of the competing rearticulations oscillating around the electrification of transportation, only their repeated mobilization and stabilization across various domains of society can prevent them from falling into oblivion (again). Likewise, the image of the car that many people hold dear had to evolve slowly over the course of Germany's troubled history in the twentieth century.

The promises of an automobile future

The ways in which modern Germany has imagined itself throughout its history are closely intertwined with the history of the automobile. Although the story of the car in Germany undoubtedly represents a success story, it also symbolizes the country's ambiguity towards what modernity stands for. At the turn of the twentieth century, the majority of people perceived cars as something foreign and strange, a passing trend in an unsettling time marked by rapid social and economic change (Volti, 2004, pp. 39–42). Kaiser Wilhelm II, who ruled Germany until the end of the First World War, notoriously stated, 'I believe in the horse, the automobile is merely a fad soon to disappear again'. Other contemporaries worried about motorization and, in particular, the escalating number of traffic fatalities. Many people equated the car with the violent surge of industrialization and urbanization, causing chaos and disturbance to their traditional lives. The anxiety did not last for long.

The emerging affection for the 'horseless carriage' was associated with two seemingly contrary predispositions, namely bourgeois romanticism and industrial tradition. Contemporary historians were able to identify the first traces of what later became the suburban lifestyle in the early romanticism around the car as a means of escapism to the countryside, which initially appeared as an activity in bourgeois circles in the first decades of the twentieth century (Sachs, 1992, p. 155). On the production side, early car manufacturing echoed Germany's economic tradition of industrial design, iron and steel craftsmanship, and manufacturing in general (Radkau, 1989, p. 86). Long before mass automobility, the STI around the car expressed key tensions within Germany's delayed path towards industrialized modernity (Kocka, 1988), tensions such as those between rural and urban life, tradition and progress, and economic inclusion and exclusion. It also gave a glimpse into the nexus between technology, industry and state politics that would emerge over the course of the century.

From the 1920s onwards, national policies pushed for mass motorization several times in German history. The proclaimed 'will to motorization' during the Third Reich gave birth to a comprehensive programme that encompassed the Fordist upscaling of car manufacturing, the nationwide development of highways and the promotion of cars as an affordable consumer product for every proud German citizen. The programme primarily aimed at boosting the economy

and reducing unemployment. It also anticipated something that later became an integral part of the automobile society: the promise of equal access to the nation's wealth and opportunities. The iconic Volkswagen Beetle was the seductive expression for what came to be known as 'the people's car' (Rieger, 2013). The historian Wolfgang Sachs notes that,

while in the twenties the automobile had conquered the desires of the masses, recreating a tense distance between those at the top and those at the bottom, the National Socialists now pledged to overcome the distance and help even the German worker get some wheels. [In doing so,] the regime lent recognition to the aspirations of the petty bourgeoisie in that it promised to strip the automobile of its luxury status in favour of a solid status as a use object.

(Sachs, 1992, p. 56)

In retrospect, the National Socialists' imagined future of mass motorization can easily be dismissed as propaganda, but this would not do justice to the imaginative forces it unleashed. The programme had few consequences for actual sales figures in the 1930s. In fact, Germany fell further behind other countries in per capita motorization (Canzler, 1999, p. 28). Nevertheless, the state's effort commences the story of automobility as a kind of socioeconomic foundation for the nation. The VW Beetle and the desire for private transportation forged the modern STI of automobility and social mobility as two sides of the same coin. For the nation as a whole, the car became the manifestation of progress, technological achievement and territorial unification. The government motorization programme reinforced that sentiment, which lasted much longer than the Third Reich itself.

After the war, the newly born (West) German Federal Republic continued bolstering the car industry and encouraged private car ownership. Car manufacturers played a pivotal role in building the – partially mythical – narrative of the West German post-war 'economic miracle' (Radkau, 1989, p. 310). They created esteemed brands of cars for export and a multitude of jobs at home. The 'American Way of Life', imported during the time of the occupation and beyond, contained all that was needed to mould the desolate and disoriented country into a respectable, peaceful member of the then-emerging Western political and economic sphere. However, it took West Germany well into the 1950s before mass motorization became a real success within its own borders. The federal government subsidized domestic manufacturers while it also took every step possible to make car ownership more attractive, not only in terms of affordable prices.

The American model extended way beyond the restructuring of West Germany's industry and also inspired Germany's collective vision of a desirable and obtainable socioeconomic future (Burkart, 1994). The country's political parties unanimously agreed that the future belonged to the suburban 'home in the green'. This national consensus included social democrats, conservatives, liberals and even the Communist Party. When it came to the combination of home

and car ownership, opposing ideologies could justify similar living arrangements while imagining fundamentally different forms of social life and social order. The ideal of the serene home outside the city supported the conservative notion of economic, political and cultural integration into the middle class. At the same time, home and car ownership catered to the idea of autonomy and self-determination using private property, which was explicitly embraced as 'the cultural will' of the working class by the Social Democratic Party (Polster and Voy, 1991, p. 303). From the moment that the state established this political consensus, it did not take long before the STI of automobility spread into other social realms.

Among urban planners and architects, the paradigm of the 'automotive city' mirrored the economic developments. As in many other Western countries, modernist philosophies of urban infrastructure gained momentum. In West Germany, one of its key figures was Hans-Bernhard Reichow, who coined the influential term 'auto-friendly city'. Similar to the ideas of the Swiss-French designer and urban planner Le Corbusier, Reichow's (1959) vision conceived the modern city as a complex organism, echoing the penchant for societal holism and technocratic functionalism during that period. Reichow perceived the traditional European city as disharmonious and hampered by obsolete material arrangements, which were no longer suitable for the era of mass automobility. Those outdated settlement structures, with cluttered housing and shabby streets, had to make room for a scientifically organized city, which would drastically improve life standards by separating work, living and consumption. At first, urban planners started realizing this vision in infrastructure projects around the country. Contrary to the United States, where this model prevailed quickly after the war and materialized in the urban sprawl, in West Germany the implementation of the auto-friendly city stopped halfway. The country settled for a much more moderate version of this modernist scheme. The majority of the population hung on to the traditional structures of the old city centres but embraced the promises attached to the functionalist penchant for private house and car ownership (Polster and Voy, 1991, pp. 309–310).

The system of automobility resulting from these political and cultural dynamics was also fuelled by a political economy of desires, where a tangible consumer product could signify societal aspirations and late industrial romanticism. Between the early 1960s and the first oil crisis in 1973, the number of registered cars quadrupled, the number of driven kilometres tripled and the length of the German autobahn system doubled. The government actively facilitated this process. It cut taxes on car ownership, subsidized home building and invested heavily in infrastructural development. A powerful STI of what the automobile meant for the nation engendered the state's involvement with mass motorization. For the recuperating West German society and its people, owning a car was synonymous with territorial unity (through the sophisticated highway system), societal access (through increased spatial mobility), economic self-esteem (through conspicuous consumption) and national pride (through the identification with West Germany as a global economic force).

Auto manufacturers and the growing car lobby jointly provided the language and imagery for this symbolic citizenship of automobility in the German version of what the cultural historian Cotton Seiler (2008) called the American ‘republic of drivers’. Since its foundation at the beginning of the century, the General German Automobile Club (ADAC), which counted 18 million members in 2012 out of a national population of 81 million people, has launched several influential ad campaigns and even mobilized protests against government regulations. In their 1965 ‘Manifesto on Motorized Travel’, the ADAC proclaimed automobility to be a universal right, in its words an ‘indispensable means for satisfying basic needs’ in a ‘free and progressive society’. For that reason, there is ‘an obligation to solve the great problems ahead of us as a nation, which stems from the dynamic between technological progress and the economic prosperity that results from it’. This obligation concerns the state in particular. According to the organization, the government is constitutionally as well as morally bound to pursue a progressive, car-friendly society in order to achieve national welfare but also to ‘nourish and deepen the friendship between the peoples’⁵ (ADAC, 1965, translated from Sachs, 1984, pp. 94–97).

Even though the traditional STI of automobility began to wane in the 1970s, it remains powerful. Traffic has lost its environmental innocence. Since the dramatic rise in air pollution and the two oil crises, it has become an administrative and political issue (Canzler, 1999, p. 19). The green movement and a new generation of urban planners have challenged the German car industry at home, as have new competitors abroad. Nevertheless, automobility still sustains key discourses of individual well-being and national identity. It has managed to integrate the conflicting poles of Germany’s (now reunified) modern sociotechnical narrative, including the tensions between socioeconomic classes, between urban and rural living, individualism and belonging, and technological progress and historical continuity. The modern social imaginary, as Taylor describes it, powered by its key notions of national progress, individualism and equal access, has entrenched the car within society (Rammler, 2008). The car has come to represent all these promises and has given them a tangible, sociotechnical reality, even as concerns about its sustainability were widely acknowledged on a more reflexive level of social discourse (Beckmann, 2001). This strong cultural bond has made it difficult to modernize private transportation and is still considered to be the biggest obstacle to the electrification of transportation today.

Emerging crisis and possible departure from the previous path

In 2015, the Volkswagen emissions scandal was a symbolic earthquake for the combustion engine-based auto industry. The secret manipulation of the software in several diesel engine-based models, which made the vehicles appear significantly cleaner during emissions testing compared to their real benchmarks, shattered consumer trust in the brand. It also reassured the proponents of alternative fuels that conventional engines cannot keep up with tightening regulations. The

scandal resulted in a legal battle in the USA and other countries, putting additional pressure on Volkswagen and its competitors. Meanwhile, German regulators and the general public remained relatively calm. The diverging perceptions of the deliberate manipulations have also shown how intimate the relationship between the German business interests, engineering cultures and national sentiments still is. While state officials and intergovernmental organizations across the industrialized world agree on the inevitability of substantial change, Germany as a country seems somewhat reluctant to follow through.

The Volkswagen scandal is only the most recent event in a jolting but ongoing shift in the STI of automobility. Defending the traditional regime has become increasingly difficult over the past decades. Although no sea change can be discerned yet and car manufacturers have continued to succeed with their fossil fuel-based models, German environmentalists and transportation experts have been advocating for an electrified transport network based on renewable energy sources. The transition towards a more sustainable, decarbonized society has become an urgent matter around the world as well. Car makers had previously pacified environmental concerns through incremental technical innovations such as the catalytic converter, efficiency gains in the internal combustion engine and more sophisticated traffic regulations. However, this strategy has started to show its costs and limitations. In the mid-2000s, the European Union committed the German government to ambitious greenhouse gas reduction plans. The consistently high oil price at that time put additional strain on the economy. Most importantly, the government was afraid that German car manufacturers could lose their edge on the global market, especially in the emerging Asian economies, if they did not invest in the electrification of their next-generation models (NPE, 2010b, p. 9).

Even though there is no consensus on how to achieve a carbon-free transportation system, the vast majority of experts and intergovernmental institutions agree that an immediate electrification of transportation must play a crucial role in this transition (European Commission, 2008; IEA, 2009, 2012). This assessment puts Germany in a difficult position. The leading car-producing nation, particularly esteemed for its fuel-consuming premium car brands, perceives any alteration of its key industry's business model as costly and risky. The German government has found itself in a paradoxical role in which it is urged to stimulate technological innovation while still undeniably being captivated by the traditional system of automobility, manufacturing and infrastructure.

Despite some ill-fated attempts to inject momentum into EV development in the 1980s and 1990s (Hård and Knie, 2001), the issue of electrification has once again become a central concern in Germany's industrial innovation policy. In 2009, the National Initiative, composed of representatives from industry, science and the state, set out to turn Germany into an EV 'lead market', bringing one million plug-in electric cars to the streets by 2020. The country also aimed at becoming the 'lead producer' for battery cars on the global market, investing 1.5 billion euros towards that end (Bundesregierung, 2009, 2011). Unlike in previous episodes, the outlook for a breakthrough on the market looks somewhat brighter

now: the technical components, especially the battery, have become more sophisticated, cost-effective and versatile (Catenacci *et al.*, 2013). Cities and states around the world have introduced traffic privileges, tax discounts and other economic incentives for these vehicles. Even consumer attitudes have slowly come to view EVs in a positive light. In Germany, however, the shift to what has been dubbed 'electric mobility' (*Elektromobilität*) appears to be a laggard compared to the USA, China, Japan, France and other countries in absolute sales numbers as well as marketing by the countries' respective manufacturers.⁶

The breakthrough on the domestic market, in particular, seems to be a long time coming. In 2014, the market share remained at a meagre 0.4 per cent, with an estimated 24,000 EVs on the roads (NPE, 2014, p. 4), which is a low absolute number, even compared to much smaller countries such as Norway or Denmark. As an accepted and widely diffused innovation (Rogers, 1962/1983), the electrification of transportation in Germany has not yet reached its tipping point. German customers seem to be sceptical or ignorant of the fully battery-powered models that are currently available. They continue to regard EVs as far too expensive and limited in their capabilities (Franke and Krems, 2013). As a consequence, when talking about the progress made towards sustainable private transport, most media outlets frame it as both a failure of German car makers to deliver convincing products and a crisis of Germany's industrial and transportation policy. Experts criticize the National Platform, the formerly praised coalition of key stakeholders from industry, research and government, for being little more than a paper tiger. In their view, the corporatist institutions set up in the late 2000s mostly legitimized industry and research subsidies but did not offer a vision for a major transformation of the current system of automobility. Radical alternatives have been articulated by different actors, often with a much longer time frame in mind.

Even though presently it remains uncertain when electric cars will turn a profit, the imagination around the 'car of the future' has become more vibrant and more contested, especially within certain parts of the German expert community. With converging technologies and new corporate alliances, the design, purpose and meaning of the automobile seem to be open to reinterpretation. This ambiguity is partially due to the elusiveness of the object itself. Within the current discourse, one seemingly simple question is rarely asked: what does the 'electrification of transportation' mean? Such a definition would provide a frame of reference for the imagination of expert communities and potential users alike while highlighting certain technologies and application scenarios that deserve further attention and investment. The electric powertrain allows for different systems of energy storage, which can be a battery, a fuel cell, hydrogen or any fuel transformable into electricity during driving. In fact, the storage component is the most elaborate, dangerous, expensive and profitable part of an EV. All solutions require different infrastructures for refuelling or recharging. Which one will prevail?

While some actors deliberately aim at a 'technological fix' (Rosner, 2004) – that is, a substitution of some elements of the car – others try to break away from

the established pathway of automobility by broadening the technological vision. They strategically rearticulate key themes of the STI around the car, evoking new images and desires for a new 'republic of drivers'. Automobility constitutes the perfect arena for futuristic reimaginings, as it has always represented much more than just a sophisticated machine or consumer product. It is a collective and distributed process, contingent upon intricate arrangements of persons, things, and signs (Rammert, 2012). Nonetheless, after so many decades, automobility has become a taken-for-granted part of modern life, a black box that is now being reopened through a more serious attempt at electrifying transportation. The EV entails an elaborate sociomaterial ecosystem of charging and maintenance, not to mention the need for new professional groups, business models and configurations of routines in everyday life (Shove, Pantzar and Watson, 2012). This situation creates a moment of possibility within the imagination around the car not only with regard to the decision between competing drive technologies but to different assemblages of actors, artefacts and practices (Oudshoorn and Pinch, 2003).

Towards a new STI of automobility: three competing 'rearticulations'

Although the old economic regime and cultural image of the conventional car persist in the media as well as on the streets, an array of competing mobility futures has emerged. Because the 2009 National Initiative could not keep up with expectations, other players have been able to fill the resulting vacuum of imagination with more radical ideas. Car manufacturers have been unwilling to move away from business as usual unless compelled to do so. The National Platform, the governance unit for the original stakeholder alliance, crumbled in the wake of disappointing sales numbers. This erosion gave way to the formation of new actor coalitions, including companies and organizations that had no previous association with transportation. Electrical grid operators, utilities and information and communication (ICT) companies gradually entered the stage with a different set of goals and expectations. NGOs, mobility experts and dedicated 'visioneers' (McCray, 2012) have been paving the way for them already by championing alternative transportation scenarios for decades. Many of the new corporate players have shown little interest in participating in the current EV market, but instead have rearticulated the STI of automobility for the next generation's technology. Meanwhile, this volatile situation allowed the car industry to adapt to the challengers, partially reforming aspects of the existing regime while drawing on traditional stories and values attached to the automobile.

The brief history of automobility in Germany provided above demonstrated that the STI of automobility has played a significant role in shaping current attitudes towards urban space, ownership and self-expression. In turn, social practices across all areas of life have nourished the collective sociotechnical imagination around the car for almost a century. This mutual interdependence has produced a very stable set of technological preferences – for engineers,

policymakers and users alike – and created a seemingly inescapable situation within Germany's larger economic and cultural landscape. The proposed electrification of transportation should be viewed against this backdrop. The STI of automobility is ingrained in the forms of social life and social order in contemporary German society. Reassembling automobility is a driving force in social change, and, at the same time, social change is a condition for a successful technological transition.

I identify three major rearticulations of mobility, by which I mean three distinct visions of what a desirable system of (electrified) automobility should look like, as well as how and to what end the current structures would be reformed.⁷ All of these rearticulations shape different assemblages of artefacts, infrastructures and users by creating different kinds of relationships between them. These emerging sociotechnical configurations are being championed and stabilized by heterogeneous alliances of actors. As a result, they are distinct in scale and force, especially in light of the actors' sources of capital, the degree of institutional support and how they currently enact their scenarios. Each evaluated rearticulation has to align with certain aspects of the traditional image of automobility as well, which is full of tension and ambiguity in itself.

The three rearticulations of the STI of automobility promote alternative socio-technical assemblages, some aligning with the existing system of automobility and some going beyond the traditional understanding of the car, addressing fundamental shifts within contemporary societies. The first rearticulation can be summarized as 'fixing the technology' (Rosner, 2004), which includes a set of technologies and actors that is in many ways heterogeneous but also unified by the belief in some invention, ideally a technological breakthrough. For reasons I will further elaborate on, this can be seen as the most conservative articulation of future mobility or, in fact, a continuation of the previous system and its promises with some adjustments. The other two are more radical and broader in scope. The second rearticulation assumes that the energy transition and the electrification of transportation constitute natural allies. The actors articulating this vision try to 'find a new purpose' for the EV. They propose to turn the battery car into a functional part of the emerging 'smart grid' infrastructure. The third rearticulation moves the focus away from the technology to the conscious citizen. In this imagined future, drivers break away from the paradigm of combined car and home ownership by joining the post-materialist 'sharing economy' and using alternative means of transportation.

Rearticulating the old promise: fixing the technology

All previous attempts to position the EV as a viable alternative to the conventional car were not only doomed to fail; they also had one thing in common: they assumed that consumers had a specific image of a desirable car in mind, an image they were used to and, thus, not willing to change. As a consequence, most of the engineering around the EV tried to emulate the capabilities of conventional vehicles. In many cases, it continues to do so. The majority of current

EVs are refurbished versions of popular models, in which engineers have replaced the internal combustion engine and fuel tank with an electric powertrain and battery. Ideally, within the paradigm of so-called 'conversion design', both the manufacturer and the driver would have to adapt as little as possible. It is therefore not surprising that, compared to the range and refuel speed of a conventional car, no EV could ever stand a chance.

General Motors challenged this paradigm for the first time with its 'EV1', the first car systematically designed as an electric vehicle, emphasizing the light coachwork, unique driving features and futuristic design elements. This design was celebrated as exceptional industrial R&D and, at least from the engineer's viewpoint, as a liberation from the burden of history: The electric car of the future did not have to be identical to the internal combustion engine-based car of the past anymore. The STI of automobility, nonetheless, was still limited to individualized modes of transportation suitable for modern family life within Californian suburbia. Today, the EV1 has almost been forgotten due to its short commercial life. Engineers and industry experts rarely refer to GM's pioneering vehicle as a point of departure. However, the idea of purpose design, which acknowledges the fact that EV technology has specific strengths and weaknesses, has become the dominant paradigm in the engineering process.

In the last couple of years, car manufacturers have started introducing distinct models that they specifically designed to drive electric. Being aware of the fact that they are marketing expensive and, in the opinion of many consumers, inferior products, most manufacturers are trying to convey an 'aura of high tech' (Henderson, 1998). By using touchscreens, advanced driving assistance systems and recognizable designs, they encourage conspicuous consumption among environmentally concerned drivers and simultaneously try to enrol technophile early adopters in an exciting new trend. Tesla Motor's high-tech luxury cars, the 2012 'Model S' and 2015 'Model X', are prime examples of this commercial strategy. Some German automakers, especially BMW and Mercedes, have quickly adopted this scheme, while the Silicon Valley start-up is progressing to the next stage of its expansion plan. Tesla announced that it would begin production and delivery of its mass market-oriented 'Model 3' in 2017, promising the range and features of its premium counterparts but at a much lower retail price. Tesla's competitors are yet again under pressure to catch up by delivering cars that can also convince more traditional customers.

The green high-tech luxury approach has been internationally successful within a small niche market, but, for the envisioned large-scale electrification, most industry experts agree that there has to be rapid technological progress. In particular, the limited capacity of battery technology is perceived as a bottleneck. Electrical engineers argue that with the current lithium-ion technology, only incremental improvements can be achieved towards cheaper and more powerful batteries. Ideally, a breakthrough innovation could bring an electrochemical cell type into play that would address all the crucial issues impeding progress towards electrification, namely range, costs and safety. The myth of the possibility of a 'miracle battery' dates back to the early twentieth century, when

Thomas Edison wanted to outrace petroleum cars, which were, at the time, perceived as more forceful and long-lasting ‘adventure machines’ (Mom, 1999, p. 19). Needless to say, Edison, although making significant inventions along the way, could not ‘fix the technology’ to the extent he intended, measured by the standard set by the combustion engine. The petroleum car triumphed, while the battery vehicle vanished.

Later R&D projects, such as the German Rugia experiment (1992–1996), concluded that battery technology was still not yet ready to take over the streets. Echoing this belief, in its National Initiative the German government put the Fraunhofer Society, one of Europe’s largest application-oriented research networks, in charge of pushing electrochemical research and exploring the effects of scale for domestic mass production. It also created a distinct task force on battery R&D within the National Platform. When the National Initiative started in 2009, many experts were hopeful they would see battery technology fixed sooner or later. They assumed the boom of mobile electronics would be a catalyst for advanced R&D in electrochemistry, a research field that has been, according to the common narrative, stagnating for many decades, at least in Germany. While being conservative in its general predictions, the EV battery task force deliberately maintained the hope that a post-lithium-ion technology was feasible within a decade and could vastly exceed the limitations of today’s batteries (NPE, 2010a). The German government was urged to invest in electrochemical research and other EV-related R&D areas to keep up with the international competition.

Following this appeal, the government focused on a long-term R&D strategy instead of offering tax incentives or subsidies for consumers as France and Norway did. The latter approach would have meant encouraging consumers to buy imported EVs, as German manufacturers had no competitive electric models available when the National Initiative took off. The investment in battery R&D still seemed surprising to some experts, considering the German government and the EU had just come out of a sobering hype–disappointment cycle in hydrogen and fuel cell research.⁸

The R&D-based rearticulation of automobility constitutes the dominant narrative today. It builds on the hope that through investment in some technology the EV could be turned into a proper substitute for the conventional car. From an engineering perspective, a breakthrough such as a miracle battery or a hydrogen car represents a radical deviation from the currently dominant regime. From the motor industry’s view, it would require profound changes in its production, supply chains and labour force. ‘Fixing the technology’ would mean ‘fixing the car industry’, a notion that German automakers have met with resistance. At the same time, encouraged by the state’s promise to make this transition for the industry as smooth and inexpensive as possible, the National Initiative implicitly reframed the electrification of transportation as a contained, orderly transition.

The government prioritized the economic well-being of car manufacturers and its central position in any articulation of an electrified transportation future over more radical scenarios. German policymakers maintained their close

relationship to the industry, while the industry, at least in theory, supported the National Initiative. The responsibility for actual progress, in terms of a large-scale diffusion of EVs, was delegated to an elaborate network of public and private R&D institutions. Since the technology was not yet ready, any serious market endeavour had to be postponed until it was. Early users validated this belief. They confirmed that consumers were, indeed, not willing to exchange their conventional car for a more expensive and somewhat limited imitation. These studies, however, took the STI of traditional automobility for granted and, thus, confirmed the inferiority of the battery car they had assumed at the outset. The imagined future in this scenario appears highly conservative. The technology fix aligns with all the key elements of the current STI of automobility. It emphasizes the modern ideals of individual self-determination and national economic progress, as well as existing infrastructures and practices such as the arrangement of private home and car ownership.

The technology fix narrative allowed the three involved groups – the state, the automotive industry and R&D institutes – to create a comfortable arrangement, which promoted the vision of electrified transportation while postponing painful changes and conflicts for the future. By reimagining only the technical components of the car as the ideal solution, all other aspects of the ‘automobile nation’ could be maintained and once again legitimized.

Finding a new purpose: cars as energy infrastructure

While the belief in a technological fix remains strong among experts and policymakers, the initial confidence in this type of solution has waned over time. With Germany dramatically lagging behind its goals and no technological breakthrough in sight, the media and political actors have started putting pressure on the government again. The resulting crisis has paved the way for new challengers coming from outside the transportation industry, in particular utilities, electrical grid operators and ICT companies. They promote the notion that the electrification of transportation and the transition towards renewable energy sources are two sides of the same coin. Energy systems engineers and industry experts have proposed treating the electric car as if it were part of the electrical grid infrastructure (Kempton and Tomić, 2005). Since the EV is, simply put, a large mobile battery, proponents of this approach argue that they could store surplus energy from volatile sources such as wind and solar power and feed it back into the electrical grid when needed.

Some experts argue that the integration of EVs into the ‘smart grid’ or ‘smart home’ would create synergies and open up novel economic applications (van der Kam and van Sark, 2015). The EV could be the key component needed to achieve high shares of renewable energy sources in the future energy mix (Loisel, Pasaoglu and Thiel, 2014). This technological trajectory implies a seamless interaction between the car and the electrical grid. An EV would not just charge until the battery has reached its maximum capacity; instead, the idea is that the car is actively connected to the grid as much as possible to provide

technical services to either the grid operator or a local microgrid. It would be embedded within a virtual ecosystem, where it is constantly connected to a server hub, available to either the driver or another agent such as a service provider. The supporters of this scenario claim that this would raise consumer interest in EVs. If drivers made their cars available to the utilities and grid operators, they would be compensated financially, which could lower the costs of EV ownership significantly, as some economic calculations suggest (Beeton and Meyer, 2015).

In the industry and expert community, these ideas have already succeeded in revitalizing the hopes and high expectations that were disappointed in the late 2000s by low oil prices, unfavourable press and dissatisfaction with the state of battery technology. The commitment to the joint project within the industry had weakened. Investments went down as critics called the technological fix narrative into question, which had previously mitigated and unified the actor coalition.⁹ While the optimism among industry experts, urban planners and policymakers slowly recovered, their attention moved further away from the market barriers to the futuristic high-tech image of mutually integrated transportation, energy and communication networks. The government reports published from 2010 to early 2014 reflect this trend (NPE, 2010b, 2011, 2012, 2014). The themes of ‘energy transition’ and ‘information technology’, which were previously marginal, now constitute an important pillar within the German electrification narrative.

I interpret the expert and policy community’s search for a new purpose for the EV as an attempt to make the stagnating electrification trajectory immune to short-term economic failures. It brings new, powerful stakeholders and images into play while leaving the car industry in a pivotal position, at least for the moment. This strategy distracts from potential conflicts between, on the one hand, established manufacturers, who are used to incremental innovation and long product cycles, and, on the other hand, new players from other industries, who are interested in the potentially disruptive opening up of the locked-in system of automobility. These nascent assemblages are still very much society (and technology) ‘in the making’ (Callon, 1987/2012) and, thus, open to interpretation. One such understanding could be that the smart grid integration represents a technological fix somewhat similar to the miracle battery but on a larger scale. In the grander version, it is the energy system, not just private transportation, which requires a technological breakthrough to be able to become more sustainable and avoid the failures of the past.

Again, it is up to R&D consortia to elaborate the rearticulation of interconnected infrastructures. Regardless of the known issues with such systems (Mullan *et al.*, 2012), several government agencies, as well as parts of the industry, have dedicated significant efforts and funds to marrying transportation and the electrical grid. Dozens of state-supported public–private partnerships have emerged across Germany over the past couple of years, while corporate public relations departments and some individuals have boosted the idea behind these often very technical enterprises. These actors include people specializing in technology forecasting, future studies, or, in most cases, simply the promotion of

early-stage products and services. Public speakers such as ‘chief futurist’ Lars Thomsen or Lawrence Burns, a former R&D executive at General Motors, have become vocal advocates for the radical transformation of urban landscapes. In his book *Reinventing the Automobile* (2010), Burns and other industry experts predict and encourage the radical ‘transformation of the DNA’ of the automobile, the electrical grid and communication networks into a ‘system-of-systems’ (Mitchell, Borroni-Bird and Burns, 2010, p. 7).

Even though this articulation of electrified mobility taps into the trope of ‘disruptive technology’ semantics championed by Silicon Valley entrepreneurs, it also resembles a much earlier mobility paradigm. In fact, the notion of private transportation and electricity as mutually integrated infrastructures is anything but new. In the late nineteenth century, densely populated cities such as New York, London and Berlin were about to be electrified. This electrification primarily concerned street lights and apartment buildings. However, many of the planning scenarios and futuristic depictions included transportation as well. At that time, the first generation of EVs had become popular among upper- and middle-class people, especially women (Mom, 2004). They viewed the ‘explosion engine’ as dirty, loud, inconvenient and, thus, unsuitable for an urban environment. Similar to the gasoline-fuelled myth around the ‘adventure machine’, which later grew into the STI of automobility, the STI of universal electrification produced its utopian images and mythologies of modernity. Berlin, for instance, sought to fashion itself into an imagined ‘Elektropolis’, a place where scarcity was eradicated once and for all by technological progress (Dame, 2011).

In contrast to the less ambitious hope of replacing the environmentally harmful combustion engine by fixing the seemingly deficient battery technology, the energy infrastructure narrative can be seen as a radical departure from the traditional STI of automobility. Such scenarios often place the EV explicitly within an urban environment, rather than in a rural or suburban context. Some scenarios even propose a combination of ride-sharing and, at some point, autonomous driving to maximize the efficiency and profitability of the envisioned ‘system-of-systems’. Instead of aligning with the taken-for-granted image of the driver as the master of time and space, the heroic individual who expresses him or herself through the car, this rearticulation applies the logics of (electrical) grids and (communication) networks to the system of automobility. It assumes that drivers will give up their vehicles and routines to become users of mobility services offered through smart technology.

There are also much less centralized and corporate versions of this rearticulation, coming from local energy cooperatives, citizen initiatives and progressive-minded mobility experts (Canzler and Knie, 2016). They advocate independent, community-based micro smart grids, based on the same vehicle-to-grid technology. Even a single household can utilize a combination of, for example, solar panels, a stationary battery and an EV to become energy independent. Such existing products can be read as counter-narratives to the grandiose corporate smart city utopias, articulated mostly by ICT companies. Simultaneously it caters to the

traditional STI of automobility, with an even stronger emphasis on bourgeois autonomy, by upholding the traditional arrangement of private home and car.

The vision of a pure patchwork of small, self-sufficient households or neighbourhoods remains marginal in the overall discourse. In most scenarios, overarching structures are meant to serve efficiency and energy security purposes. Urban planners and grid operators will most likely favour centralized, corporate-run solutions. With vehicle-to-grid assemblages being one of the more distant and elusive electrification scenarios, only time and ethnographic inquiries into the practical enactments of this rearticulation can tell how things will play out in different sociotechnical configurations.

Redefining the citizenship of mobility

The previous two rearticulations of the STI of automobility centred on technological innovation, but what if all the technology needed to electrify transportation was already available? EVs have been around for more than a century. Modern models such as GM's EV1 started out with high hopes, targeting a potential mass market. Commentators on the EV1's debacle attribute its failure not to disinterested consumers but to the catastrophic commercial strategy, which led to the termination of existing leasing contracts and a universal recall by GM (Hård and Knie, 2001, p. 97). Reflexively engaging with past failures and shortcomings, environmentalist non-profits, citizen groups and academic experts argue that society should abandon its confidence in technological fixes and acknowledge that sociotechnical change primarily means a rearticulation of our collective desires, beliefs, and habits (Canzler and Knie, 2011). They also stress the urgency for immediate action. In their view, pollution and climate change are pressing problems that should be tackled with existing means and not postponed to the future.

Car sharing could be the first step away from the old paradigm of car ownership, at least within an urban context. In Germany, car sharing has been relatively successful in the major cities, with one million registered drivers combined across all providers (bcs, 2015). As yet, only small shares of these fleets are electric. In 2012, however, the French auto manufacturer Citroën launched the first electric-only car-sharing programme in Berlin, marketing it as 'the driving experience of the future'. Although the economic feasibility of commercially shared EVs is contested compared to conventional vehicles, the companies agree that the (perceived) limitations about the range and quick recharging do not apply in the context of car sharing. The obstacle of a high purchase price becomes irrelevant for the potential driver as well. The German motor club VCD, the eco-oriented counterpart to the General German Automobile Club, actively encourages drivers to use car sharing as often as possible, as long as the service providers are using electricity from renewable sources.

The VCD and other environmental organizations also promote mobility services beyond automobility. They campaign for the improvement of the so-called intermodality between various means of transportation. Instead of relying on

cars entirely, drivers could use them as needed. Most of the time, the argument goes, cars could be left at the car park if there were other more efficient means available. Trains could allow for long-distance trips in combination with EVs for short drives to and from the station. Similarly, commuters could transfer from cars to public transport before entering the city, thus avoiding traffic jams and parking fees. The idea is not entirely new. It has been discussed by transportation experts since the 1960s, first in the context of freight transport and, increasingly, concerning public and private mobility. The vision of intermodality proposed in these scenarios often includes the EV as a substitute for the conventional car, but is not limited to automobility. Cars of any kind are more often depicted as part of the problem than part of the solution. Environmental organizations argue that within an intuitive and flexible transportation system, cars will automatically become less attractive. Within the intermodal paradigm, even the most affordable EVs with a range lower than 80 kilometres are perfectly suitable for almost every participant's mobility needs.

Unlike in the former rearticulations, there is no necessity for expensive R&D, but academic experts still play a crucial role in advancing this otherwise marginal position. Pushing the STI of automobility beyond private ownership and detaching the car from the perception of socioeconomic achievement goes against deeply rooted beliefs in Germany's modern collective identity. It also confronts the national constellation of auto manufacturers, R&D institutes and government agencies, which perceives itself to be the backbone of the German economy. As a consequence, economic and sociological studies that show the inefficiencies and failures of the system of automobility become powerful devices in public communication and political lobbying. They draw attention to little-known facts such as the rarity of long-distance trips among the vast majority of the population or the extensive periods of time cars remain idle in their car parks. Such studies have even informed the regular governmental progress reports issued by the National Platform (NPE, 2014, p. 16). Nevertheless, these figures are mostly meant to confirm the National Initiative's economic goals to be viable but obstructed by the supposedly ignorant public. The reports continuously imagine drivers who exhibit an irrational range anxiety and technological conservatism.

Although the National Initiative and its challengers both seek to convince the public of electrified transportation, they are motivated by entirely different rationales. For these mostly large German corporations represented in the National Platform, the economic stakes are high in this transition. Their rearticulations of the STI of automobility may encompass technologically radical scenarios such as turning EVs into a component of the energy infrastructure. They cannot, however, promote a vision where innovation is mostly a change of attitudes and practices. A more efficient use of cars through car sharing and the integration of public transportation into the system of automobility could mean lower sales numbers. Moreover, the STI of automobility, which helped to forge the German economy and nourished the post-war modern social imaginary, would not simply be rearticulated in terms of new technology but could fade away entirely.

In this third rearticulation, the ‘citizenship of automobility’ is being redefined. What the environmentalist non-profits and mobility experts are asking for is nothing less than to abolish the ‘republic of drivers’ and rewrite the constitution of modern mobility. The electrification of transportation is envisioned as only the beginning of a larger societal shift towards individualization, as well as sustainability, which also comprises the rapid advancement in digital communication and the so-called on demand or sharing economy. In the ideal future city, people would deliberately say ‘no’ to a particular type of convenience and status expression through car ownership. The advocates of this partially electrified but mostly car-free future employ similar narrative strategies, depicting cities that are highly accessible and at the same time sustainable, post-materialist and individualistic (Rammler, 2014). These themes align with an entirely different German STI, the environmentalist values and goals that date back to the early period of industrialization (Radkau, 1989). In a modern understanding, they have become institutionalized and central to public discourse after the emergence and political consolidation of the green and anti-nuclear movement in the 1970s and 1980s.

Conclusion: the dreamscapes of mobility

Throughout its history, Germany has imagined itself with and through the STI of automobility. The car industry and automobile culture paved the nation’s way to modernity by capturing and placating the emerging tensions such as individualism vs. belonging, technological change vs. historical continuity, socioeconomic inclusion vs. exclusion, and rural vs. urban. In this regard, they have contributed to the constitution of what Charles Taylor calls the modern social imaginary. This interdependence has produced a robust set of practices for both engineers and drivers alike, which constitute the reality of Germany’s larger economic and cultural landscape, and vice versa.

Recently and despite previous failures, the push towards an electrification of transportation has created a moment of possibility within the STI around the automobile. Although the conventional car still dominates public discourse, as well as the roads, a range of competing electrification futures has emerged within the expert and policy arena. The 2009 National Platform turned out to be mostly a paper tiger, but the issue allowed new alliances to form under the umbrella of more radical mobility futures. Each of the three presented rearticulations articulates what a desirable mobility future should look like and how and why the current regime should be changed (see Table 7.1). Heterogeneous alliances of actors co-produce and stabilize the envisioned sociotechnical configurations. As a consequence, each proposed mobility future varies in its scope, force and normative assumptions.

The rearticulations entail different notions of the involved artefacts, infrastructures and users and how they relate to each other. They align with certain aspects of the traditional image of automobility, which is in itself full of tension and ambiguity. Alternatively, they tap into STIs beyond the car, such as energy

Table 7.1 Comparing three rearticulations of the sociotechnical imaginary around the car

	<i>'Rearticulating the old promise'</i>	<i>'Finding a new purpose'</i>	<i>'Redefining the citizenship of mobility'</i>
Actors involved	Federal government, automotive industry, R&D stakeholders	Federal government, energy and ICT companies, futurists	Environmentalists, municipalities, mobility experts
Institutional position and power	Dominant and stable (incumbent position in the mobility field)	Emerging and unstable (challenger position in the mobility field)	Marginal; supported by a robust but lose network across society
Narrative focus	Inferiority of the EV, fixing the technology	Technological synergy and convergence	Post-materialism, behavioural change
Temporality	Breakthrough of S&T expected in near future	Long-term visions of technological utopias	Immediacy of change, urgency of action
Strategies	Continuation through partial technical innovation, postponement of radical change	Experimentation, disruption, introduction of new business models	Grass-roots advocacy, expert engagement, focus on available technology

independence, environmental protection and post-materialism. This finding applies to the attempt to redefine the 'citizenship of mobility' in particular, but also versions of the 'car as energy infrastructure' concept. Both address fundamental shifts within contemporary societies, instead of just focusing on 'fixing the technology'. The belief in some technical breakthrough remains strong. It can be seen as a hope to perpetuate the previous cultural matrix and its promises. The more radical articulations of electrified transportation challenge this belief in two contrasting ways. One situates the EV within the even greater narrative of the transition towards a sustainable society in the distant future. The other stresses the urgency of change and the fact that, to a certain degree, all the means necessary for a completely redesigned, low-emissions urban transportation network are already available.

The question is not which of these rearticulations will ultimately prevail. The past episodes in the history of German automobility – the incomplete manifestation of Reichow's 'auto-friendly city', for example – tell us that most likely the world to come will turn out to be a combination of the proposed scenarios. There is already considerable overlap and fluidity in between the narrative streams I have tried to separate neatly for the purpose of analysis. Perhaps things will play out entirely differently. Empirically probing STIs can neither point towards the most likely nor the right pathway into a (sustainable) future. Instead, this framework draws attention to the interdependence between competing technological developments, persisting path-dependencies and cross-cutting cultural underpinnings. Understanding the (re)visions of any given STI

remains a goal for scholars and, hopefully, for policymakers as well. Looking at the implicit assumptions and power structures behind today's competing socio-technical configurations in the making and their blind spots from the STI perspective could help engineers, experts and policymakers to become more aware of them and open them up to debate.

Notes

- 1 Many thanks to Weert Canzler for his helpful comments on an earlier draft of this chapter. The chapter also benefited significantly from the remarks made by the reviewer and the editors of this volume.
- 2 Sociologists Hård and Knie (2000), historians Kirsch (2000), and STI scholars Fogelberg (2000); Callon (1980); and Brown (2001) have presented several case studies and analyses that looked into the reasons why electric cars have failed in such a variety of historical and national contexts. Although all studies point to similar technological and economic obstacles, no universal conclusions can be drawn for today's situation. With transportation, in particular, the opportunities to innovate seem to be closely tied to a country's or region's mobility culture and industrial politics. What has not worked in a specific time and place could very well work in a different setting – and vice versa.
- 3 The case study is based on continuous ethnographic fieldwork over the course of three years, including 30 interviews and informal conversations, within the German EV community. The main results for this chapter are supported by a comprehensive document analysis. My data includes public speech transcripts, observations, artefacts, government reports, commercial materials, visual advertisements and presentations at trade fairs. In particular, I looked into various next-generation application scenarios that have been proposed by companies across different sectors of industry, ranging from car manufacturers to utilities companies and IT firms. My interpretative approach is informed by a mix of sociological discourse analysis (Keller, 2012), situational analysis (Clarke, 2005) and visual sociology (Harper, 1988).
- 4 The most recent *Handbook of Science and Technology Studies* (2007) mentions 'cars' or the 'automobile' only a couple of times on over 1000 pages, most notably in the article on 'user–technology relationships' written by Oudshoorn and Trevor Pinch (2008).
- 5 My translations from the original German. The passage quoted last reads:

Das Automobil sollte nicht nur als Symbol des Wohlstandes angesehen und bezeichnet werden. Es ist viel mehr einer der bedeutungsvollsten Aufträge an die Politik, die Voraussetzungen dafür zu schaffen, daß es für alle zum Segen des technischen Fortschritts wird und dabei seiner schönsten Aufgabe zu dienen vermag: die freundschaftlichen Beziehungen der Menschen und der Völker untereinander zu ebnen und zu vertiefen.

(Sachs, 1984, p. 96)

- 6 BMW represents a notable exception from this inertia. The car company has seen moderate success on the market with its critically acclaimed premium 2014 models BMW i3 and i8. It also dedicated significant funds to R&D. In 2015, BMW joined forces with the market-leading electric car producer Nissan to speed up the deployment of charging infrastructure in a number of countries.
- 7 The rearticulations I describe stem from an inductive analysis of documents and expert interviews, which I have combined with three years of ethnographic observations in the German context. This means that there are indeed positions that are not represented here, since they have been muted or excluded from the discourse (Clarke 2005, p. 181). I decided to leave out such possible but marginal or simply unarticulated futures from

the analysis. This decision is based on the fact that sociotechnical imagination is, by definition, infinite. In order for an idea to become relevant for social practice, it must be institutionally stabilized and publicly performed, even if this consolidation is limited to a national expert community.

- 8 In the early 2000s, many European governments put their hopes and research funds into hydrogen research, which was, back then, believed to be close to a breakthrough (Bakker, van Lente and Meeus, 2011). Generating hydrogen from water is energy-intensive but could be done using renewable energy sources. A hydrogen-fuelled car could drive potentially carbon-free, while matching the range and refuelling speed of conventional cars. This technological fix would have combined the advantages of both the battery vehicle and the petroleum car. However, by the time the National Initiative took form, industry experts and policymakers deemed the hydrogen technology to be still too distant from a serious application and explicitly excluded it as possible scenario from the national EV road map. Recently, hydrogen has seen something of a renaissance, since it has become clear that, in spite of a rapid fall of production costs, nothing close to a miracle battery was in sight.
- 9 This was quite obvious when I started conducting my fieldwork in early 2012. The Forum Electromobility and the Berlin Agency for Electromobility, two state-funded governance units for the National Initiative, each hold annual conferences on the status quo of electrification. In 2012 and 2013, the atmosphere at these events can be described as pessimistic or even devastated. The discussions mainly revolved around Germany's technological lag in battery research and manufacturing, potential customers' range anxiety and the auto industry's reluctance to commit to more ambitious goals. With every subsequent year, the call for the 'miracle battery' was expressed less frequently at the conferences and workshops I participated in. Instead, application scenarios based on the idea of the EV as smart grid infrastructure gained traction in spite of their technical and economic elusiveness.

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