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Politics of urban energy transitions: a case study of new energy vehicle (NEV) development in Shenzhen, China

Abstract: Cities are critical arenas for low-carbon energy transitions as a means to address challenges of climate change and sustainable development. This article explores the unfolding transition politics during new energy vehicle (NEV) implementation in Shenzhen, China. It shows that two competing processes of urban energy transitions (destabilizing and stabilizing dominant regimes) confront each other in the battleground of urban materiality, particularly the construction of charging infrastructure. This paper argues for reflexive and interactive transition governance that highlights the capacity of learning and adjustment of not only policy-makers but also other transition actors.

Keywords: politics; urban energy transitions; governance; new energy vehicle, China

1. Introduction

Cities are increasingly recognized as critical arenas for addressing the challenges of climate change and sustainability development (Coutard and Rutherford 2010). Low-carbon discourse is increasingly central in urban politics (Bulkeley and Betsill 2005, Jonas *et al.* 2011). Urban low-carbon energy transitions, in particular, respond to the global imperative of the decarbonization of current energy systems.

Urban energy governance represents 'the multitude of ways in which urban actors engage with energy systems, flows and infrastructures to meet particular collective goals and needs' (Rutherford and Jaglin 2015: p. 174). Multilevel

governments are taking the lead in designing policies, forming partnerships and enforcing actions. However, experiences gained from urban experiments within a diversity of contexts suggest that a low-carbon transition does not follow a clear roadmap and is not a process that can simply be planned, managed and controlled. Rather, the urban energy transition is a messy, chaotic, and uncertain 'reality' that engages diverging interests, competing visions, and complex power relations (Meadowcroft 2009, Jaglin 2014, Rutherford and Coutard 2014, Huang *et al.* 2018). It is a process that inevitably redistributes benefits and costs, restructures existing power relations, and reconfigures systems of institutions.

Urban energy transitions are intrinsically political (Truffer and Coenen 2012). Coutard and Rutherford (2010) conceptualize energy transitions as 'political processes in/through which ideas and interests diverge'. Energy transitions and urban politics are seen as mutually constituted (Rutherford and Coutard 2014). On the one hand, deciding where boundaries should be drawn in relation to areas and the dimensions of change in transitions are inherently political judgements (Meadowcroft 2009). On the other hand, transitions redistribute benefits and costs, and alignment often needs to be reached between competing interests and visions (Castán Broto and Bulkeley 2013b).

Recent years have witnessed a growing interest in the politics of low-carbon energy transitions (Bulkeley and Betsill 2013, Geels 2014, Hess 2014, Avelino *et al*. 2016, Partzsch 2017). Some scholars try to sketch the contours of transition politics by borrowing from institutional theories (see for instance, Avelino and Wittmayer 2016, Lockwood *et al*. 2017), while others are more concerned with political processes

involved in transformations of urban materiality (see for instance, Rutherford 2014, Gailing and Moss 2016, McEwan 2017a, Wodrig 2018). The fact that the dynamics of local political discourse can dramatically shape transition trajectories (McFarlane and Rutherford 2008, Späth and Rohracher 2010, Hodson and Marvin 2012, Moss 2014) calls for fuller understandings of the politics of urban energy transitions. However, in mainstream sociotechnical analyses of sustainability transitions, the dynamic politics and power relations between actors are often underplayed (Meadowcroft 2011, Lockwood *et al.* 2017), and 'an eternal search for consensus and unanimity' is favored instead (Coutard and Rutherford 2010, p. 724).

This brings us to energy transitions in China, where energy governance is often labeled as authoritarian (Cox 2016), and where the agency of other transition actors is generally assumed to be suppressed. Adding to the emerging body of literature on the politics of urban energy transitions (Truffer and Coenen 2012, Hodson and Marvin 2010, Jaglin 2014), this study uses the case of new energy vehicle (NEV) implementation in Shenzhen, China to present an empirical illustration of the political dynamics that underlie urban energy transitions. The empirical analysis builds upon a novel analytical tool, the Dimensions of Urban Energy Transitions (DUET) framework (Huang and Castán Broto 2018), and focuses on the political dimension of energy transitions. The study shows that, even under the authoritarian governance system in China, different transition actors demonstrate significant agency in shaping urban energy transitions, reflected through the dynamics of changing discourses and the confrontation of different transition interests and visions. Through the Shenzhen case,

the study provides an exemplary illustration of the politics of urban energy transitions, that merits more detailed analysis. Centrally, we call for more adaptive and reflexive approaches to transition governance.

The remainder of this article proceeds as follows. The next section explains the DUET framework, paying particular attention to its utility in understanding the politics of urban energy transitions. We then introduce the study area, methodology and data. We proceed with a systematic analysis of the politics of NEV development in Shenzhen, in which we explore three facets of the politics of urban energy transitions, before providing an in-depth discussion of the empirical results and our conclusions.

The DUET framework

In this study, we adopt Huang and Castán Broto's (2018) DUET framework, which is the culmination of a two-year project on urban energy transitions in China. The DUET framework is a tool to systematically examine the multidimensional nature of urban energy transitions. Centrally, the framework conceptualizes three dimensions of urban energy transitions: 1) sociotechnical experimentation; 2) urban political processes; and 3) sociospatial (re)configuration (figure 1).

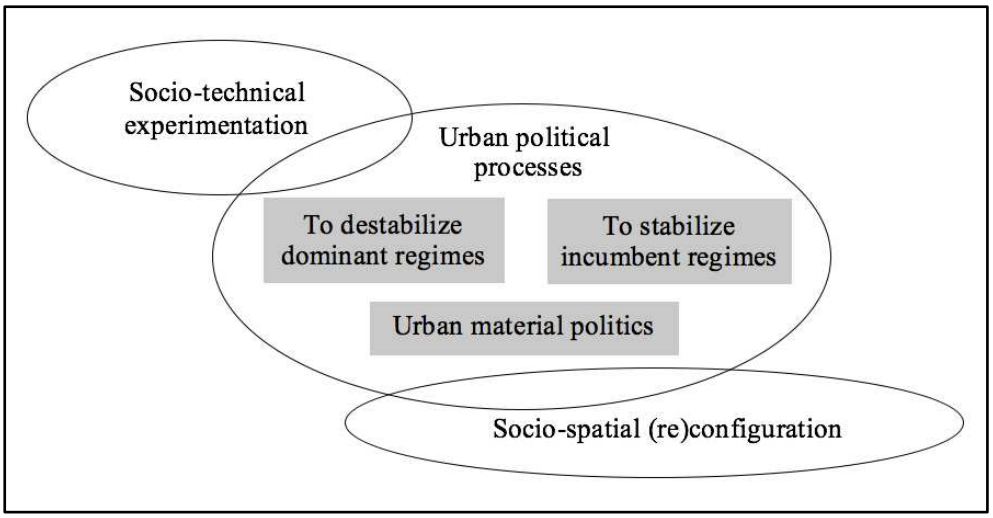

Figure 1. Three dimensions of the DUET framework (adapted from Huang and Castán Broto 2018)

Sociotechnical experimentation denotes purposive efforts and activities to introduce new innovations into the urban context. Urban experiments aim at radical changes that would trigger various urban political processes and involve a wide range of actors. Transitions become manifest in the urban materiality when sociospatial configurations are transformed and reconfigured around the new technology. The first dimension of the DUET framework is built upon theories of innovation studies (e.g. the technological innovation system) that emphasize the processes of purposive innovation, while the dimensions of urban political processes and sociospatial (re)configuration are conceptualized based on the current debates about the necessity of incorporating the conceptions of politics and spatiality into transition studies. Originally developed within the context of China, the wider applicability of the DUET framework has been tested in a comparative meta-analysis of cases of urban energy transitions worldwide (see Huang and Castán Broto 2018).

The three dimensions of the DUET framework are simultaneous processes of change that encompass multiple sub-processes. In this study, we focus on the second dimension of the DUET framework: urban political processes. It involves three sub-processes: destabilizing dominant regimes, stabilizing incumbent regimes, and urban material politics (figure 1). These processes deserve more attention because the dynamics of local political discourse about energy can dramatically change the direction of transition trajectories (McFarlane and Rutherford 2008, Späth and Rohracher 2010, Hodson and Marvin 2012, Castán Broto and Bulkeley 2013a, Moss 2014).

The first political process, destabilizing dominant regimes, describes how transitions emerge when predominant regimes are challenged by the introduction of new technologies into the urban context. Attempts to destabilize dominant regimes are well documented by a burgeoning body of literature on urban experiments (Castán Broto and Bulkeley 2013a, 2013b, Evans *et al.* 2016). Multilevel governments possess strong capacities in initiating radical changes through a variety of governance approaches (Rutherford and Jaglin 2015). The role of local governments in destabilizing dominant regimes is well demonstrated in many cities (see for instance, Li *et al.* 2016). Intermediaries are imperative for coordinating different future visions and competing, or even conflicting, priorities (Guy 2011). The introduction of new technologies into the urban contexts and the creation of niches are, however, not always as smooth as expected. Translation of policy into local contexts might encounter a variety of operational difficulties. A recent study, for instance, shows that

territorialization of solar thermal technology in Shenzhen failed as a result of a lack of alignment and compatibility between the technology and the city's sociospatial settings (Huang *et al.* 2018).

The second political process, stabilizing incumbent regimes, explains how radical and progressive changes are inevitably confronted with contestations, which can induce conflicts and resistance (Geels 2014). Car owners in Stockholm, for example, were not as enthusiastic as the government when biogas transport was first introduced in the city, mainly due to limited biogas availability (Vernay *et al.* 2013, Hjalmarsson 2015). These forces represent the tendency of the urban society to maintain and reproduce incumbent (high carbon) energy regimes, which is closely related to the so-called 'lock-in' of the incumbent technologies (Smith and Stirling 2007). A regime represents the establishment, which often possesses a higher position in the ladder of power and influence (Smith and Stirling 2007, Scrase and Smith 2009, Lockwood *et al.* 2017). This suggests that success of energy transitions might depend on the coupling of green visions/strategies with local resources and capacities.

Finally, the third political process, urban material politics, explains how urban materiality accommodates transition politics, following energy flows through urban infrastructure networks and the urban fabric (Rutherford 2014, Rutherford and Coutard 2014, Gailing and Moss 2016, McEwan 2017). The urban materiality might concomitantly shoulder great political commitments and impose 'everyday' struggles during radical transitions (Rutherford 2014). Urban material politics is increasingly documented by a rapidly growing body of literature in transition studies (Castán Broto

and Bulkeley 2013a, Moss 2014, Gailing and Moss 2016). Materiality is often seen as interacting with social practices, where politics arise (Hoffman and Loeber 2016). Avelino *et al.* (2016, p. 559) argue that the politics of materiality 'is located at the interface between governing regimes and practices on the one hand, and sociomaterial arrangements on the other hand'.

In the next section we detail how to deploy the DUET framework methodologically to better understand the politics of urban energy transitions in Shenzhen, China.

Study area, methods and data

Shenzhen is a coastal city located in the southeast of China. Ever since its designation as a protected economic zone in 1979, Shenzhen has had rapid urban development. As of 2017, its urban built-up area was 923.25 km^2 and it hosted a population of 12.52 million people (SBSM 2018). Shenzhen is a pioneer city in NEV development[1]. In 2009, Shenzhen was designated as one of the 13 national NEV demonstration cities (SSZD 2017), most of which have a strong industrial base of the automotive sector. Since then, Shenzhen has adopted more proactive approaches to facilitate NEV implementation, and it has become one of the most successful demonstration cities. As of 2017, the share of NEVs in Shenzhen ranked second among the 13 demonstration cities (CATARC *et al.* 2018) and the total ownership of NEVs in Shenzhen reached 156,726, with the most E-buses, E-taxis and Electric logistic vehicles among cities in the world (D1EV 2018, Southcn 2018, TCSM 2019) (Table 1).

Table 1. Statistics of NEV implementation in Shenzhen (2011-2017)

[1] According to the State Council of China, NEVs include plug-in hybrid electric vehicles, battery electric vehicles, and fuel cell vehicles. (Source: http://www.gov.cn/zwgk/2012-07/09/content_2179032.htm)

Year	Ownership of NEVs	Growth rate (%)	Share of NEVs (%)
2011	3035	-	0.15
2012	3961	30.51	0.18
2013	6895	74.07	0.26
2014	10919	58.36	0.35
2015	40719	272.92	1.28
2016	80828	98.50	2.51
2017	156726	93.90	4.66

Source: Transport Commission of Shenzhen Municipality (TCSM)

The rationale behind the selection of the Shenzhen case lies in the fact that Shenzhen had exhibited significant manifestations of an energy transition based on NEVs. The NEV technology has embedded in the urban materiality and local economy.

Indeed, NEVs have already reconfigured Shenzhen's transportation system, especially the public transportation system. In 2017, Shenzhen became the world's first city to electrify 100 percent of its public buses, with a total of 16,359 E-buses running on the roads of the city (TCSM 2017a). Shenzhen also has the world's largest E-taxi fleet, with a total of 12,498 E-taxies. As of the end of 2017, E-taxies accounted for 62.5% of the total taxi market, and the Shenzhen municipal government plans to establish an all-electric taxi system by 2020 (TCSM, 2018). To support the rapid growth of NEVs, Shenzhen has accelerated the construction of charging infrastructure. As of July 2017, a total of 173 charging stations and 36,550 charging piles have been deployed (TCSM 2017b). The NEV industry has also played an increasingly important role in Shenzhen's economy. Shenzhen is the birthplace of the largest NEV manufacturer in China, 'Build Your Dreams' (BYD). A NEV industry cluster has formed in Shenzhen based on leading enterprises such as BYD. In 2016, the output of the NEV industry reached 103.8 billion RMB (about 15.57 billion USD). Since 2009, the average annual growth rate of Shenzhen's NEV industry has exceeded 100% (TCSM 2017c).

Overall, NEV development in Shenzhen represents a typical energy transition in-the-making that has already gained recognition in the transition community (Li *et al.*

2016, Tyfield and Zuev 2016, Huang and Castán Broto 2018). Impressive achievements of NEV implementation have demonstrated a radical transitional process, which has made it an ideal case for investigating the politics behind urban energy transitions.

Drawing upon the DUET framework, we show how efforts to bring new innovation ideas (NEV experimentation) to a given spatial context (Shenzhen) have triggered urban processes of simultaneously destabilizing and stabilizing dominant regimes and reconfiguring urban materiality.

In order to better understand the areas of consensus and controversies in the transitional process, we conducted two rounds of interviews between 2013 and 2015. We chose this timeframe because it enables more in-depth and detailed observation of the politics underlying radical NEV implementation in Shenzhen since 2009, particularly in public transport. We interviewed individual from all actor groups involved in the energy transition process in Shenzhen, including governmental officials, researchers, NEV manufacturers, service providers, and corporate and individual users. We interviewed a total of 30 participants through 11 semi-structured individual interviews and four group interviews (Table 2).

Table 2. Interview information

No	Actor type	Affiliation of interviewees	Date of interview
Individual interview			
1	Researcher	Graduate School at Shenzhen, Tsinghua University	2013-11-02
2	Researcher	Graduate School at Shenzhen, Tsinghua University	2013-11-02
3	Researcher	Graduate School at Shenzhen, Tsinghua University	2013-11-02
4	Governmental official	Shenzhen Development and Reform Commission	2013-11-07/ 2013-12-26

5	Corporate user	Peng Cheng E-taxi Company	2013-11-19
6	Service provider	Li Neng Company	2013-11-19
7	Manufacturer	Shenzhen Wu Zhou Long Motors	2013-11-27
8	Manufacturer	Build Your Dreams	2013-12-03
9	Manufacturer	Build Your Dreams	2013-12-03
10	Manufacturer	Build Your Dreams	2013-12-03
11	Corporate user	Shenzhen Bus Group	2013-12-10
Group interview			
1 (5 participants)	Individual user (Taxi-driver)	Peng Cheng E-taxi Company	2015-03-08
2 (5 participants)	Individual user (Taxi-driver)	Peng Cheng E-taxi Company	2015-03-10
3 (6 participants)	Individual user (Taxi-driver)	Peng Cheng E-taxi Company	2015-03-14
4 (3 participants)	Individual user (Private ICE Vehicle owner)	-	2015-03-15

We complimented this primary qualitative data with the following secondary data sources: documents and bulletins issued by multilevel governments, government websites, key public media and web-based reports. These data enable a better contextualization of interview data, by providing information on the social and political context of events revealed in interviews.

Analysis and Results

This section analyses how the three dimensions of urban energy transition politics- destabilizing dominant regimes, reproducing incumbent regimes, and urban material politics- are reflected in the Shenzhen case. We first detail the primary actors involved in transition politics along with their key capacities and motivations for participating in the transition, before explaining how their competing interests shape the NEV implementation in Shenzhen through the three DUET political processes.

In general, three types of transition actors are involved in the implementation of NEVs in Shenzhen: government, industry actors, and end-users (Table 3). They are the main stakeholders during the transitional process.

Table 3. Main transition actors in NEV development in Shenzhen

Actor type		Actors
Government	Central government	Ministry of Science and Technology (MOST)
		National Development and Reform Commission (NDRC)
	Local government	Shenzhen Development and Reform Commission (Shenzhen DRC) Transport Commission of Shenzhen Municipality (TCSM) Urban Planning, Land and Resources Commission of Shenzhen Municipality (Shenzhen UPLRC)
Industry actor	NEV manufacturer	BYD
	Service provider	Li Neng Company Southern Grid of China (SGC)
End-user	Corporate user (public transport operator)	Shenzhen Bus Group
		E-taxi company
	Individual user	E-taxi drivers Passengers Private NEV owners

Multilevel governments possess strong incentives and capacities to shape urban energy transitions, through for example regulatory and economic policy instruments. For the central government, the NEV industry can ensure energy security and promote industrial upgrading. Under China's authoritarian political system, there are strong political motivations for local governments to follow national strategies. In particular, the top-down demonstration policy has played a key role in the implementation of new energy technologies on the ground (particularly at the city level) (Zhao and Gallagher 2007, Lo 2014). Demonstration cities are obligated to accomplish the targets set by the central government for technology application and diffusion. Therefore, for the

Shenzhen municipal government, one trigger for proactive implementation of NEVs is Shenzhen's designation as a national NEV demonstration city.

In addition to political motivations, there are also environmental and economic incentives to implement NEV development. The promotion of NEVs in Shenzhen can not only improve the urban environment but can also boost the urban economy through the development of local enterprises such as BYD (Li *et al.* 2016). However, consensus needs to be reached among different departments within the municipal government. As the main responsible department, the Shenzhen Development and Reform Commission (Shenzhen DRC) has actively led NEV implementation. In contrast, the Transport Commission of Shenzhen Municipality (TCSM), the department responsible for the management of urban public transportation, was initially rather skeptical about large-scale application of E-buses and E-taxies in Shenzhen. The main concern of TCSM lies in the increase in management costs and the potential financial burden for public transport operators (Interviewee 7, 2013-11-27). Moreover, provision of charging infrastructure for NEVs would greatly reconfigure the urban materiality, which requires the coordination of departments such as the Urban Planning, Land and Resources Commission of Shenzhen Municipality (Shenzhen UPLRC).

Also, as one of the main transition actors, the private sector possesses substantial transition capacities, and enterprises actively engage in urban transitions under strong economic incentives (Huang and Castán Broto 2018). For example, BYD is a main player in NEV implementation in Shenzhen. The rise of BYD, in turn, is inseparable from favorable policies and public resources provided by multilevel

governments. Statistics show that more than 90% of the E-buses in Shenzhen were manufactured by BYD. Similar to NEV manufacturers, NEV service providers, such as Li Neng Company and the Southern Grid of China (SGC), also regard NEV implementation as a promising business opportunity and they seize the chance to cultivate the market niche.

Finally, compared with the government and industry actors, end-users (including both corporate users and individual users) are equipped with the weakest transition capacity and play a relatively passive role in the transition process. Different from government and industry actors, end-users, particularly individual users, often exhibit more heterogeneity in their transition perspectives, take plural stances, and hold more disparate opinions, the main reason for which could be individualized experiences and preferences.

In what follows, we show how different actors with differing interests and transition capacities together shape the politics behind NEV implementation in Shenzhen.

Destabilizing Dominant Regimes: The role of multilevel governance in destabilizing the internal combustion engine (ICE) regime

As early as 1991, the Ministry of Science and Technology (MOST) started the development of NEVs. Since then, NEV implementation has been articulated in many national policies, including through specific implementation targets. However, it remains unclear how this top-level design is scaled-down and territorialized in local contexts. After Shenzhen's designation as the national NEV demonstration city in 2009,

the municipal government established the 'NEV Implementation Leading Group'. The mayor was appointed as director and the Shenzhen DRC as the lead department in order to form leadership and adapt transition institutions for prompt decision-making, In July 2009, the Shenzhen DRC issued the 'Work Plan for the Demonstration and Implementation of NEVs (2009-2012)', in which three NEV market segments were highlighted: state-owned public service vehicles, public transport, and privately owned vehicles.

Because NEVs are more expensive and have a more limited performance range than the internal combustion engine (ICE) vehicles, radical implementation of NEVs, particularly in public transport, is a great challenge for urban management. Various measures have been developed. For example, one novel business model, called the 'financial leasing, separating vehicle and battery, and combining charging and maintenance' model, has been proposed by Li Neng Company and supported by the municipal government. The Shenzhen Bus Group pays the same amount of money that they pay for an ICE bus. Li Neng pays the rest of the price and leases the bus to the Shenzhen Bus Group, keeping the ownership of the battery and providing an 8-year warranty for the battery. The Shenzhen Bus Group pays Li Neng the amount of money they normally spend on oil as charging fees, and Li Neng thus profits on the price difference between electricity and oil (Interviewee 6, 2013-11-19). Because this business model can to a great extent reduce the financial burden on bus companies, it has been very successful in Shenzhen.

Among many incentives, multilevel governments consider subsidies to be an effective policy instrument, which is especially important for opening up a niche market

for privately owned NEVs. In June 2010, Shenzhen was selected as one of five pilot cities for the provision of subsidies to privately purchased NEVs (Wu *et al.* 2016). The subsidy package consisted of both national and local subsidies. Subsidies are directly provided to NEV enterprises, who recalculate the price based on subsidies when they put their products in the market. The purchase price for NEVs has been substantially reduced by government subsidies, with a maximum discount of 120,000 RMB (about 17,640 USD) for every vehicle (SSZD 2010). The price of one type of NEV produced by BYD, for example, decreased nearly 50%, from 169,800 RMB (about 24,961 USD) to 89,800 RMB (about 13,201 USD) (ibid.). As a result, NEVs are significantly more affordable to consumers. However, the utilization of financial instruments is not without problems. One highly contentious issue is subsidy fraud, which was quite prevalent and involved not only small enterprises, but also some large manufacturers. In 2016, the central government launched a fraud investigation, in which five NEV enterprises were exposed and fined for subsidy fraud, and Shenzhen Wu Zhou Long Motors was one of them (MOF 2016). Reports show that 1.67 billion RMB (about 0.25 billion USD) of subsidies have been acquired by NEV enterprises by illegal means (Hu 2017). Subsidy fraud reflects the complexity of urban energy transitions: some industry actors may pursue short-term benefits while sacrificing the long-term development of the industry.

In addition to subsidies, municipal governments have also limited ICE vehicle ownership through a license plate control policy. Since January 2015, the total number of vehicle license plates issued every year has been limited to 100,000, of which 20,000 are exclusively allocated to NEVs (TCSM 2015). This policy instrument has significant stimulating effect on the application of NEVs. Catalyzed by policies such as these, the growth rate of NEVs sky rocketed from 58.36% in 2014 to 272.92% in 2015 (Table 1).

Overall, multiple governance efforts have been devoted to nurturing a market niche and to destabilize the incumbent regime of ICE vehicles not only by multilevel governments but also through the coordination between local government and other urban actors, especially industry actors.

Reproducing Incumbent Regimes: Resistance to NEVs from end users

> 'The implementation of NEVs threatens the interests of many parties. It is much harder to change current interest distribution than to change the soul…' (Interviewee 4, 2013-11-27)

NEV directly challenges the ICE car regime. In Shenzhen, there have been intense conflicts between the NEV-empowering protective space and the incumbent ICE regime. This is particularly the case for the public transport sector, where NEVs have been more radically implemented by the Shenzhen DRC and the number of NEVs has been rapidly increasing.

In fact, at the beginning, disparate narratives existed even within the municipal government. As one of the main responsible departments, the TCSM, for example, was initially reluctant to increase the number of E-buses. As indicated by one interviewee:

> 'They [TCSM] tend to resist newly emerging things. From the perspective of management, it [NEV] decouples the original interest chain. Additionally, the top-down governance approach of the Shenzhen DRC tends to provoke resistance of the Shenzhen Bus Group.' (Interviewee 7, 2013-11-27)

The Shenzhen Bus Group, which operated on behalf of the ICE public transportation regime, once openly refused to use E-buses at a large scale, claiming that

E-buses still have unsolved problems such as safety issues, high repair and maintenance costs, and limited continuous voyage capability.

Another arena of contestation is E-taxi implementation, represented by disparate narratives among individual end-users such as taxi drivers and passengers.

For taxi drivers, although the government offers substantial incentives, many interviewees noted that they still favor driving ICE taxis over E-taxis, citing concerns about the safety issues of E-taxis. Among taxi drivers, there have long been concerns that E-taxis are radioactive and detrimental to health, and some taxi-drivers thus even refuse to drive E-taxis. To dispel these doubts, the municipal government and NEV enterprises organized several educational activities. For example, BYD organized factory tours in which taxi drivers and media were invited to visit the laboratories of BYD, where on-site testing of the radiation level of E-taxis was conducted. BYD technicians explained the testing results to taxi drivers, which showed that the radiation level was even lower than that of a microwave (LGG 2016). The municipal government also published an article on its website that refuted the rumor of high radiation in E-taxis and reported the results of the radiation tests during BYD's factory tours (TCSM 2017d). However, interview data confirms that the worries of some taxi drivers have still not been fully relieved because of a clear distrust of the government and NEV manufacturers.

In addition, fierce conflicts have arisen between ICE taxi drivers and E-taxi drivers. As reported by one E-taxi driver:

> 'We are considered as a big threat to them [ICE taxi drivers]. They blame us for stealing away their business…' (Group Interview 1, 2015-03-08)

Similarly, another interviewee described the following:

> 'They [ICE taxi drivers] view us as enemies. Why? Because E-taxis are designed to be more comfortable and are favored by passengers. They think it is unfair to them, and because of this, sometimes they even play dirty tricks behind our back.' (Group Interview 1, 2015-03-08)

For taxi-passengers, although some are willing to take E-taxis, others remain skeptical about the new technology and wonder if E-taxis are as safe as ICE taxis. The safety concern of E-taxis was particularly fueled by a traffic accident in 2012. A speeding car crashed into a BYD E-taxi. The E-taxi exploded and burst into flames, killing all three people. This accident had at that time received wide public attention and was even reported by international media such as Reuters (2012) and the New York Times (2012). After the accident, the safety of E-taxis, and especially their batteries, was strongly questioned by the public (NEA 2012). Although BYD's battery was later eliminated as the cause of the explosion in an independent expert investigation report, the negative influence on the market faith was sustained for months.

Taxi-driver and passenger interests, therefore demonstrate that disparate narratives exist among different stakeholders around the implementation of NEVs in Shenzhen and that efforts to destabilize the ICE regime encounter resistance to change. This tendency to maintain the incumbent regime is still strong, particularly under changing and contested public discourse.

It is worth noting that, because NEV implementation in Shenzhen represents an urban energy transition in-the-making, the landscape of politics between stakeholders has not yet manifested fully. The contestation between the NEV-empowering protective

space and the incumbent ICE regime is a primary dynamic of transition politics. As transition deepens, particularly as the market share of privately owned NEVs expands, more arenas of conflict are likely to emerge. For instance, political pressure exerted on multi-level governments might increase as actors representing the ICE car regime (not only ICE car manufacturers but also oil companies) conduct more extensive and intensive lobbying activities to maintain their dominance in the sector, and socioeconomic problems might also be induced when the replacement of ICE vehicles leads to industrial restructuring and employment relocation (Hildermeier and Villareal 2011).

Urban Material Politics: The challenges of providing NEV charging facilities

Urban materiality is the ground for disputes between those actors who, on the one hand, challenge the urban regime and, on the other, defend/reproduce it. Urban political processes are thus also represented by the politics of urban materiality, in particular the materialities of infrastructures. Indeed, there was a dynamic politics around the reconfiguration of urban materiality during the implementation of NEVs in Shenzhen.

One of the key urban facilities for NEVs is charging infrastructure. In Shenzhen, the further implementation of NEVs faces a difficult dilemma: on one hand, a lack of charging infrastructure is a major obstacle for scaling up the private market; on the other hand, the relatively small market of privately owned NEVs gives little incentive for investors to invest in charging infrastructure. Although the municipal government has been active in facilitating the construction of charging infrastructure, the city faces

a major challenge in the provision of urban land. Shenzhen is a city with very limited land resources. The total land area of the city is 1996.78 km^2, of which more than 70% is mountainous and not developable (SWRB 2016). Against a general situation of land shortage, it is extremely difficult to allocate land for charging stations in central urban areas. As expressed by one interviewee:

> 'Right now charging infrastructure is lacking. Shenzhen is a city with very limited land resources, and land use is a major obstacle.' (Interviewee 5, 2013-11-19)

The difficulty is also institutional. On the one hand, land use for the construction of charging stations is not considered in urban land use planning; on the other hand, it is also very difficult to make amendments to previous land use plans that have been legally approved by national and provincial governments. One service provider said that:

> "It is very difficult to construct charging stations. In urban planning, there is no land use category for charging stations and charging piles, which right now can only be registered as 'temporal buildings'." (Interviewee 6, 2013-11-19)

This difficulty of land provision is especially acute for the construction of bus charging stations, which require larger tracts of land and involve the coordination of different government departments. In March 2014, the deputy Prime Minister of the State Council hosted a meeting in Shenzhen, a key issue of which was the construction of charging infrastructures. After the meeting, the deputy Prime Minister called a meeting of relevant departments of Shenzhen Municipality and urged solutions for land provision for charging stations in Shenzhen. Under pressure from the central

government, the Shenzhen UPLRC drew up the land use planning for charging infrastructure to tackle the constraints of urban land use. However, even if agreement is eventually reached between the different departments within the municipal government, land provision for charging infrastructure construction involves more social stakeholders, and it is often very difficult to align disparate/conflicting interests. For example, news media reported that a project to construct a bus charging station in a residential neighborhood, which was planned and approved by the government, encountered strong resistance from residents in that neighborhood. Residents worried that potential safety problems could be incurred such as electrical leakage and fire hazards. Under strong resistance, the project was eventually terminated (LGG 2016).

The provision of charging facilities to private NEV users is more complicated than the construction of bus charging stations, which are mainly operated and invested in by large state-owned operators such as Li Neng Company and the SGC and have enjoyed more government support. Since 2013, the SGC has not invested in the construction of charging piles but instead encourages NEV owners to install charging piles in their own parking lots. However, users encounter many difficulties. The strongest opposition often comes from the real estate management company, which is in charge of the maintenance and management of the entire residence community. Real estate management companies lack incentives to support the installation of NEV charging piles because this would considerably increase their management cost and because they are also concerned with the potential safety hazards of charging piles. In 2016, the National Development and Reform Commission (NDRC) issued “Notice on

Accelerating the Construction of Electric Vehicle Charging Infrastructure in Residential Areas", in which it is specified that the real estate management company should play a more active role in supporting the construction charging infrastructure.

Paradoxically, in infrastructure provision, despite the fact of urgent needs for more charging infrastructure, existing charging facilities are not fully or efficiently utilized, mainly due to fierce competition between NEVs and ICE vehicles over parking space. Because parking space is a particularly scarce resource in Shenzhen, many parking lots with charging piles are often occupied by ICE vehicles and thus cannot be used by NEVs. According to an investigation published by an NGO, of the 3,697 public parking lots equipped with charging piles, 41.33% were occupied by ICE vehicles (PowerLife 2017). This represents a great challenge for urban governance.

Overall, urban materiality is the battleground during NEV implementation. Major disputes revolve around the construction and provision of charging infrastructure for NEVs. Land use is a primary constraint, and the alignment of different interest parties is difficult. More efficient use of existing charging facilities is another issue for which fierce competition between NEVs and ICE vehicles over (scarce) parking space is evident. It is worth noting that, given the present scale of NEVs in Shenzhen, significant pressure on the power grid has not yet been exerted, which is an important facet of urban materiality. In preparation for the increase of NEVs and the deepening of the transition, a central task in Shenzhen's "13th Five-year Plan for Energy Development" is to strengthen the power grid to ensure the capability to meet the future electricity supply needs of NEVs.

Discussion: toward the 'reflexivity' of transition governance

NEV development in Shenzhen provides an exemplary illustration of the politics of urban energy transitions as conceptualized in the DUET framework. The Shenzhen case shows that multilevel governments possess strong capacities to shape urban energy transitions by deploying various policy instruments to nurture the NEV market niche and to destabilize the ICE regime. In particular, NEVs have been radically applied in urban public transport, which has encountered substantial resistance both within the municipal government and from other actors such as bus companies and taxi drivers. Although it is unsurprising that industry actors have proven to be particularly important players in urban energy transitions, this case illuminates some creative strategies they have used to destabilize dominant regimes. For example, innovative business models have been designed to relieve financial pressures exerted on public transport operators by separating the ownership of vehicles and batteries. In Shenzhen, a strong coalition exists between the local government and industry players, in which urban priorities (particularly the priority of boosting local economies) are in alignment with industry interests in NEV implementation. However, due to the profit-driven nature of enterprises, industry actors might in some cases jeopardize the transition in pursuit of short-term economic benefits. In contrast to government and industry actors, who actively and coherently engage in urban energy transitions, end-users are more passive and exhibit substantial heterogeneity in their transition perspectives. This heterogeneity is reflected particularly in the disparate narratives that exist among both taxi-drivers and passengers.

NEV implementation in Shenzhen has been influenced by some elements of authoritarianism. For example, Shenzhen's designation as a national demonstration city has provided strong political incentives for the municipal government to implement NEVs. NEVs have been radically implemented in public transport in a mandatory fashion, and the central government has played an influential role in coordinating different departments within the Shenzhen municipal government on the key issue of charging infrastructure provision. Under authoritarianism in China, the politics and power relations are generally considered more latent and elusive compared with those of Western countries. Importantly, the Shenzhen case shows that even under the authoritarian governance system in China, transition actors possess considerable agency in shaping the trajectory of urban energy transitions. For example, local residents' resistance resulted in the termination of the construction of a bus charging station in their neighbourhood. Further, the case demonstrates how government actors often encounter uncertainties and must adapt to new situations. For example, the case shows how the municipal government reacted promptly in addressing public concerns after the BYD E-taxi accident and eventually oriented the discourse toward a more positive view of the new technology. This suggests a certain level of policy learning and adaptation in the Shenzhen case.

This learning reflects recent calls in the transition community for 'reflexivity' in transition governance (Smith and Stirling 2007, Jaglin 2014). In the face of dynamic urban political processes (disputes, ambivalences and conflicts), the reflexivity of transition governance recognizes the agency of not only governments and industry

actors but also other transition actors such as end-users (Hendriks and Grin 2008, Meadowcroft 2009). It moves away from examining and illuminating 'power' to get it 'out of the way' to dynamizing and opening up constitutive power relations themselves. Reflexive transition institutions coevolve with changing politics by continuously repositioning themselves and readjusting their roles in the transformation process (Scrase and Smith 2009).

This study uncovers the messy and contingent character of urban energy transitions and accentuates the importance of acknowledging, accepting and dealing with conflicts and contestations. It is politics that stands behind policy, it is politics that mediates (critical) transition decisions, and it is politics that serves as a mechanism to resolve conflicts and avoid serious consequences. Therefore, politics offers policy-makers the opportunity of policy-learning and readjustment. In sum, transition politics, as illustrated in the Shenzhen case, points to the necessity of incorporating 'reflexivity' into transition governance, which eventually cultivates 'the capacity for continuous and self-conscious societal reflection, assessment, and readjustment' via policy learning and interactive decision-making (Meadowcroft 2009, p.323).

6. Conclusions

Politics is at the heart of energy transitions because such transitions necessarily involve the redistribution of benefits and costs, and there are inevitably conflicting visions of the scope, direction and speed of the transformation among transition actors (Markard 2018). However, there is a tendency in transition theories to downplay the political

dimension of energy transitions. Premised on Meadowcroft's (2009) view that energy transition is a chaotic, uncertain, and open-ended 'reality' that engages diverging interests, competing visions, and complex power relations, this article applies the DUET framework (Huang and Castán Broto, 2018) to explore the unfolding transition politics during NEV implementation in Shenzhen city. We show how two contesting processes of urban energy transitions (destabilizing and stabilizing dominant regimes) confront each other in and manifest through urban materialities. On the one hand, multilevel governments have provided various incentives to steer the use of NEVs in Shenzhen; on the other hand, implementation of a new technology has fueled tensions and disputes between urban actors. For example, major disputes revolve around the reconfiguration of urban materialities, particularly the construction of charging infrastructure for NEVs.

Cities are playing an increasingly central role in advancing meaningful and fundamental transformations. Against the deepening and widening of sustainability transitions, sociotechnical experimentation proliferates in different cities in the world with the application of new technologies to decarbonize the energy system. NEV implementation in Shenzhen represents a case of such urban energy transitions in-the-making. A key contribution of this study is that it uncovers the contested nature of urban energy transitions and the fact that the rhythm of transitions is influenced by a constellation of transition actors with varied interests and priorities. It thus adds an important, albeit often neglected, political dimension to our understanding of the transitional process.

Interestingly, despite being situated with authoritarian institutional setting, various transition actors in Shenzhen such as the industry actors and end users have exhibited substantial agency in shaping the trajectories of the transition. This suggests that in more democratic political contexts similar political dynamics exist. These dynamics remain underexplored, however, despite their potential contribution to our understanding of how cities are increasingly shaping local and global politics in different contexts. The politics of energy transitions points toward more complex perspectives on the strategies and approaches of urban governance.

An important policy implication generated from this study is the necessity to incorporate reflexivity into transition governance, which goes beyond the Chinese context and is also relevant to policy makers in other countries. Reflexive transition governance offers novel and potentially productive ways in which transition policy and practice alike can engage with a complex, highly politicized, and open-ended transition process.

This study proposes the following avenues for future research. First, the DUET framework offers a valuable lens through which to understand the political dimensions of urban energy transitions and is worth deploying in other contexts for different technologies. Second, this case highlights the need for comparative studies on energy transitions between different technologies. With differences in technological characteristics, the incentives and power relations of main stakeholders might differ and the materialization of technologies into the urban context might exhibit different patterns and induce differing political processes. Therefore, comparative studies that

account for the differences of technologies can provide more nuanced insights into the complexities and varieties of transition politics.

Reference

Avelino, F., Grin, J., Pel, B. and Jhagroe, S., 2016. The politics of sustainability transitions. *Journal of Environmental Policy & Planning*, 18(5), 557-567.

Avelino, F. and Wittmayer, J. M., 2016. Shifting power relations in sustainability transitions: a multi-actor perspective. *Journal of Environmental Policy & Planning*, 18(5), 628-649.

Brown, H. S. and Vergragt, P. J., 2008. Bounded socio-technical experiments as agents of systemic change: The case of a zero-energy residential building. *Technological Forecasting and Social Change*, 75(1), 107-130.

Bulkeley, H. and Betsill, M., 2005. Rethinking sustainable cities: Multilevel governance and the 'urban' politics of climate change. *Environmental Politics*, 14(1), 42-63.

Bulkeley, H. and Betsill, M. M., 2013. Revisiting the urban politics of climate change. *Environmental Politics*, 22(1), 136-154.

Castán Broto, V., 2012. Social housing and low carbon transitions in Ljubljana, Slovenia. *Environmental Innovation and Societal Transitions*, 2, 82-97.

Castán Broto, V. and Bulkeley, H., 2013a. Maintaining Climate Change Experiments: Urban Political Ecology and the Everyday Reconfiguration of Urban Infrastructure. *International Journal of Urban and Regional Research*, 37(6), 1934-1948.

Castán Broto, V. and Bulkeley, H., 2013b. A survey of urban climate change experiments in 100 cities. *Global Environmental Change*, 23(1), 92-102.

China Automative Technology and Research Center (CATARC), Nissan China and Dongfeng Motor, eds., 2018. Annual Report on New Energy Vehicle Industry in China (2018). Beijing: Social Sciences Academic Press (China). (in Chinese)

Coutard, O. and Rutherford, J., 2010. Energy transition and city–region planning: understanding the spatial politics of systemic change. *Technology Analysis & Strategic Management*, 22(6), 711-727.

Cox, M., 2016. The pathology of command and control: a formal synthesis. *Ecology and Society*, 21(3), 33.

D1EV, 2018. Shenzhen has the world's largest E-taxi fleet, with approximately 13 thousand E-taxies[Shenzhen cheng quanqiu chundiandong chuzuche yunying guimo zuida chengshi, guimo yijin 1.3 wan liang] (in Chinese). Available from: https://www.d1ev.com/news/shichang/65315 [Accessed 7 January 2019].

Diao, Q. H., 2012. The implications of Hong Kong's Land Use Model for Land Reform in Shenzhen. *China Real Estate*, (15), 19-21. (in Chinese)

Evans, J., Karvonen, A. and Raven, R., eds., 2016. *The experimental city*. London: Routledge.

Gailing, L. and Moss, T., eds., 2016. *Conceptualizing Germany's energy transition: institutions, materiality, power, space*. London: Springer Nature.

Geels, F.W., 2014. Regime resistance against low-carbon transitions: Introducing politics and power into the multi-level perspective. *Theory, Culture & Society*, 31(5), 21-40.

Guy, S., ed., 2011. *Shaping urban infrastructures: intermediaries and the governance of socio-technical networks*. London: Routledge.

Hendriks, C. and Grin, J., 2008. Contextualizing reflexive governance: The politics of Dutch transitions to sustainability. In: Newig, J., Voß, J. and Monstadt J., eds. *Governance for sustainable development: Coping with ambivalence, uncertainty and distributed power*. London: Routledge.

Hess, D. J., 2014. Sustainability transitions: A political coalition perspective. *Research Policy*, 43(2), 278-283.

Hildermeier, J. and Villareal, A., 2011. Shaping an emerging market for electric cars: How politics in France and Germany transform the European automotive industry. *European Review of Industrial Economics and Policy*, November 3. Available from: http://revel.unice.fr/eriep/index.html?Id=3329 [Accessed 25 January 2019].

Hjalmarsson, L., 2015. Biogas as a boundary object for policy integration–the case of Stockholm. *Journal of Cleaner Production*, 98, 185-193.

Hodson, M. and Marvin, S., 2010. Can cities shape socio-technical transitions and how would we know if they were?. *Research Policy*, 39(4), 477-485.

Hodson, M. and Marvin, S., 2012. Mediating Low-Carbon Urban Transitions? Forms of Organization, Knowledge and Action. *European Planning Studies*, 20(3), 421-439.

Hoffman, J. and Loeber, A., 2016. Exploring the micro-politics in transitions from a practice perspective: The case of greenhouse innovation in the Netherlands. *Journal of Environmental Policy & Planning*, 18(5), 692-711.

Hu Zejun, 2017. The Audit on the Implementation of the Central Budget and Other Financial Revenues and Expenditures for the Year 2016 [Guowuyuan guanyu 2016 niandu zhongyang yusuan zhixing he qita caizheng shouzhi de shenji gongzuo baogao] (in Chinese). Available from: http://www.gov.cn/xinwen/2017-06/23/content_5204961.htm [Accessed 6 January 2019].

Huang, P. and Castán Broto, V., 2018. The interdependence between urban processes and energy transitions: The Dimensions of Urban Energy Transitions (DUET) framework. *Environmental Innovation and Societal Transitions*, 28, 35-45.

Huang, P., Castán Broto, V., Liu, Y. and Ma, H., 2018. The governance of urban energy transitions: A comparative study of solar water heating systems in two Chinese cities. *Journal of Cleaner Production*, 180, 222-231.

Jaglin, S., 2014. Urban energy policies and the governance of multilevel issues in Cape Town. *Urban Studies*, 51(7), 1394-1414.

Jonas, A. E., Gibbs, D. and While, A., 2011. The new urban politics as a politics of carbon control. *Urban Studies*, 48(12), 2537-2554.

Li, Y., Zhan, C., de Jong, M., et al., 2016. Business innovation and government regulation for the promotion of electric vehicle use: lessons from Shenzhen, China. *Journal of Cleaner Production*, 134, 371-383.

Lo, K., 2014. A critical review of China's rapidly developing renewable energy and energy efficiency policies. *Renewable and Sustainable Energy Reviews*, 29, 508-516.

Lockwood, M., Kuzemko, C., Mitchell, C. and Hoggett, R., 2017. Historical institutionalism and the politics of sustainable energy transitions: A research agenda. *Environment and Planning C: Politics and Space*, 35(2), 312-333.

Markard, J., 2018. The next phase of the energy transition and its implications for research and policy. *Nature Energy*, 3, 628-633.

McEwan, C., 2017. Spatial processes and politics of renewable energy transition: Land, zones and frictions in South Africa. *Political Geography*, 56, 1-12.

McFarlane, C. and Rutherford, J., 2008. Political infrastructures: Governing and experiencing the fabric of the city. *International Journal of Urban and Regional Research*, 32(2), 363-374.

Meadowcroft, J., 2009. What about the politics? Sustainable development, transition management, and long term energy transitions. *Policy Sciences*, 42, 323-340.

Meadowcroft, J., 2011. Engaging with the politics of sustainability transitions. *Environmental Innovation and Societal Transitions*, 1(1), 70-75.

Ministry of Finance (MOF), 2016. Announcement on Local Budgets and Final Accounts and the Special Investigation on Subsidies for New Energy Vehicle Implementation. [Guanyu defang yujuesuan gongkai he xinnengyuan qiche tuiguang yingyong buzhu zijin zhuanxiang jiancha de tongbao]. (in Chinese) Available from: http://www.mof.gov.cn/zhengwuxinxi/bulinggonggao/tongzhitonggao/201609/t20160908_2413434.htm [Accessed 7 January 2019].

Moss, T., 2014. Socio-technical Change and the Politics of Urban Infrastructure: Managing Energy in Berlin between Dictatorship and Democracy. *Urban Studies*, 51(7), 1432-1448.

National Energy Administration (NEA), 2012. The 'Shenzhen Model' for the Development of Electric Vehicles [Shenzhen moshi geili chundiandong qiche fazhan]. (in Chinese) Available from: http://www.nea.gov.cn/2012-09/05/c_131828199.htm [Accessed 7 January 2019].

Partzsch, L., 2017. 'Power with' and 'power to' in environmental politics and the transition to sustainability. *Environmental Politics*, 26(2), 193-211.

Reuters., 2012. Chinese probe clears electric battery in deadly accident – BYD. Available from: https://in.reuters.com/article/byd-china-probe-idINL2E8J33CB20120803 [Accessed 7 January 2019].

Rutherford, J., 2014. The vicissitudes of energy and climate policy in Stockholm: politics, materiality and transition. *Urban Studies*, 51(7), 1449-1470.

Rutherford, J. and Coutard, O., 2014. Urban energy transitions: places, processes and politics of socio-technical change. *Urban Studies*, 51(7), 1353-1377.

Rutherford, J. and Jaglin, S., 2015. Introduction to the special issue – Urban energy governance: Local actions, capacities and politics. *Energy Policy*, 78, 173-178.

Scrase, I. and Smith, A., 2009. The (non-) politics of managing low carbon socio-technical transitions. *Environmental Politics*, 18(5), 707-726.

Longgang Government (LGG), 2016. Public Charging Poles: Difficult to Construct and Troublesome to Use [Gonggong chongdianzhuang: jianqilai nan yongqilai fan]. (in Chinese). Available from: http://www.lg.gov.cn/hdjl/lgms/201605/t20160504_11065862.htm [Accessed 25 January 2019].

Shenzhen Special Zone Daily (SSZD), 2010. The Work Conference for the Provision of Subsidies to Privately-purchased New Energy Vehicles Held in Shenzhen [Quanguo siren goumai xinnengyuan qiche butie shidian gongzuo huiyi zai Shen zhaokai]. (in Chinese). Available from: http://www.sz.gov.cn/cn/xxgk/zfxxgj/zwdt/201007/t20100707_5292871.htm [Accessed 25 January 2019].

Shenzhen Special Zone Daily (SSZD), 2017. Shenzhen Continue to Lead in New Energy Vehicles [Shenzhen xinnengyuan qiche jixu lingpao]. (in Chinese). Available from: http://info.carec.hc360.com/2017/08/310911628141.shtml [Accessed 25 January 2019].

Shenzhen Water Resources Bureau (SWRB), 2016. *Notice of Shenzhen Water Resources Bureau on the Issuing of "Planning of Water and Soil Conservation (2016-2030)" [Shenzhenshi shuiwuju guanyu yinfa "Shenzhenshi shuitu baochi guihua (2016-2030)" de tongzhi]* (in Chinese). Available from: http://www.szwrb.gov.cn/xxgk/zfxxgkml/ghjh/swgh/201711/t20171115_9688128.htm [Accessed 25 January 2019].

Southcn, 2018. The NEV ownership in Shenzhen is expected to exceed 250 thousand this year [Shenzhen jinnian xinnengyuan che baoyouliang youwang tupo 25 wan liang] (in Chinese). Available from: http://sz.southcn.com/content/2018-08/29/content_183096257.htm [Accessed 7 January 2019].

PowerLife., 2017. Report on the Charging Pile Industry in Shenzhen (2017). (in Chinese). Available from: https://www.powerlife.com.cn/9951.html [Accessed 25 January 2019].

Smith, A. and Stirling, A., 2007. Moving outside or inside? Objectification and reflexivity in the governance of socio-technical systems. *Journal of Environmental Policy & Planning*, 9(3-4), 351-373.

Späth, P. and Rohracher, H., 2010. 'Energy regions': The transformative power of regional discourses on socio-technical futures. *Research Policy*, 39(4), 449-458.

Statistics Bureau of Shenzhen Municipality (SBSM), 2018. *Statistical Communique of Shenzhen's Economic and Social Development (2017) [Shenzhen shi 2018 nian guomin jingji he shehui fazhan tongji gongbao]* (in Chinese). Available from: http://www.sz.gov.cn/zfgb/2018/gb1048/201804/t20180428_11803423.htm [Accessed 25 January 2019].

New York Times, 2012. BYD releases details about electric taxi fire. Available from: http://www.nytimes.com/2012/05/30/business/global/byd-releases-details-about-electric-taxi-fire.html [Accessed 7 January 2019].

Transport Commission of Shenzhen Municipality (TCSM), 2015. *Implementing Rules for the Control of the Growth of Motor Vehicles in Shenzhen [Shenzhenshi xiaoqiche zengliangtiaokong guanli shishi xize]* (in Chinese). Available from: http://xqctk.sztb.gov.cn/glbf/ [Accessed 25 January 2019].

Transport Commission of Shenzhen Municipality (TCSM), 2017a. Shenzhen has 16358 E-buses, electrifying 100 percent of its public buses [Shenzhen tuiguang chundiandong gongjiaoche 16359 liang, zhuanying gongjiaoche shixian chun diandonghua] (in Chinese). Available from: http://www.sztb.gov.cn/zwgk/jtzx/gzdt/gjdt_80994/201712/t20171228_10630454.htm [Accessed 7 January 2019].

Transport Commission of Shenzhen Municipality (TCSM), 2017b. The Number of New Energy Vehicles in Shenzhen Has Exceeded 76000; Its Public Buses Will Be Electrified 100 Percent till the End of This Year [Shenzhen xinnengyuan qiche chao 7.6 wanliang, niandi gongjiaoche jiang baifenbai chun diandonghua]. (in Chinese). Available from:

http://www.sz.gov.cn/cn/xxgk/zfxxgj/bmdt/201709/t20170908_8551058.htm [Accessed 7 January 2019].

Transport Commission of Shenzhen Municipality (TCSM), 2017c. Industry Interests behind the Electrification of Public Buses [Gongjiaoche chun diandonghua beihou de chanye hongli]. (in Chinese). Available from: http://www.sztb.gov.cn/zwgk/jtzx/gzdt/gjdt_80994/201708/t20170830_8298607.htm [Accessed 7 January 2019].

Transport Commission of Shenzhen Municipality (TCSM), 2017d. E-taxi has high level of radiation? Not True [Diandong chuzuche fushe gao? Wuchuan]. (in Chinese). Available from: http://www.sz.gov.cn/jw/jtzx/wycx/czcx/cxtx/201712/t20171204_10101551.htm [Accessed 7 January 2019].

Transport Commission of Shenzhen Municipality (TCSM), 2018. Electrify the Taxi Fleet and Facilitate the Building of Green Shenzhen [Chuzuche chun diandonghua, zhuli lvse Shenzhen jianshe]. (in Chinese). Available from: http://www.sztb.gov.cn/zwgk/ztzl/msss/ldgz/201801/t20180112_10651936.htm

[Accessed 7 January 2019].

Transport Commission of Shenzhen Municipality (TCSM), 2019. Electrify the Taxi Fleet and Facilitate the Building of Green Shenzhen [Shenzhen yi yunyin de chundiandong chuzuche you 20135 liang, zhan chuzuche zongliang 94.21%]. (in Chinese). Available from: http://jtys.sz.gov.cn/zwgk/jtzx/gzdt/czdt/201901/t20190104_15246494.htm [Accessed 7 January 2019].

Truffer, B. and Coenen, L., 2012. Environmental Innovation and Sustainability Transitions in Regional Studies. *Regional Studies*, 46(1), 1-21.

Tyfield, D. and Zuev, D., 2016. Case Study 5: Low carbon mobility transitions in China. *In:* Higham, J. and Hopkins, D. eds. *Handbook of Low Carbon Mobility Transitions*, Oxford: Goodfellow Publishers, 247-255

Vernay, A.L., Mulder, K.F., Kamp, L.M., et al., 2013. Exploring the socio-technical dynamics of systems integration–the case of sewage gas for transport in Stockholm, Sweden. *Journal of Cleaner Production*, 44, 190-199.

Wodrig, S., 2018. New subjects in the politics of energy transition? Reactivating the northern German oil and gas infrastructure. *Environmental Politics*, 27(1), 69-88.

Wu, Z., Tang, J. and Wang, D., 2016. Low carbon urban transitioning in Shenzhen: A multi-level environmental governance perspective. *Sustainability*, 8(8), 720-734.

Zhao, L. and Gallagher, K.S., 2007. Research, development, demonstration, and early deployment policies for advanced-coal technology in China. *Energy Policy*, 35(12), 6467-6477.