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Stasis, dynamism and emergence of the e-mobility system in China: A power relational perspective

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ABSTRACT

Efforts at urban e-mobility transition in China are of crucial global significance. Exploring these developments, however, demands significant reframing of dominant theories of socio-technical system transition to accommodate the strikingly different socio-political context of China to that of the global North where these theories have been developed. In particular, greater attention must be paid to issues of power, conceptualized as dynamic power/knowledge relations constitutive of social formations and evolving in interactive parallel with specific innovation trajectories. We illustrate such a productive reframing focusing on complex processes of empowerment and highlight that there remains relative stasis in the grand plan of a rapid transition to electric *cars* (EVs) in China's growing cities, with the EV still widely regarded as "risky" mobility. At the same time the EV in China is becoming a constituent of a new kind of digitized and smart mobility, as Chinese ICT companies emerge as globally powerful players establishing alliances with traditional automobile companies.

1. Introduction

Transportation accounts for approximately one quarter of global greenhouse gas emissions (GHGs) (IEA, 2015) and is key to efforts to mitigate climate change. Multiple transitions around the world are necessary to sustainable development (Kemp et al., 2007; Rock et al., 2009). While there is embryonic evidence of 'peak car' in the 'global North', especially amongst younger people (Cohen, 2012; Lyons and Goodwin, 2014), mobility-related emissions are rising fast in populous countries like China and India (Schwanen et al., 2011). These trends are particularly striking in China, rendering it globally central to low-carbon mobility transition.

Cars in China increased more than six times between 2002 and 2013 to 137 million (OICA, 2013). The 'car-ing' of Chinese society constructs China as a test-case in the challenges of decarbonizing urban mobility that face established 'car' societies in the global North, not just those of rapidly developing countries. Yet decarbonizing the currently car-based urban mobility is not merely pressing but is also a 'wicked' set of intractable, huge and *system* problems (Marletto, 2014).

The dominant policy narrative in China today, dominating plans for future city mobility at all tiers of government, focuses on decarbonising *car transport through electrification*, specifically in the form of a *Chinese* system of New Energy Vehicles (usually treated synonymously with electric vehicles, 'EVs', specifically electric cars) (Teng et al., 2015). The EV thus represents a necessary starting point for analysis of current low-carbon mobility innovation in China.

Yet how are we to understand and/or expedite and shape urban e-mobility transition in China? This paper argues that literatures and theories dominating study of low-carbon system transition to date, and emergent from research focusing on case studies in the Global North, struggle with illuminating the radically different context – socio-political, economic and cultural – of China. Conversely, revisiting and developing a perspective on socio-technical system transition through reflection on the Chinese case presents a new power relational perspective that promises not only to illuminate this crucial global case more fully, but also to motivate a broader reframing of such work. Accordingly, our aims in this paper are two-fold: to present and demonstrate this power relational perspective at work in insightful analysis of the case of Chinese urban e-mobility innovation; and to highlight the theoretical insights regarding how this perspective is of broader relevance to addressing some of the persistent criticisms of systems transitions literature.

Central to this argument is that the issue of power has not been adequately integrated into the socio-technical analysis of sustainability transitions, yet is key to understand the transition to sustainable urban mobility, especially in China. We demonstrate the importance of analysis of innovation initiatives that focuses directly on the interplay between novel socio-technical interventions and existing relations of

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power/knowledge (Flyvbjerg, 2004).

In particular, we show how shifting to a power relational perspective both broadens the relevant sociotechnical system under analysis from that of the (electric) 'car' to dynamic and emerging *systems of mobility*; and presents evidence, which is otherwise overlooked, of considerable system dynamism (section 5), challenging the stasis of continued techno-economic lock-in and innovation weakness (section 4). Finally, returning to the significance of our findings we highlight that the key future challenges for e-mobility transition in China are likely to become increasingly political and cultural; the dimensions that the socio-technical systems literature has tended, to date, to downplay. First, however, we explore the specific challenges China poses to existing Western-formulated theories of socio-technical system transition and articulate the necessity of a different approach to these questions that grapples directly with dynamic systems of power/knowledge relations.

2. Theoretical and conceptual issues: low-carbon transition in China as power transition

There is a distinct body of literature that focuses on transitions towards more sustainable socio-technical systems and which considers the dynamics of sustainable technological change in some depth (Smith and Stirling, 2008). This includes a socio-technical approach, along with the complex systems view and governance perspectives that were nurtured by the Dutch Knowledge Network on System Innovation and Transitions (Grin et al., 2010). The socio-technical transition perspective situates technologies in the contexts that enable them to work (ibid.) and focuses not only on artefacts (technologies) but the structures, agents and processes that reproduce a 'socio-technical practice' (Rip and Kemp, 1998).

The lack of attention to power and politics in transition studies has recently emerged as an important point of critique on early transition research (Avelino and Grin, 2016). There has been ongoing debate on the questions of agency, power struggle and politics in some of the theories of middle range, such as the multi-level perspective (MLP) (Kern, 2011; Kern et al., 2014; Lockwood, 2013; Smith et al., 2014). The MLP perspective, a heuristic which aims at explaining the process of substitution of a technological paradigm as new 'niches' of innovation grow to the point of discontinuity at system level, has been criticized for underplaying the role of agency – and cognate concepts such as politics, power, practices and daily habits, and culture – in transitions (Genus and Coles, 2008; Meadowcroft, 2009; Shove and Walker, 2007; Smith et al., 2010). Conversely, proponents have argued that the perspective accommodates issues of agency but has not developed analysis of some particular types of agency (Geels, 2011).

Nonetheless, responding to such criticisms there have been numerous attempts to include various types of agency and incorporate insights on power from political science (Grin et al., 2010), social movement studies (Elzen et al., 2011) and by developing a cultural dimension (Geels, 2014; Geels and Verhees, 2011). Grin et al. (2010) have developed a governance approach that aims to address the pivotal issue of agency, shedding light on its distributed nature and the multiplicity of agents that exert influence on a transition (Grin et al., 2011). The questions of strategic agency and ability of competent agents to connect are crucial in understanding the interactional dynamics between four institutions of market, government, science and technology and the outcomes. This perspective in understanding the politics of transition emphasizes that the regime embodies power and some of the practices of the regime will be preferred over the others. Hence the incumbent regime generates resistance to new, rising niches, including through the significant effects of its dominant discourses on struggles for legitimacy of the new innovations (Grin et al., 2011).

Other studies emergent from this tradition conceptualize power within a complex systems approach (Avelino and Rotmans, 2009; Rotmans and Loorbach, 2010). Avelino and Rotmans propose an interdisciplinary framework to study power in relation to structural change. In particular, they address the issue of "innovative power" as a "capacity of actors to create or discover new resources" (Avelino and Rotmans, 2009: 552) and stress the need to address empirically the exercise of innovative power in a micro-level, local context.

While taking seriously the neglect of the role of power in transition studies, however, these studies have continued to focus overwhelmingly on corporate, manufacturing and policy actors, leaving out the user or demand side (Shove, 2003; Spaargaren, 2003). At the same time many studies of politics in sustainability transitions draw on case studies in north and western Europe and have limited applicability to other geographic cases, including the majority world or potentially globally-significant ones, such as China. For instance, important studies of coalition politics (in the US - Hess, 2014) and advocacy coalitions (in Switzerland - Markard et al., 2016) have highlighted the need to consider the political circumstances that make adoption of policies possible or likely, yet these contexts are significantly different in China to western Europe.

Of perhaps greatest importance, however, is how even the most sophisticated literature (Geels, 2012; Smith et al., 2010; Van Bree et al., 2010) – while going beyond the persistent and inadequate technocentric policy orthodoxy that characterizes policy in China – continues to deal insufficiently with the central role of power in the *construction, constitution, shaping, and driving* of such low-carbon transitions (Tyfield et al., 2015). To stress, therefore, the primary shortcoming of this literature is not that it must, nor even that it does, neglect issues of power, politics and culture, but that it continues to conceptualize these key dimensions – constrained by its ready-made multi-level framework – in ways that are unable properly to accommodate them.

Symptomatically, most studies thus focus on issues of power in terms of their ongoing difficulties as system "lock-in" (Geels, 2014; Marletto, 2014; Cf Unruh, 2000), rather than offering ways of productively conceptualizing possible discontinuities and 'break-out'. 'Power' is thus understood as a purely negative consideration, frustrating transitions that are understood to be desirable *ex ante* (on the normative dimension of MLP studies, see Smith et al., 2010), and often framed in thin, binary terms of 'good, 'green' innovation constrained by 'bad', 'high-carbon' socio-technical regimes.

This approach, thus, not only sets a research agenda overwhelmingly focused on the *quantitative* challenge of maximally expediting low-carbon transition, to the relative exclusion of the all-important and omnipresent *qualitative* and sociological considerations of *which* transition, benefitting whom and where. By conceptualizing power as that which is held by incumbent regime actors (perhaps 'over' weaker niche actors), it also presents an analytical framework in which regimes are dynamically locked-in almost by definition. The role of power analysis in this case, then, is to explicate the networks and interactions of the incumbently empowered, thereby explaining the ongoing tribulations of various desired low-carbon niches in effecting the discontinuity at regime level. This approach thus tends to privilege a certain resignation regarding the persistent intransigence of 'power' to resist socio-technical system change, together with an empirical gaze firmly directed to these constraints. And, conversely, it legitimates a particular Western political common-sense in which the apparent solution to this problem is explicit political resistance and/or social movement-building of various sorts.

Conversely, we elaborate the centrality of the political dimension in sociotechnical transition by proposing that politics and power relations cannot be something that is a mere sociocultural 'context' for innovation, nor something that enters the analytical gaze at a later stage. In placing politics as central, we are thus concerned more broadly with the transformation and (re-)constitution of and *by* power – or, on this conceptualisation, *power/knowledge relations* (Foucault, 2010; Dean, 2010; see Tyfield et al., 2015), so that power and knowledge are treated as two sides of the same coin –, as evidenced in the transformations and reconstitution of nexuses of social practices (McMeekin and Southerton,

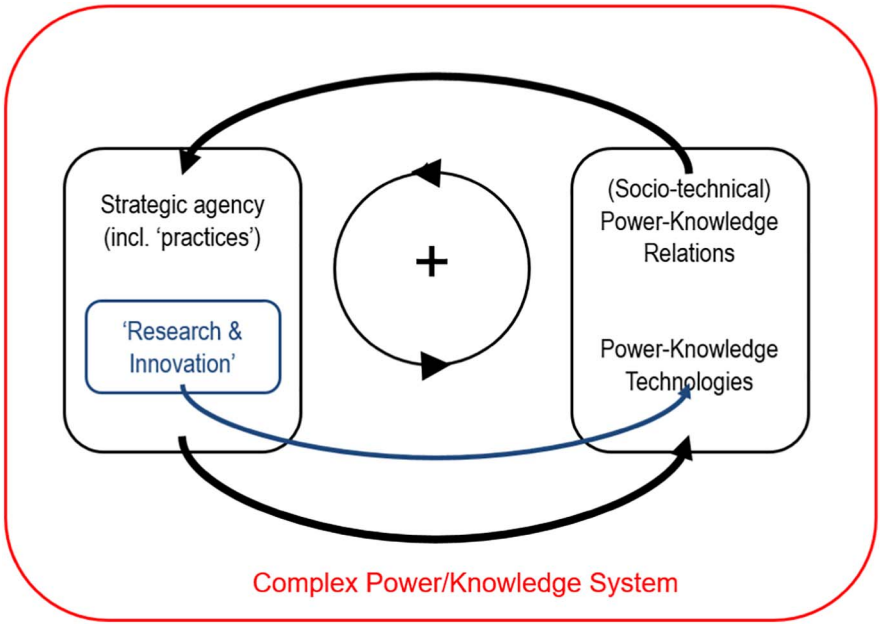

Fig. 1. Complex socio-technical power/knowledge systems.

2012; Reckwitz, 2002; Shove et al., 2012) and associated group boundaries (Zietsma and Lawrence, 2010) that constitute a given social formation as complex systems of knowledge and power relations (Tyfield, 2017).

We thus study the *empowering*, and not just the shielding and/or nurturing, of specific 'niches' of innovation (Smith and Raven, 2012) where these are taken as significant sites in which power relations are being actively remade, possibly with wider social implications. 'Power' (/knowledge relations) and 'politics' are *not*, therefore, simply synonyms for normatively problematic domination, to be contrasted with rational and participatory argument; nor with the normatively lauded arena of participation and contestation. Rather power is irreducible, ubiquitous and essential for the actual constitution of socio-technical transitions; and, *as such*, potentially (but not necessarily) problematic and in need of being held to account and actively shaped.

From this perspective, low-carbon innovations can be understood as driving a broader shift at the 'level' of socio-technical regimes only to the extent that new constellations of agents, institutions and artefacts are enabled, while other groups are disabled. This enabling takes the form of the strategic alignment of that 'regime' (and even 'landscape', in the terminology of MLP) with pursuit of *their* specific interests and projects, and vice versa, generating positive feedback loops of emergent, self-sustaining 'power momentum' (see Fig. 1). And in both cases these are manifest through changing social practices, and the social identities and lived norms that accompany these.

Hence, once low-carbon transition is conceptualized as itself a *power transition*, this entails researching the changing power-knowledge relations associated with – conditioning and affected by – such low-carbon innovation, in multiple forms, sites and scales (Tyfield et al., 2015). This especially includes not just the official and informal structures of state policy-making, but also new user[1] collective identities, cultural phenomena and patterns of social stratification, as well as changing forms of the corporation that emerge in parallel with such innovations – all understood here as technologies and relations of power/knowledge (Tyfield, 2017).

Moreover, this theoretical reframing is particularly promising because it offers a more insightful and strategically energizing analysis regarding the case of China. Conceptualizing power as constitutive but ambivalent, and inseparable from socio-technical change, it affords analysis in geographical contexts with very different political systems and definitions of 'politics' to that presumed by MLP work. For instance, one of the characteristic elements of power relations in China is (interpersonal) "relational power" in terms of the ties of mutual dependence (Chong et al., 2013) and *guanxi* ("connections"), both important aspect of Chinese culture. Chinese political culture can also be more generally characterized as collectivist with high power distance and hierarchy, where the state is seen as a major agent in implementing – but also frustrating – radical change (interviews, 2014–2016), while also being persistently 'under-institutionalized' (Breznitz and Murphree, 2011), experimental and opportunistic (Heilmann, 2008).

Attending to the globally significant and singular case of China also brings out the particular significance of several important elements of this shift in theoretical perspective, forcing a confrontation with two particularly important issues. As argued elsewhere (Tyfield, 2014), these are:

- first, the obvious, 'common-sense' importance of politics, state and government in contemporary Chinese everyday life. The corollary is thus a strategic pragmatism that works with and takes for granted that uncontrollable, shifting and high-stakes context, giving rise to an *everyday politics* (see Zuev et al., forthcoming). This may be contrasted with a dominant Western paradigm that strives for understanding of techno-economic change (and even socio-technical change) without such causal centrality accorded to political and/or power-relation issues; and,
- secondly, the way in which especially today, in the context of both a 'rising' China and various global crises, a 'landscape' of supposedly exogenous and stable political economic relations cannot be taken as given for the analysis, nor even as a useful first heuristic (Geels, 2014), but is itself profoundly changing. Indeed, in China this grander 'landscape' is precisely and explicitly what is in play (Jakobson, 2007; Segal, 2010) in terms of techno-nationalist ambitions and strategies invested in the electric car as vehicles (metaphorical and possibly literal) for China's final ascent back to global geo-political and techno-scientific centrality. Hence the ongoing shaping of low-carbon innovation and transition in China cannot be understood except to the extent it recognises the scale of the current ambitions in terms of *transforming* (even landscape-level) power

[1] The term "user" is problematic in the context of our study (see e.g. Oudshoorn and Pinch, 2003) but we stick with the term, while remaining cognizant of its shortcomings, due to the lack of clearly superior alternatives.

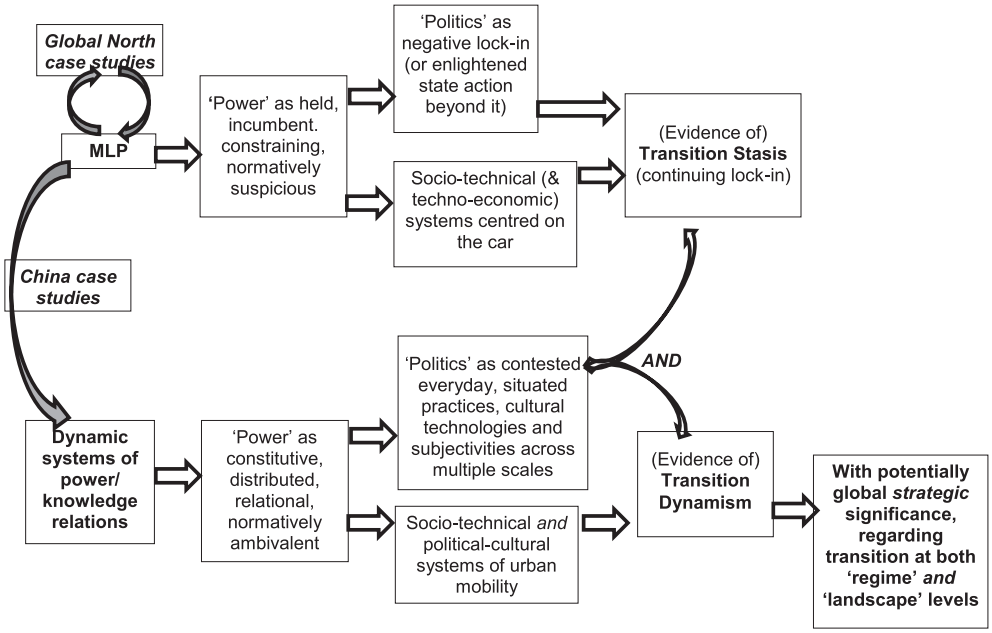

Fig. 2. From multi-level perspective (MLP) to systems of power/knowledge relations.

relations, as well as the constellation of power relations behind those ambitions in the first place. In short, projects of low-carbon mobility transition in China quite evidently go well beyond mere 'greening' of Chinese cities within given global geopolitical 'landscapes'.

These two considerations in turn point to two key foci for empirical research into low-carbon transitions. First, dynamic assemblages of power/knowledge relations, instantiated in specific and situated everyday social practices and subjectivities, are the essential resource for implementing changes in specific settings. Focusing on practices in this way also significantly opens up the relevant system in question, from the techno-economic system of urban (car-based) transport to systems of mobility (Dennis and Urry, 2009; Urry, 2004). Indeed, as evidence of the importance of this neglected dimension, the lack of knowledge about the local user practices and everyday politics of mobility has actually caused a governance crisis in several Chinese cities dealing with specific modes of transportation essential for the sustainability transition: electric-two wheelers (Wells and Lin, 2015).

Secondly, this empirical focus on dynamic clusters of everyday practices of mobility systems is examined through the lens of power/knowledge relations constitutive of a society (at both 'regime' *and* 'landscape' levels) in parallel with trajectories of specific socio-technical innovations. In other words, the goal here is to construct plausible (Wilkinson et al., 2013), if necessarily uncertain, trajectories over the short- to medium-term of *how* transition may occur – and, inseparably, *who* it may serve to empower and disable or newly burden. This is thus an analysis of low-carbon transition as an exercise in power-aware strategic wisdom, or phronesis (Flyvbjerg et al., 2012). It thus asks (Flyvbjerg, 2004): how are power relations regarding the e-mobility system in China tendentially developing, who gains and who loses and by which mechanisms of power?

As we will show, however, examined from this perspective a dynamic picture emerges regarding the prospects and possible futures of low-carbon innovation in China, that is strikingly different to, and more open than, that offered by either the dominant framing in terms of hi-tech advance or an analysis in terms of socio-technical system lock-in and contesting 'niches' (Fig. 2).

What follows, therefore, is a preliminary summary and illustration of this framework, drawing on both existing literature, (re-)interpreted through the power relational perspective, together with original empirical fieldwork, likewise framed by this approach. As regards the latter, the article presents the results of a two-year-long empirical study based on fieldwork and participant observation in three major Chinese cities (Shanghai, Shenzhen and Beijing) and Shandong province (see Appendix for anonymized list of interviewees). We make references to secondary data (research reports, web-documents, media releases and policy documents) and primary data collected via over 50 in-depth interviews and seven focus-groups with academic and marketing experts, car-users, manufacturers, infrastructure providers, government and planning officials, and transportation NGO experts.[2] Interviews were also conducted with relevant foreign government, manufacturing and academic experts working in China.

The focus-groups in Beijing[3] and Shenzhen were conducted with different groups of users (e-bike informal transportation providers (*heiche*), EV-taxi drivers, car-users). We also succeeded in having a mixed gender representation amongst taxi-drivers and car-owners. Each focus-group consisted of six to seven participants where attempts were made to make the sample as representative as possible, in particular trying to include people of different socioeconomic, educational and professional background. As for the expert interviews, after the initial exploratory stage, follow-up interviews with senior managers in various urban mobility start-ups and car-sharing companies in Shanghai and Shenzhen allowed observation of the development of low-carbon mobility innovation in Chinese cities. The interview data was supplemented by fieldwork notes which consisted of informal conversations, diary notes, visual ethnography and observations in nine different locations in China visited during the two years of the project. The final batch of data comes from a collaborative knowledge production stakeholder workshop that was organized by the project team in Shenzhen in March 2016[4].

[2] The project is titled 'Low Carbon Innovation in China – Prospects, Politics and Practice' and we gratefully acknowledge the funding from the UK's ESRC, 2013–17, grant number ES/K006002/1.

[3] We acknowledge with gratitude the assistance of our colleagues, Zhu Di at Chinese Academy of Social Sciences, Beijing and Li Ping at Tsinghua University, Shenzhen in co-organization of the focus-groups.

[4] We thank our project colleague, Li Ping (of the Graduate School, Tsinghua University, Shenzhen) for his invaluable assistance in arranging this event.

3. The Chinese case of urban e-mobility transition

China represents a distinctive case of (attempted) sustainability transition, being a post-socialist state, where the automobility sector was virtually non-existent until 1995; e.g. just two million vehicles were produced per annum as recently as 2000 (Personal Cars and China, 2003) for a country of 1.3 billion people.

The future of urban mobility, including in China, undoubtedly requires significant low-carbon innovation and this is acknowledged at the highest levels of government, as well as within business, both private and state-owned enterprises (SOEs). Indeed, low-carbon mobility is understood as a significant, once-in-a-generation opportunity for China to develop innovations of global stature in this key economic sector. In particular, the EV has been imagined as a "national hero" (Tillemann, 2015: 16) and as the route towards Chinese breakthrough – "overtaking round the corner" in the language of Science Minister (and former Audi executive) Wan Gang – into the global automotive oligopoly.

This is, of course, an intensely competitive industry with high barriers to entry from proprietary technologies and tacit knowledge capacities of global (supply chain) management, innovation and branding. The EV has thus been invested with intense hopes in China to be a key pillar of the broader project of squaring globalized economic growth and continued one-party-state government through global innovation leadership (Cf Zhao, 2010 on ICTs), and hence the key policy priority regarding China's programme of low-carbon mobility transition.

In the context of highly fragmented and locally protected automotive industry in China (Thun, 2006), and the related political context of techno-nationalism (Jakobson, 2007; Zhao, 2010), the apparent opportunities presented by the EV have proven decisive in setting the policy agenda. Moreover, the seeming need for significant government support to develop a viable EV system appears to play to another supposed strength of the Chinese political economy. For instance, a shift to the EV involves considerable challenges of coordination (Tyfield, 2013), such as the construction of infrastructures for charging batteries before there is any consumer demand for such vehicles. Similarly, while there is a clear consensus in China in favour of pursuing EV innovation, other nation-states capable of mounting such an initiative are aligned with automotive companies that see the internal combustion engine (ICE), not the EV, as their priority and advantage (Germany, Japan); or have political economies not inclined to a strong programme of industrial policy (UK); or both (US).[5]

In 2010, EVs were declared a 'key strategic industry for the next 5 years', and RMB100 billion (£10 billion) of government support was announced. Targets of producing 500,000 EVs by 2015 and 5 million by 2020 were announced. To encourage demand, a 0% sales tax was introduced, along with subsidies of RMB 60,000 from the central government, which was matched by some cities (notably Shenzhen, home of the company, BYD) and even some districts.[6] Furthermore, a programme focusing on the 'electrification' of mobility within 25 major pilot cities was also introduced.

All this support for an industrial and technological project would suggest significant strides would follow towards Chinese global leadership in EV transition. Yet, there have been numerous challenges. First, in terms of the EV as an agent of *low-carbon* transition, there are serious questions regarding their emissions, especially in China (Huo et al., 2010). Nationally, over 70% of electricity is generated by coal, and in many areas (particularly in the North and North-East) the percentage is much higher. As much of this coal is, in turn, of low quality and burned in low efficiency power stations, the emissions associated with EV mobility even exceed those of conventional ICE mobility in some regions of China (iCET, 2011).

Moreover, despite the favourable conditions listed above, against the target of 500,000 by 2015, fewer than 12,000 'alternative fuel vehicles' of any description (i.e. including HEVs) had been sold by end 2012. Sales subsequently climbed significantly in 2014 (Bidness etc., 2015) and 2015, to approximately 220,000 vehicles (Reuters, 2015a), but total sales remained approximately 26% below targets. Moreover, while late 2015 saw sales surge, pushing the Chinese market into the global top spot, figures have been brought into serious question as many of the sales were 'ghost cars'; accounting fictions used fraudulently to claim government subsidies (Yang, 2016). This growth of EV sales has also been based on those subsidies, yet government already planned to reduce these as quickly as possible (by the end of the 13th Five Year Plan in 2020) and will likely now do so ever more quickly in light of the scale of the fraud. Increasing numbers ten-fold to 5 million EVs (including plug-in hybrids) by 2020 thus seems a 'Herculean' task (Yang, 2015a). And, in terms of transition, such numbers must also be set alongside *annual sales* of over 20 million ICE cars.[7] A rapid shift to system domination by the EV thus remains implausible even if these ambitious government targets are met.

Furthermore, up to 2015, EVs have also been largely purchased in government procurement for municipal taxis (Li et al., 2016). Private purchases of EVs in China remain a major challenge and utterly dependent on the government subsidies and/or city-based policies of licensing that favour NEVs; for instance, EV manufacturer BYD's revenue would have been negative in 2014 and 2015 without these subsidies (Bloomberg, 2015a). Amongst automotive SOEs presented with government targets for developing what are unprofitable EVs as against their profitable ICE businesses, the result has often been half-hearted engagement at best, and positive foot-dragging (Wang, 2013) or apparently now subsidy fraud at worst. Private automotive companies, however, are more ambitious in pursuing an EV strategy (Bloomberg, 2015b). *Geely Automobile Holdings* plans new energy vehicles to make up 90% of its sales and plans to offer them at prices equivalent to conventional ICE vehicles.[8]

The usual explanations for this lack of progress concern issues of immature and hence expensive battery technology and inadequate charging infrastructures, which are undoubtedly important considerations (Costa Maia et al., 2015). For instance, regarding the key challenge for e-mobility of charging, State Grid Corporation of China is responsible for the masterplan of providing national charging infrastructure. But there is no national EV-charging legislation, and each province and municipality bases its legislation on local conditions, especially when it comes to dealing with the major issue of property management companies that manage public parking spaces (Wu, Ma and Ou, 2015; Wu et al., 2015) and residential parking.

Even in the most developed regions, building charging infrastructure is still meeting opposition from property management companies, which require residents to have a designated parking space; a prized and expensive resource. Central government has encouraged the construction of charging piles and allocated central fiscal funds to subsidize the provinces and enterprises which construct and operate charging piles (Global Information, 2016), but oversees no national policy drive.

In practice, since 2014 the charging infrastructure has been co-created by multiple state and private actors (including foreign companies such as Tesla and their Supercharger program) and entrepreneurs[9] (Global Information, Inc., 2016). Some of the most notable players in

[5] See Schamp, 2014 on the possible exception of France.

[6] According to the list announced by Beijing, six EV models were subsidized with subsidies ranging from RMB63,000 to RMB108,000. The six EV models on the list are DENZA and E6 made by BYD; Roewe E50 made by SAIC Motor; ZINORO made by Brilliance Auto; E150 EV and C70GB made by Beijing Automotive Group; and iEV4 made by JAC Motor.

[7] http://www.ft.com/intl/cms/s/3/569e90c0-a000-11e5-8613-08e211ea5317.html.

[8] In July 2017, Geely's foreign subsidiary, Volvo, also announced that none of its cars will be purely ICE-propelled by 2019: https://www.chinadialogue.net/article/show/single/en/9928-Volvo-s-EV-push-hints-at-China-s-electric-ambition.

[9] http://www.chinadaily.com.cn/business/2017-01/26/content_28058742.htm.

this field have been *TELD*[10] (Shandong province), *BYD* (Shenzhen) and *Potevio* (Shenzhen). It is also important to note the geographical unevenness of the development of charging infrastructure in residential areas, with eastern coastal regions, capital cities and Guangdong province in the south benefitting the most while several regions in the West are literally untouched (Wu, Ma and Ou, 2015).

Notwithstanding these crucial techno-economic hurdles, though, conceived as a process of socio-technical system change there is no reason they must be considered as primary, let alone definitive. Indeed, it must also be stressed that even the now-growing numbers of EV purchases, including by private drivers, should not be mistaken as evidence per se of a smooth unfolding of system transition. To the contrary, such growing adoption of the EV remains dwarfed by continuing growth of the ICE car market and thus a minor and complementary niche. Here, in other words, we confront the perennial question and test for MLP-framed analyses of how to illuminate in real-time the crucial, strategic and uncertain path from niche to regime disruption. Instead, exploring EV innovation in China from a complex power/knowledge relational perspective suggests many of the key challenges and sources of current stasis are political-cultural, and as such both largely overlooked by this form of analysis and likely to persist, especially insofar as these factors remain neglected by policy and strategy.

4. Socio-technical and power relational stasis

The political-cultural issues regarding EV transition in China are multiple and complex, involving issues of: industrial and innovation policy (for different industries, ICE cars, EVs, electronics and ICTs, oil/gas/(gasified) coal, infrastructure and construction, and so on); environmental politics; and rapidly changing social power relations at the 'ground' level of society, including issues of consumerism, social distinction and even gender relations. Given the very 'systemic' nature of the challenges, however, instead of aiming for comprehensive analysis we focus instead on the illumination of key points of strategic blockage and leverage. In this context, analysing this field can be usefully divided it up into issues of e-mobility system producer and user perspectives. The striking picture that emerges in both cases, however, is one of both considerable tensions and, more importantly (in the next section), *significant dynamism and change* in power relations that in turn demand an opening up beyond the 'EV' and 'transport' frames to analysis in terms of mobility systems.

Crucial throughout the Chinese approach to EV transition is how it is framed at the national level by the constitutive tensions of a techno-nationalism, by way of a deeper engagement with a changing globalization (Zhao, 2010). This tension is then manifest through fragmented authoritarianism (Mertha, 2009) in a geographically diverse devolution of decision-making power into 'local state corporatism' (Oi, 1992; see also Nolan, 2004; Huang, 2002, 2009; Thun, 2006). Together these forces affect the key issue of (uneven) local implementation of top-down directives, and shape the continued relative failure of breakthrough of the EV.

More concretely, three overlapping dimensions characterize this diversity of EV policy implementation. There is first the distinction between regions with powerful automotive SOEs and those with private companies (or none at all). Second, there is the extent to which regional/provincial/local industrial policy privileges the (central party-) state or markets and private enterprise, and thence the openness to global business. And third, we can examine the localized power of 'carbon capital' interests (of companies and individuals who disproportionately benefit from oil-based industries) (Urry, 2013: 75) vis-à-vis other industrial sectors, notably electronics and/or what may be termed 'digital capital'. Along each dimension, Shanghai may be identified as archetype of the former (Huang, 2009) and Shenzhen of the latter. Both locations are also central to efforts at EV transition in China, but importantly, as yet, neither has succeeded in incubating the conditions of transition at the system ('regime') level.

In Shanghai, a local economic model of state-led industry that includes a powerful incumbent SOE ICE-automotive industry raises serious questions about the extent to which, for all its stated goals of prioritizing EVs, policy actually supports EVs – not just in the abstract, but *in competition* with ICE cars (Cohen, 2010). Conversely, Shenzhen's strength lies in the *absence* of a major state-owned automotive corporation and the *presence* instead of digital capital giants and an entrepreneurial culture. But the flipside is that Shenzhen is not party to the most powerful coalition shaping national Chinese automotive politics.

At national level, this fragmentation of power relations contributes to the key government grievance regarding China's car industry and a continuing issue for the attempted hi-tech EV transition – i.e. the continuing domination of the foreign JV partners, including in ownership and innovation of key technologies (Winebrake et al., 2008). Indeed, this forms something of a positive feedback loop between the intensity of Chinese policy's specific hi-tech focus, pursued in the hope of rectifying this problem, and its ongoing disappointment, in inadequate implementation of national high-technology-push policies.

Despite the booming production, diversified manufacturing landscape and the growth of official sales figures, the actual use of EVs and their visibility in Chinese cities is still very low. But even the figures in question[11] still account for just a little over 1% of the total annual car market in China.[12] In comparison, in Norway, EVs have a 22% market share. Even with legitimately acquired subsidies at national and provincial level, "fast-movers", such as BYD, have EV production and marketing at an embryonic level (Masiero et al., 2016). Moreover, while adoption of EVs (as 'electric cars') benefits from several complementarities and synergies with the existing ICE system of automobility (e.g. development of road and parking infrastructures, driving instruction or capacities for development of car bodies and factories), these conditions all tend to benefit the incumbent system disproportionately more, deepening its lock-in. In short, then, the politics and power relations on the producer side significantly constrain the convergence of forces onto an effective and nationally implemented industrial strategy in favour of the EV *over* the ICE.

These conclusions are merely strengthened by considering a key issue overlooked by current hi-tech supply-side policy, namely, consumer demand (Cf Wolf et al., 2015) and the issues of user politics. In recent years in China the car has become the number one consumer aspiration; an essential aspect of the extraordinarily rapid current *construction* of an automobility socio-technical system.[13]

Cars are increasingly affordable for growing numbers of Chinese. But this demand is complex and is not simply a matter of consumption utility preferences, complicating the cultural politics of automobility purchases. Rather, in a post-socialist country characterized by 'individualization without individualism' (Yan, 2010), in which the domains of increasing personal autonomy reside squarely in the economic as opposed to the civic sphere, consumerism is of heightened social and political significance. It is primarily through the consumption practices of oneself and one's family that contemporary Chinese citizens can exercise their individual freedom, cultivate a sense of individual and networked-collective identity and put it and their material success upon display, and hence claim a certain social status and personal quality (*suzhi*) (Yu, 2014; Anagnost, 2004). Demand thus depends not only on fit with existing social practices of (demand for) mobility (Pasaoglu

[10] https://www.teld.cn/About/About.

[11] http://www.forbes.com/sites/michaeldunne/2016/08/30/china-aims-to-kill-off-most-of-its-electric-vehicle-makers-why-and-will-it-work/#372cc7d95208.

[12] http://www.theicct.org/blogs/staff/2015-global-electric-vehicle-trends.

[13] See AC Nielsen (2011), and 'Chinese car sales trail consumer aspirations', http://www.scmp.com/article/494103/chinese-car-sales-trail-consumer-aspirations;

et al., 2014; Shove et al., 2012), but also on how these practices are changing in ways charged with social importance.

At first, this involved the car being primarily a status symbol. Focusing on economic success or freedom, this conditions the adulation of a particularly unlimited and conspicuous form of wealth (Zavoretti, 2013). In the circumstances of personal affective investment and the bodily experience of consumption of autonomous mobility, the car assumes an almost unrivalled position. This is compounded by the multiple novel risks, technological and financial, assumed in growing car ownership. Together these manifest as a strong preference for big, expensive, foreign cars with powerful engines associated with high quality, more interior comfort and advanced technology; elements of a 'Western' lifestyle to which many Chinese aspire, as marks of high *suzhi*. The conventional fossil-fuel car has thus been to date a key element in the forming of the social identity of the Chinese 'middle class' (Zhou and Qin, 2010; Yu, 2014). And given the importance of this stratum of society for broader regime legitimacy (Guo, 2008; Goodman, 2015), this suggests serious *political* obstacles to policies that would penalize the petrol-powered 'car' in support of an EV alternative (e.g. The Economist, 2016a).

Today market tastes are developing fast. According to Gao et al. (2016), the two top car attributes that matter to Chinese consumers today are brand and price, while it is still the second most important family investment (after an apartment). Chinese consumers are becoming thriftier when buying a car and more open to purely instrumental or pragmatic criteria. Yet the political power of this appetite for the car remains. Meanwhile, whether on status or price, the EV is still regarded as a relatively unattractive option, even as national brands of EVs (such as BYD) are becoming increasingly popular.

Interviews and focus groups in 2014/15 with actual and potential EV drivers also revealed widespread concerns about risks of EVs. Inadequately developed charging infrastructure has been identified as one key reason for remaining low levels of EV sales to individuals (Gao et al., 2016); findings corroborated by our own interviews, in which the "slow" development of charging infrastructure was likewise continuously mentioned to explain slow acceptance of EVs by urban residents. But the risks here also concern the lack of knowledge about the *inside* of the technology – specifically its battery pack and influence of the battery on health and safety of the user. In particular, the issue of "radiation" or magnetic field from the battery was a common theme in the focus-group interviews with EV taxi drivers in Shenzhen, conducted in 2015.

The much-hyped growth in sales in recent years can be also explained by growing difficulty for aspiring car drivers to acquire a car license plate in big cities such as Shanghai or Shenzhen. The act of EV purchase thus hardly signifies a change towards environmental consumer choices amongst Chinese consumers, but rather the pragmatic approach of the users to accessing *car* ownership in whatever form presents itself as possible.

This has further implications for the sustainability credentials of EV adoption. For instance, a survey conducted by Shanghai Electric Vehicle Public Data Collecting Monitoring Center suggests that majority of the PHEV (plug-in hybrid) owners in the city rarely charged their cars and ran them predominantly in petrol mode (SHEVDC report, 2015), simply taking advantage of the free license plate without using their electric capabilities.[14] Again, therefore, we see that, even as EV sales pick up, propelling China into the global top spot in this market, this metric must not be confused with evidence of a growing momentum of system transition to a dominant low-carbon e-mobility regime.

A decade of significant policy efforts to encourage the shift to EVs – their production and consumption – thus appears to evidence separate spheres of evolving 'normal' consumer aspiration for mobility, in terms of desire for a *car*, on the one hand, and of 'low-carbon' EV mobility innovation, in terms of the various technology-push policies of government support, on the other. The prospects of an EV sociotechnical transition, by contrast, would need these to co-evolve and to converge. Evidence of *this* process, however, *is* forthcoming once we broaden our perspective, focusing on dynamic systems of power relations in parallel with changing innovations, beyond the lens of the electric car and transport to the *co-evolution of e-mobility systems*.

5. Socio-technical and power relational dynamism

To start with, we must consider developments in the politics and governance of the EV sector itself. The sales of EVs in China stumbled in 2014 but 2015–2016 was marked by growing sales and increasing visibility of EVs of national and foreign brands in the cities, while EV car-sharing schemes have grown rapidly across the country. This booming EV start-up environment led to some further important government announcements, aiming to regulate the "creative chaos" in Chinese EV-manufacturing (Dunne, 2016).

First, there is the decision to limit the number of EV start-ups, leaving just 10 out of 200 players, with the aim of increasing technology standards. Secondly, in November 2016 the Ministry of Industry and Information Technology[15] formally decided to regulate the low speed electric vehicle production, which has boomed in recent years but remained in a legal grey zone (Fang and Zhu, 2015; Tyfield and Zuev, 2016). These measures coincided with the enforced and concerted effort to eliminate the electric two-wheelers (E2Ws) from the streets of some major cities (Shepard, 2016).

To understand these developments, however, they must be situated within more deep-seated political challenges currently afoot that condition a situation of considerable dynamism, even as the domination of SOEs, and of the state-capitalist model of development more generally, seemingly remains entrenched. First, there is the growing corporate competition regarding future mobility *between* SOEs, opening up and contesting power relations in that domain, particularly between telecoms and electricity and car companies.

Secondly, though, is the growing success of private Chinese businesses in creating just the kind of global and hi-tech brands for which the government, and broader population, aspire. These, however, are not predominately in the car industry (notwithstanding the growth of private companies such as BYD or Geely), or indeed any of the sectors of heavy industry dominated by the increasing number of massive SOEs that feature in the Fortune Global 500 of the world's biggest firms (by revenue). Rather, they are in ICTs, electronics and social media and are quintessentially identified with the more global and entrepreneurial provinces of the south and south-east, specifically Guangdong (which includes Shenzhen) and Zhejiang.

This would include the still-emerging digital innovations and web 2.0 social media or the 'digital capital' players, such as Baidu, Alibaba and Tencent (collectively, the 'BATs') (Tse, 2016). Moreover, ICTs have been an unquestionable technological revolution and commercial success in China recently – and a largely *Chinese* one to boot – as against the relative stasis of the EV and car industries. On the user side, China now has more regular users of the internet, and increasingly the mobile internet, than any other country (674 million in 2015, or more than the US and India – numbers 2 and 3 in global rankings – combined).[16] In this context, the emergence of imaginaries of smart mobility and mobility-as-a-service (The Economist, 2016b) has been firmly grasped (and shaped) by the ICT giants as their opportunity to become industrial pillars of the 21st century; and on a global scale that has largely eluded them to date as internet businesses (given the 'Great Firewall of China').

[14] https://www.bloomberg.com/news/articles/2014-12-10/china-offers-billions-to-subsidize-electric-cars-on-gas.

[15] http://www.miit.gov.cn/n1146295/n1146592/n3917132/n4545264/c5281913/content.html.

[16] http://www.internetworldstats.com/top20.htm.

Dynamism regarding e-mobility in China is thus primarily observable in terms of just this digitized mobility system, with the EV seen as a mere, if crucial, constituent thereof.

Digital mobility and EV innovations are thus beginning to develop in multiple complementary, if not yet seamlessly intertwining, ways. The importance of ICTs in EV manufacturing and the use of EVs in various mobility services is evident. ICT companies are providing digital technologies and establishing digital platforms for connecting users that create a sense of digital communities of users while simultaneously collecting data about car users' behaviour (Zipser et al., 2016).

Chinese ICT companies do not pretend to have vehicle production expertise nor manufacturing facilities, and they also do not have actual license to manufacture automobiles. But they are in strong position to support and develop e-mobility-related digital innovation and establish new joint-ventures with traditional (local and foreign) car-manufacturers that are strong in automobile technology (e.g. all three of the BATs with Audi and SAIC with Alibaba). Chinese ICT companies also have competitive advantages over foreign tech companies in China, with the latter facing heavy regulation and, due to internet filters, providing limited access to their products.

Crucially for the development of an EV industry, the co-evolution of ICT companies, automobile manufacturers and battery producers is accompanying the co-creation of a different knowledge organizational framework where the knowledge is exchanged and supplemented for creating a cutting-edge artefact. It involves later stages of servicing the new product (EV), building infrastructure on demand for charging and repair, and constant upgrading and *updating* the product.

As such, while “carbon (state) capital” players, such as (fossil-fuel-based) electricity generators and traditional SOE car manufacturers, are slowly, with government funding, shifting production capacities to accommodate the EV manufacturing and infrastructures demanded by central government, digital capital actors are simultaneously exploring opportunities for smart EV production using their own monies. In 2015 Tencent Holdings, the largest Chinese software giant, announced its agreement with Hon Hai (Foxconn) manufacturing and Harmony Auto dealers to enter electric vehicle production (Reuters, 2015b), and with BMW i segment joining in 2016. Moreover, spurred by competition, several key representatives of Chinese digital capital announced their plans to participate in the smart EV race with each player setting ever bolder goals. Alibaba (e-commerce giant) has paired with SAIC motors. Baidu (China's leading search engine) announced independent entrance in the smart and driverless car production.

This followed a separate race in 2014 between the Chinese ICT companies to sign deals with taxi apps, both local Chinese versions Kuaidi and Didi and, belatedly Uber. Subsequently Didi has emerged pre-eminent after acquisition of a stake in Uber in 2016, and Uber quitting the Chinese market. The merger ended several years of multimillion dollar competition and has created a significant scale in a ride-sharing business in China, again with significant BATs involvement and investment.

This massive surge in corporate activity in digital-carbon capital alliances since 2015 suggests an emerging promotion of the EV as a *digital* commodity or service, rather than a conventional car, with a price only a few times higher than an authentic Apple computer.[17] It would seem likely that the EVs affordances and its technological base will be developed by digital, software giants, who have the ready capital for investment and the requisite technological expertise for this new type of vehicle and the massive amounts of data-processing involved in their increasingly ready access. Crucially, though, understood as a process of dynamic power momentum, popular acceptance of this reimagining of the ‘car’, of which there is also embryonic evidence (see below), could condition a significant challenge to the seemingly unassailable power dominance of the ICE as carbon (state) capital constellation, as demands for *its* goods and services wanes.

At this stage there remain many legitimate questions regarding the credibility of digital capital claims regarding future mobility. But what is undeniable is that these corporate moves show how socially important is another sociocultural trend in contemporary Chinese innovation politics, namely the omnipresent undercurrent of competition with ‘Silicon Valley’. To be a progressive and future-oriented digital capitalist in China increasingly means that one has to be (or at least sound) like Google or Apple and be investing surplus capital in new projects, in this concrete case related to mobility devices. Again, in MLP terms, this is precisely a matter of imputed and intentional competition at landscape level.

Moreover, the EV itself also exemplifies this. The privately-purchased EV most readily visible on Chinese streets still in 2016, albeit in limited numbers and in the more prosperous megacities (Beijing, Shanghai, Shenzhen), was Tesla. This is so even as the Chinese brand BYD led in 2016 both in PHEV and EV sales[18] for the simple reason that the Tesla model S is a striking sports-car saloon (all of which are famously EVs), while BYD vehicles are largely indistinguishable to the untrained eye from other conventional ICE cars. Moreover, while BYD models are often purchased for taxi and car-sharing services, Tesla S models are bought as luxury sports cars. Sales figures early in 2015 suggested Tesla has struggled in China, and it has been scolded by its Chinese customers and employees, many of whom were sacked in a significant downscaling of sales-staff in 2014 which influenced likability of Tesla.[19] Yet its sales rebounded in 2016, reaching nearly 2000 units in the first quarter, well on its way to the company's goal of 5000 for the year. The sales boom has continued in 2017, precipitating the milestone agreement to build a first Tesla factory outside of US in China, near Shanghai.[20]

Moreover, regardless of its own corporate fortunes, it seems undeniable that Tesla's presence in China has dramatically shaken up and accelerated activity around the EV. This is the case in terms of eliciting bigger promises from central government for public charging infrastructure projects (Yang, 2015b), or scaring the automotive SOEs into more ambitious activity, or simply illuminating the competitive medium-term possibilities in establishing dominant positions over 21st century urban mobility for companies outside the automotive sector, like digital capital. In short, then, while the incumbent politics of EV production remain heavily stacked in favour of high-carbon SOEs, the emergence of both critical immanent challenges to this structure of power relations and significant ‘external’ experiments showing increasing success together present a dynamic picture of potential instability and/or transition. And it is a reading of contemporary Chinese e-mobility innovation through the lens of dynamic power relations across the mobility system that reveals this dynamism, not just the lock-in at the level of the ‘car’.

Regarding user politics, a similar conclusion emerges. The politics of mobility consumption are dynamic and may be subject to rapid change. Indeed, the social meaning of the ‘middle class’, with which these issues are intimately bound, is far from settled and is the site of considerable political and socio-cultural agency by multiple groups seeking ownership and/or control of this increasingly empowered label (Tyfield, 2017). The meaning of ‘middle class’ in this context is of particular relevance, as it is the most systemically enabled group to drive the changes in the knowledge and power nexus. Notably, it is also the middle class, the educated and well-off, often West-oriented urban-resident individuals who are leading China's discourse of environmental

[17] The preliminary price of Tencent/Hon Hai/Harmony vehicle is estimated to be around US$10,000.

[18] http://ev-sales.blogspot.pt/search/label/China.

[19] http://www.reuters.com/article/us-tesla-china-exclusive-idUSKBN0LE2Q320150211.

[20] https://www.bloomberg.com/news/articles/2017-06-19/tesla-said-close-to-agreeing-on-plan-for-china-production-plant.

justice and sustainability.

Yet the two key issues with which the car is increasingly associated in China are significant *problems*, and not experiences of 'freedom' on the 'open road' as in multiple icons of mid-20th century American culture, integral elements of the 'American Dream' and US hegemony (Paterson, 2007). These two issues are air pollution (Qin, 2015) and daily gridlocked congestion. In both cases, this poses serious challenges to the construction of a middle class identity of hoped-for ('moderately well-off', *xiaokang*) prosperity and increasing quality of life in which the 'car' – privately owned and parked, ICE, four-door etc. – retains its centrality.

Rather the car is increasingly associated with trade-offs that tarnish, and so threaten, the entire social vision – now formalized in the new top-level political discourse of 'China Dream' – of contemporary Chinese modernity and progress. For instance, a recent study by Sandow (2011) in Sweden shows that a long or painful commuter experience is directly linked to personal unhappiness and a loss of family cohesion (see also Putnam, 1995). This could have far-reaching consequences in undermining the popular imaginary and 'common sense' upon which the current Chinese political economic order is built: Americans and Europeans did not face such trade-offs in their rise to 'middle class' prosperity in the mid-20th century, but rather achieved that prosperity precisely *through* growing (ICE) car ownership. As a result, significant shifts, including in government policy to accommodate these tensions, might be expected.

Thus faced with the persistent challenges of air pollution (Kahn and Zheng, 2016; Reuters, 2015a) and congestion, the 'car' serves to sensitize Chinese urban residents to issues that may problematise further entrenchment of the existing automobility system. This is particularly so for the emerging middle class(es), as it is this group that has the existing resources, incentive and leverage to demand improvements in their quality of life, such as in their environment and access to 'clean' city-living (food, water, air etc.…) and 'liveability'. Similarly, when owning a car means that one must set off to work very early or very late to avoid congestion, it becomes apparent that what is valued is not the car per se but the personalized mobility.

Such dynamics already seem to be in evidence. For instance, another link between the car-ownership and congestion concerns the car as an important item of conspicuous consumption in China. This includes the desire to demonstrate purchasing power leading to ownership of the second family car. As discussed above, however, recent surveys suggest that Chinese car owners are becoming more practical and less status-conscious than ever (Gao et al., 2016). In this context, two developments seem particularly important.

First, small, inexpensive and Chinese-branded EVs are increasingly attractive as second cars, often in gendered ways as 'her car'. The added attraction of easier and/or cheaper access to a license plate significantly compounds this appeal. Yet, interestingly, the majority of electric vehicle (EV) owners are keen to buy EVs again, and the proportion of consumers who say they are interested in buying an EV has tripled since 2011. Secondly, car-sharing has increased its appeal while car-ownership in general is not losing its stronghold, with second-hand cars becoming highly sought after. Taken together, these trends suggest a 'both/and' situation may be developing in the short-/medium-term in which families able to afford a car continue to buy a conventional, foreign-branded 'first' car but also increasingly experiment with, and become pleasantly acquainted with, EVs and car-sharing or both.

In these circumstances, then, a new openness may be emerging to multiple possible alternative models of urban mobility, especially in China's biggest, most prosperous cities that brings adoption of the EV with it, rather than as primary driver. This includes a growing willingness to experiment with forms of mobility, including intermodal travel, where cars will no longer dominate the urban landscape and commuters could use a scheme of inter-connected personal-vehicle-cum-public-transportation. According to the IBM commuter pain index survey, [20] residents in both Shenzhen and Beijing were already in 2011 open to switch to public transport under certain conditions, such that it is fast, less crowded and/or low-carbon. Two unprecedented air pollution red alerts in December 2015 in Beijing[21] show how little things have improved since 2011 (Kahn and Zheng, 2016) and that new measures are needed to take China's cars off the streets (Muscat, 2015).

Evidence for such changes in user mobility cultures and politics emerges from diverse quarters and forms of mobility, including emerging ride-hailing and car-sharing initiatives. This may include EV fleets, such as one established by major SOE Shanghai Auto (SAIC) in 2014 and multiple schemes in Shenzhen. But also of potentially crucial, if systematically overlooked, significance in China is extraordinary bottom-up success of the electric two-wheeler (Cherry et al., 2016), with over 200 million on China's roads, and the role of public vehicle sharing systems (Lohry and Yiu, 2015;Wu Ma and Ou, 2015;Wu et al., 2015). Since September 2016, this would also include the mushrooming success of smartphone app-enabled access to conventional bicycles. These initiatives, such as *MoBike* and multiple copycat competitors, are already ubiquitous in Chinese cities and even growing overseas after less than one year, though many are plagued by problems (such as bicycle theft), suggesting the boom is unsustainable (Yang and Yang, 2017); a familiar dynamic of Chinese innovation (Kirkegaard, 2016).

Ongoing changes in mobility choice are further bolstered by important generational changes in China, again specifically around *digital* technologies and their deepening 'common-sense' mediation of everyday life (Yu, 2014; Keith et al., 2013). In 2017, those now in their mid-twenties or younger have grown up in a post-'89 China – the "strawberries" (*caomei*) generation (Lin and Sun, 2010). A new cosmopolitized, Westernized outlook amongst a young "*xiaozi*" class (literally "petty bourgeoisie", but connoting more "bourgeois bohemian" or "bobo") has emerged in China (Wang, 2008). These young urbanites may well not yet be able to afford certain products, such as a car or an EV, but are also more likely to experiment with new things, such as personal digital gadgetry or new (shared) vehicles, and have greater awareness of developments and forms of life elsewhere in the world. They are also more likely than previous generations to check the Internet for other people's usage experiences or comments (Wang et al., 2016).

At the same time, important technological and institutional synergy may be emerging between electric two-wheelers and EVs (Zuev et al., forthcoming). Indeed, the development of low speed EVs and E2Ws in China may be a signal example of co-evolution (Cf Geels and Raven, 2007), where development and growth of both sectors as powerful clusters leads to political pressure on surrounding institutional and governance structures to change. Regarding the power relational dynamics in this case, both sectors are also noticeable as having developed autonomously, without support from the technology-push policies of government. As such, they instantiate the broader lessons regarding the private sector 'disruptive' innovators characteristic of China's growing innovative capacity (Breznitz and Murphree, 2011; Tse, 2016; Atherton and Newman, 2017; Tyfield, 2017). Most importantly, that the central government is now paying these sectors, and the industrial opportunities they present, − systematically neglected to date by the high-tech imaginaries of the EV technology-supply policies – greater attention is a *political* development of considerable significance.

In short, regarding quintessential blockages and system lock-ins in both producer and user realms, the expansion of analytical perspective to a broader co-evolution of changing power relations and evolving sociotechnical and power relational *systems of mobility* points to significant dynamism in urban mobility transition.

[20] http://www-03.ibm.com/press/us/en/pressrelease/35359.wss; Time (2014).

[21] http://www.theguardian.com/world/2015/dec/21/beijings-smog-red-alert-enters-third-day-as-toxic-haze-shrouds-city.

6. Conclusions

We have presented an analysis of the crucial global case study of urban mobility transition in China from a perspective that explores dynamic evolving power/knowledge relations of mobility systems. This shows, situates and explains continuing disappointment regarding mass adoption of the electric car in China, corroborating familiar arguments about techno-economic lock-in to the 'car system'. But by focusing on the broader issue of innovation across mobility systems and the parallel reshaping of power/knowledge relations potentially constitutive of *new* trajectories of socio-technical *and* political-cultural change, it also foregrounds a highly dynamic vista.

This incorporates fast-changing corporate capacities, collaborations and coalitions on the producer side, and fast-evolving consumer tastes, identities and common-senses on the user side, together increasingly reshaping even the high politics of government policy priorities and power concentrations. And this dynamism emerges into view from attendance to both changing everyday user practices of mobility and the parallel evolution of the domestic and international politics of China. Exploring *how* these specific socio-technical trajectories are evolving in parallel with the latter also affords the crucial capacity to analyse this process without assuming a familiar Euro-centric political context of liberal democratic states and explicit 'political' action.

Our purpose in setting out this illustration has been two-fold. First, to show the analytical benefits of adopting the power/knowledge relational twist on socio-technical systems analysis, illustrated with and motivated by a crucial case study in its own right; and thereby to make the broader argument for the applicability of this political-cultural systemic approach to research into the potential future impacts of specific cases of sociotechnical change as it can strategically illuminate prospective, and not just retrospective, *construction* of system transition – as complex cycles of growing power momentum. Moreover, this approach offers insights into such unfolding trajectories across the world, including in significant geographical contexts that may be different to those presumed by Global North-based theorizing (especially relevant, for example, in other crucial cases, such as India). In this way, this approach promises to *illuminate real-time global transitions* that do not presume any essential continuity with existing Western-dominate geopolitics; and to do so in ways that are strategically and prospectively insightful, and not merely explanatory and post hoc.

As regards the former point, our analysis reveals several key insights. Despite the popular (Western) vision that Chinese state can simply issue top-down technology plans that change the order of things, this is clearly not the case. Rather, there remains a disappointing stasis in the grand plan of a rapid transition to electric cars in China's growing cities. In many respects, this is because of a persistent hi-tech focus of policy, ignoring precisely the political and cultural considerations highlighted herein. Still, in 2016/17, such is the dynamism and power momentum of e-mobility innovation in China that low-carbon transition in this domain *is* arguably emergent. This dynamism, though, is in many respects in spite of, in the interstices of and even because of the stasis, frustrations and disincentives of the official national plans for the electric car *as a power/knowledge relational assemblage*.

Such illumination, however, elicits one final question, which remains the obvious focus of future research: where could this dynamism be leading regarding system transition; and what strategic openings and challenges – again political and cultural, not just techno-economic – present themselves as this new mobility system qualitatively shapes future societies?

Preliminary responses to this further question, however, point precisely to ways in which the Chinese case, while in many respects unique, suggests that in many places around the world – with both established and/or burgeoning automobility systems – a power relational perspective may be particularly insightful. First, the Chinese case strongly suggests EV mass adoption depends on broader socio-technical systems change and will not overtake the ICE car to the extent it is imagined and pursued as a 'car' with an electric engine. Conversely, to the extent this is grasped as strategic and power/knowledge relational *opportunity* – a change in perspective more likely by outsiders to the current automobility system and which involves reimagining political *power* and cultural *meanings* of dominant mobility systems – it can be readily conceived how this could be to EVs' longer-term advantage (and possibly China's).

Moreover, in the context of broader research into sustainable smart mobility, the Chinese case forces, and resonates with, a broader reframing of urban e-mobility, in which the EV features as one amongst *several* mobility options; as a crucial *part* of urban mobility transition (Low, 2013) that is self-consciously 'new' and attractive to the diverse and novel demands for mobility, perhaps especially for Chinese 'middle-class' consumers. The 'EV'-as-electric-'car' is thus not only a dead-end – since 'more cars means more city problems' (Calthorpe et al., 2012) even if they are electric – but also a barrier to the reimagining of 'electric vehicles' more generally, including by way of development of small electric vehicles that could present considerable new opportunities.

What the 'EV' *is*, in terms of novel assemblages of technologies (batteries and charging standards, digitized used and access, real-time traffic information and data analysis etc.…) but also social meaning and 'common-sense' forms of ownership, use and associated practices, remains far from certain. In particular, while an imaginary of smart mobility-as-a-service is increasingly taking shape, not least in China's prospering megacities, it remains embryonic and, hence, far from settled, with many essential contestations and uncertainties still to play out. In other words, this analysis suggests that we do not yet even know *who* the 'EV' is, as producer or user; and anywhere in the world, not just in China. This is thus perhaps the most important, if neglected or presumed, question for future research.

This is a fundamentally political – as power/knowledge relational – question. For instance, how the current Chinese regime, on the one hand dependent for support from the rising middle classes, can, on the other, accommodate their growing and more vocal demands for 'liveable urbanism' and autonomous mobility remains a key question, and for global mobility transitions, not just for Chinese politics; e.g. with air quality and congestion central issues, as presuppositions of the individualized pursuit of 'high quality' urban lifestyles.

In short, the power relational perspective on mobility systems transition opens the possibility that the dynamism and power momentum of innovation in China may be much more than just another case study of a struggling EV niche. Instead it may be shaping a rising China that may yet, in turn, dominate the construction of new form of 21st century urban mobility, just as a rising US did in the mid-20th century (Tyfield, 2017; Cf Paterson, 2007). In these circumstances, strategically illuminating *this* political and cultural process so as maximally to expedite the urgently needed low-carbon system transition *while also* optimizing public participation surely becomes all the more important.

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.techfore.2017.09.006.

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