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Energy firms' responses to institutional ambiguity and complexity in long energy transitions: The case of the UK and China

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Abstract

We compare and contrast the UK and China as maximum variation cases for understanding long energy transitions from the state and the firm perspectives. We present case histories and corpus-based computer-assisted textual analyses on the long energy transitions in both countries. With these, we explore and explain how and why energy supply firms respond the way they do to the institutional ambiguities and complexities that characterize the long energy transitions in each case. Our findings demonstrate that a centrally coordinated and imposed approach by the state can generate institutional clarity in long energy transition, which is quickly seized on by firms striving to preserve and increase their resources and influence. Such clarity and transition processes lose momentum owing to the perennial trilemma of energy affordability, security and sustainability. Market-based mechanisms to trigger and sustain long energy transitions, complemented with focused and continuous state interventions (e.g., incentives, taxation) provide a more effective and accountable institutional framework for the state and energy firms to deal with the energy trilemma. Irrespective of the logic of the type of economy that manifests the backdrop for any long energy transition process, institutional ambiguity and complexity never disappear completely, owing to both the energy trilemma and the institutional multiplicities.

Keywords: Long Energy Transitions, Energy Supply Firms, UK, China, Corpus analysis

Introduction

Centuries-long investments in the hydrocarbon-based economy and renewable energy's security challenge (e.g., intermittent supply) mean that an entirely decarbonized global energy supply system is unlikely to be achieved anytime soon. The global energy supply sector is at the heart of the grand energy transitions challenge as it is the single most emitting economic sector, responsible for 25% of the total global greenhouse gas (GHG) emissions (EPA, 2018). Additionally, bourgeoning electrification in other sectors (e.g., transportation) implies an exponential demand for clean energy. Therefore, mitigating global GHG emissions and, thereby, combating the potentially disastrous consequences of climate change requires taking the decarbonizing challenge of the global energy supply seriously and doing so with the necessary urgency. This is particularly so, when we consider the challenge of addressing global climate change as a transnational and 'tragedy of the commons' type challenge (Hardin, 1968; Ansari et al., 2013). In other words, this is a challenge that spans national boundaries and, hence, interacts with a wide range of institutional domains.

The multiplicity of institutional domains in long energy transitions is not reducible to a national boundary notion as one institutional unit. Even within national boundaries, there is a multiplicity of institutions with conflicting operating principles or logics (Thornton and Ocasio, 2008), which generates institutional ambiguity and complexity for energy firms in the path of long energy transitions. For example, within liberal market economies such as the US and the UK, national policy frameworks accommodate market-driven and hydrocarbon-based energy production and expand them into new terrains, such as shale gas, on the back of national and international investors who prioritize short-term financial returns over other long-term concerns (Boersma and Johnson, 2012; Gevorkoyan et al., 2006; Brown and Hess, 2016; Nyberg et al.,

2018). On the other hand, coordinated market economies, such as Germany, seem to foster more ambitious transition targets and, hence, national policymakers make firmer market interventions in favour of renewables (Toke and Lauber, 2007). These, however, do not necessarily engender multiple-term transition plans, and lead to contradictory outcomes such as increased hydrocarbon-related emissions (Renn and Marshall, 2016; Szulecki et al., 2016).

While few studies have empirically examined developing country national policy frameworks and broader institutional contexts for long energy transitions (e.g., Markard et al., 2012; Hess 2013), neoclassical economics conjectures a convergence or catch up between emerging and developed countries regarding liberal market structures and decreasing frictions against utility maximizing resource allocations and price formations (Kose et al., 2010). This conjecture matters because it not only informs the market-based policy interventions of international economic organizations (e.g., the World Bank, the International Monetary Fund) in the developing world but also underpins, to a large extent, the valuation frameworks by which international capital allocate funds to developing and developed country energy sectors alike (Sparkes and Cowton, 2004; Rodrik, 2007; Crifo and Mottis, 2016). At a broader level, marketized solutions to climate change, such as emissions credits and emissions trading, have been promoted by the United Nations Framework Convention on Climate Change (UNFCCC) and its signatory countries (Stavins and Stowe, 2017; COP24, 2018). Yet, these solutions are shown to generate adverse market outcomes such as depressed carbon prices and, even more worryingly, may contribute to increasing GHG emissions (Mackenzie, 2009; Veal and Mouzas, 2012). Given these ambiguities and complexities, and their adverse outcomes for long energy transitions within and across national boundaries, we focus on *how* energy supply firms respond to the challenges that stem from institutional multiplicities in long energy transitions. More specifically, we explore *how institutional ambiguities and complexities around long energy transitions emerge and evolve in different national settings and how energy supply firms*

respond to these challenges. We provide answers to these pressing and unexplored questions by offering novel empirical insights from the UK and China.

We focus on these countries and their respective energy supply sectors for a number of reasons. Firstly, China has been the number one emitter of GHGs since 2005 and is poised to keep this position for the foreseeable future (Niu et al., 2016). Therefore, the Chinese long energy transition matters for the global energy transitions and climate change dynamics and deserves further investigation. The UK, which had been in the top 5 of the emissions table for more than half of the 20th century, dropped out of the top 10 emitters list in 2004, and is on a fast course to dropping out of the top 20 in coming years (Lepling et al., 2018). The UK's relative success in emissions reduction in recent years therefore deserves closer scrutiny for a better understanding of success in long energy transitions.

Secondly, the energy supply sectors in both countries, like the global energy supply sector, have been the biggest source of GHG emissions in each country in recent years. For example, China's energy sector increased its CO_2 emissions, one of the biggest sources of GHGs, by 365 million tons in 2013 (Friedrich et al., 2018). This was equivalent to 72 % of the total CO_2 emissions in the UK in the same year (DECC, 2015). Whereas the UK energy supply sector made 75 % of the UK's total emissions reduction between 2008 and 2017 (CCC, 2018, p. 11). In sum, the energy sector in each country matters considerably for their long energy transitions. For this reason, we focus on the energy supply sector in each country.

Thirdly, despite their divergent emission dynamics, like all countries that are signatory to and having ratified the UNFCCC agreements, the last of which happened in Paris in 2015, the UK and China have emission reduction targets pledged under international law and incorporated

into national legislation. As will be explained, however, there are marked differences in how the UK and China have each been managing their targets, and more specifically their long energy transitions in the energy supply sector. These differences stem from the political and economic backdrops each country has been providing for long energy transitions. The UK has been a parliamentary democracy for several centuries and a liberal market economy dominated by the private sector since the 1980s (Hall and Gingerich, 2009). Accordingly, it has mainly used marketised mechanisms to manage the energy transitions and other concerns (i.e., energy affordability and supply security (Szulecki et al., 2016)) in its energy supply sector and broader democratic polity. On the other hand, China has been a one-party socialist state since 1949. As such, it has developed a socialist market economy, with a private sector growing at the margins of the state-controlled sectors and enterprises since the 1980s. This transformation has happened under successive leaders committed to President Deng Xiaoping's Reform and Opening-up (Rodrik, 2007; Breslin, 2008; Gong and Cortese, 2017). Accordingly, it has mainly used centrally set energy transition targets and subsidies for the state-dominated energy sector to manage its relatively nascent transitions, sometimes at the expense of other concerns in the sector and broader socialist polity.

For these reasons together, we explore the long energy transitions in the UK and China as two maximum variation cases (Flyvbjerg, 2006) in terms of the state's role in triggering and shaping long energy transitions and how energy supply firms respond to the ambiguities and complexities that come with these variations. The long energy transitions in the UK and China are embedded in the aforementioned political economic transformations since the 1980s. We therefore provide case histories for each country starting from this period and focusing on *why* and *how* the transitions were politically and legislatively triggered, *how* these were then translated into specific plans and interventions, and *how* energy supply firms responded to these. We take a dynamic view on long energy transitions and demonstrate that ambiguities and

complexities are endemic to institutional change processes (Greenwood et al., 2010), and lead to new triggers, interventions and responses, thereby facilitating or hindering the transition momentum or even its direction. To complement our case histories and detect the institutional ambiguities and complexities in the long energy transition cases, we collated what we describe as the long energy transition corpora from each country; comprising approximately 3,000 individual texts containing around 30 million words. Each corpus consists of political and legislative (i.e., political speeches and debates, legislation, statutory plans and directives) and reporting (i.e., annual and sustainability reports) texts from government and energy supply companies in each country. We subject these texts to corpus-based 'concordance' analyses (McEnery and Hardie, 2011) by which we identify the statistically significant frequencies or 'keyness' (Leech 2007) of what we call long energy transition keywords (henceforth LETs) in the long energy transition corpora in the UK and China. We then explore the LETs' statistically significant collocations with other words/phrases (Illia et al., 2014) within and across time and theme clusters. We identify the time and theme clusters on the basis of our long energy transition case histories, and formulate and test hypotheses on the keyness and collocates of the LETs, corresponding to our long energy transitions time and theme clusters in the UK and China.

Our findings demonstrate that a centrally coordinated and imposed approach by the state can generate institutional clarity in long energy transitions, which is quickly seized on by firms striving to preserve and increase their economic and non-economic resources and influence in their sector and society. Nevertheless, such clarity and accompanying transition process lose momentum owing to the perennial trilemma of energy affordability, security and sustainability (Szulecki et al., 2016). Interestingly, and although not perfectly contrary to axiomatic understandings of them, market-based mechanisms to trigger and sustain long energy transitions, when complemented with focused and continuous state interventions (e.g.,

incentives, taxation) appear to provide a more effective and accountable institutional framework for the policy makers and energy firms to deal with the energy trilemma. Irrespective of the logic of the economy (e.g., liberal vs. state-controlled) that provides the institutional backdrop for any long energy transition process, institutional ambiguity and complexity never disappear completely, owing to both the energy trilemma and the institutional multiplicities within and across national borders (Greenwood et al., 2010). Dealing with both requires continuous 'institutional work' (Lawrence and Suddaby, 2006) towards forming an overarching long energy transition logic.

In fact, we suggest that the state remains the most capable institutional actor for this role, as long as the institutional work takes the form of exploring, recognizing and explaining to stakeholders the possible trade-offs among the energy trilemma, and incentivizing, instead of imposing (Verbeke et al., 2017) multifaceted innovations that alleviate prohibitive economic and social costs of energy transitions. If left to the devices of corporatized entities that populate energy sectors and markets, the long energy transition process would remain institutionally too complex and ambiguous to make meaningful progress. In such circumstances, firms simply follow the prevailing logic of the time (e.g., the corporation and shareholder value maximisation, the developmental state and fulfilling implicit/explicit political commands) to preserve and increase their economic and non-economic resources and influence.

In the following section, we explain our theoretical and methodological approach. We then present our case narratives, which are followed by our corpus-based discourse analysis findings. We conclude with a discussion on the relevance of our findings for the long energy transitions literature as well as management and organization theory.

Theoretical underpinnings

Ambiguity and complexity for energy firms in their operating environment can be conjectured to stem from a multiplicity of institutions, such as the state, the capitalist market, the profession, and the corporation, each of which have a central logic that consists of organizing and operating principles that shape individual actors' resources and agency (Thornton, 2004; Thornton and Ocasio, 2008). Accordingly, the institutional logics approach goes beyond institutions as mere uncertainty reducing constraints (cf., North, 1991) and defines logics to be historically-contingent and socially-constructed 'structural (coercive), normative, and symbolic (cognitive) systems' that define 'the content and meaning of institutions' that 'shape rational, mindful action' (Thornton and Ocasio, 2008, p.101). Given the multiplicity of institutions, the institutional logics approach conceptualizes society as an inter-institutional system (Thornton and Ocasio 2008). It is this historically evolving inter-institutionality that also generates institutional ambiguity and complexity for firms operating in a given market (Greenwood et al., 2010). Unlike other new institutional perspectives that overlook 'agency, power and politics, and the process of institutionalization' (Bello and Kostova 2012, p. 541), the logics perspective allows a dynamic understanding of the central institutions of society, such as the state, the corporation, the market, and of specific industries, which feel the influence of these institutions' extant logics in varying degrees (Thornton, 2004; Lawrence and Suddaby, 2006; Greenwood and Suddaby, 2006; Marquis and Lounsbury, 2007; Greenwood et al., 2011).

In this vein, the central institutions' prevailing logics as a 'set of overarching principles' are not stationary, mutually exclusive, nor reducible to specific norms, rules, regulations (Greenwood et al., 2011). For example, the state as an institution might have the prevailing logics of deregulation and devolution after decades of state-controlled economic activity and centralized decision-making, just as it has been experienced in many developed and developing countries since the 1970s (Rodrik, 2007, 2011). These new logics describe a context where the state

gradually becomes the promoter and guarantor of the market logic and its specific mechanisms (e.g., the commodification or commensuration of things, information efficient resource allocation and price formation). These mechanisms may take hold in previously state and/or profession-controlled sectors and displace or compete with their predominant logics (Thornton, 2004; Marquis and Lounsbury, 2007).

It is not just the state that can experience dynamisms in overarching principles or logics. In recent decades, the corporation as an institution has experienced dramatic changes owing to the increasing primacy of scientifically calculable financial considerations, such as shareholder value, over any other concerns or values, including industrial relations, and environmental sustainability (Sundaram and Inkpen, 2004; Froud et al., 2006). Nevertheless, more conscientious shareholders and intermediaries have successfully brought other overarching principles, such as environmental sustainability, good governance and social responsibility, into the range of value(s) the corporation should generate (Donaldson and Peterson, 1995; Freeman et al., 2004). Furthermore, given the ongoing internationalization of economic activity, many corporations operate across many national jurisdictions and find themselves in a position to negotiate institutional multiplicities in not just their home country but also other jurisdictions (Kostova et al., 2008).

In pursuit of their goals, firms therefore routinely re-enact and negotiate competing institutional logics and exploit institutional resources and contradictions, which bring institutional stability and dynamism (Greenwood and Suddaby, 2006; Thornton and Ocasio, 2008; Greenwood et al., 2010). The multiplicity of institutional logics in cross-national contexts imply contradictory preferences and plans regarding long energy transitions, too (Gevorkyan et al., 2016; Verbeke et al., 2017). Contrary to earlier static understandings of mimetic organizational responses to

institutional pressures in an industry or organizational field (DiMaggio and Powell, 1983), energy firms operating under institutional multiplicities will be under weak isomorphic pressures to devise and/or conform to a coherent long energy transition strategy (Escobar and Vredenburg, 2011; Backman et al., 2017). In such circumstances, firms manage contradictory regulatory and stakeholder pressures concerning broader environmental concerns, and energy transitions for that matter, by recognizing and translating them into a 'business paradigm' or discourses of 'maximizing shareholder value', without making any meaningful progress in long energy transitions (Nyberg and Wright, 2016).

The management literature reviewed so far points to an impasse in long energy transitions, caused by the multiplicity of institutions and logics within national and transnational fields. This also implies that an overarching set of principles for energy transitions, similar to predominant institutions and the logics of contemporary age (e.g., the corporation and shareholder value maximization) can actually provide an unequivocal impetus for long energy transitions. Owing to its transnational character that generates a 'tragedy of the commons' type challenge (Hardin, 1968), climate change and its decarbonization solution have been the subject of decades-long intergovernmental negotiations, followed by international and national frameworks and mechanisms, such as binding emission reduction targets, emission trading mechanisms, carbon pricing, and more recently nationally determined contributions to emission reductions (Ansari et al., 2013, Falkner 2016). Moreover, the literature on the legitimacy of and compliance with environmental governance demonstrates that the state's regulatory interventions in the market and over corporations are more effective than voluntary schemes such as certifications, reporting standards, and voluntary decarbonization blueprints and implementations (Bernstein, 2011; Kim and Lyon, 2011; Hiatt et al., 2015; Backman et al., 2017). The 'transnational commons logic' (Ansari et al., 2013)- namely, the intergovernmental recognition of the need for overarching universal principles to deal with boundary spanning

'tragedy of the commons'(Hardin, 1968) issues such as hydrocarbon-driven climate change, and this logic's national manifestations (e.g., legislation) has put the state in the centre stage of long energy transitions. Nevertheless, it remains unclear which overarching principles or logics (e.g., direct regulatory interventions vs. market-based mechanisms, or both) a state would adopt in the long energy transition process or whether it would adopt any strategy at all.

While the state is generally associated with a regulatory and bureaucratic logic of appropriateness over any human activity (Friedland and Alford, 1991; Schmidt, 2005; Thornton and Ocasio, 2008; Ansari et al., 2013), it is also associated with the emergence and continuation of distinct economic and market systems, such as liberal, coordinated, developmental, and socialist, in which long energy transitions would be steered (Fligstein, 2001; Beeson, 2009; Hall and Gingerich, 2009). Relatedly, distributional conflicts over the cost of decarbonization (Falkner, 2016), high profile non-ratifications of intergovernmental agreements (Chasek, 2007; Cooper, 2018) and revoking of commitments and policies (Nyberg and Wright, 2016) in long energy transitions are symptomatic of a state favouring national and/or corporate economic concerns, such as international competitiveness of certain sectors, economic growth and energy supply security, over long energy transition itself. Moreover, the expanding state ownership in hydrocarbon energy supply is shown to be operating according to a logic of state capitalism- that is combining the principle of long-term energy security and geopolitical influence with 'business intent [to] maximize wealth to return to citizens' in developed and developing countries alike (Bass and Chakrabarty, 2014). The multidimensionality of energy policies, along with the triangle of security, affordability, and sustainability (Szulecki et al., 2016) not only present a potential trilemma for the state but also embed energy supply firms in a long energy transition context that is ambiguous and complex.

In the following section, we explain our methodology to explore *how* such ambiguities and complexities have emerged and been managed by the state in the UK and China and *how* the major energy supply firms in each case have responded to the challenges that stem from these institutional contexts. We then present our findings.

Methodology

A comparative case study of the energy firms in the UK and China

We employ the case study methodology in this paper. As a method of site selection, the case study methodology lists a number of case types, such as intrinsic, instrumental, extreme, and maximum variation (Stake, 1994; Flyvbjerg, 2006). As previously mentioned, the UK and China constitute maximum variation cases in terms of the way the state as an institution is organized and relates to other institutions of society, such as the market and the corporation.

Since the late 1970s, the UK has gone from a welfare state to a liberal market economy where the state has promoted the market logic in previously and currently state-owned and professional-logic dominated public services (e.g. energy, health) (Heffernan, 2005). As a result, the UK energy sector is a market dominated by six companies- popularly called 'the Big Six', owned by publicly-traded for-profit holding companies from the UK and Europe. With a privatization process that preceded the European Union (EU) energy market reform directives since the 1990s, the UK energy sector is the most privatized one in the EU, with no state ownership in energy supply and distribution (Jamasb and Pollitt, 2005).[1]

[1] After the Electricity Act 2013, the Low Carbon Contracts Company was established as a government-owned counterparty to issue renewable energy production contracts.

In the same period, China has gone from a socialist developmental state to a socialist market economy that has liberalized and deregulated its economy at fast-growing margins (Rodrik, 2007; Beeson, 2009; Gong and Cortese, 2017). Notwithstanding its hybridization reform of the economy, including its energy sector consisting of multiple state-owned enterprises (SOEs) and private firms (Xu, 2000), the Chinese state still retains tremendous policy and ownership control over the sector. The state control over strategic sectors or 'commanding heights' (Beeson 2009, p. 29), including the energy sector has been integral to China's developmental state logic and spectacular economic growth in recent decades (Ang, 2016).

Despite these institutional differences at the state and market level, the UK and China cases are similar in relation to how the state takes centre stage in long energy transitions by legislation and market interventions, and thus shapes the institutional complexities and ambiguities inherent in long energy transitions. In this respect, the UK and China constitute instrumental cases (Stake, 1994) to generate 'contextualized explanations' (Welch et al., 2011, p. 745) on the institutional ambiguities and complexities generated by the state-led long energy transitions, and on how energy supply firms, who find themselves embedded in these institutionalizing processes, respond to them (Bello and Kostova, 2012).

A corpus-based textual data and analysis

To understand the origins and workings of ambiguities and complexities in each long energy transition process and how firms have responded to them, we focus on the political, legislative and corporate texts in each of the case countries. Textual analysis of international business and management related phenomena have become an established methodology (e.g., Livesey, 2002; Vaara and Tienari, 2011; Balogun et al., 2011; Ansari and Philips, 2010; Ansari et al., 2013; Nyberg and Wright, 2016; Nyberg et al., 2018). Drawing on a social constructivist

understanding of social life and business environments, these discourse analysis studies take discourse and text as reflective of the individual, organizational and institutional constituents and dynamics of reality.[2] Discourse and its textual manifestations are therefore taken to be constitutive of social reality, no matter how ambiguous, complex and contradictory they can be owing to the institutional multiplicities in society (Mayr, 2015).

In their exploration of the institutionalization process, discourse analysts focus on texts that make sense and mediate actions, which together enact, re-enact and modify the individual institution as a discourse (Philips et al., 2004). Discourse analysis therefore conceptualizes individual institutions as linguistic and extra-linguistic systems that are capable of monitoring, sanctioning, and rewarding/punishing individual behaviour (Boje et al., 2004). Yet, recognizing the multiplicity of institutions and their interrelationships (Philips et al., 2004), discourse analysis also focuses on how texts from different institutions and their specific logics (e.g., the corporation and financial accounting vs. the corporate social responsibility (CSR) and environmental accounting) reify, modify or muddle organizational behaviour and the individual and inter-institutional trajectories of continuity and change (Archel et al., 2013; Alawattage and Fernando, 2017).

We therefore collected the legislative text corpus on different dimensions of the energy transition triangle or trilemma in each country case. As political prologues and epilogues to the legislative corpus, we included the parliamentary debates within the UK's House of Commons on the legislative corpus that we collected, and the Chinese premier's annual 'Report on the Work of the Government' at the Chinese National Congresses between 1980 and 2017 (Ahrens et al., 2018) as well as the 'White Papers of the Government'- namely, key policy guidance

[2] Discourse is 'a system of statements which constructs an object' (Parker 1992:5, cited in Philips et al., 2004: 635) and text is the spoken and written building blocks of discourse.

from the State Council, headed by the Chinese President on the future of the policies on energy, economy, and climate change (Cooper, 1999). We complemented these legislative and political texts with the energy companies' annual reports on operations and CSR activities. As such, our body of texts represents the population (Leech 2007)- namely, all available legislation and company texts. In total, we have collected approximately 3,000 documents (~30 million words) most of which were issued between 1979 and 2017. Table 1 and Table 2 present the legislative, political and company text types and their time span in each country.

Table 1 around here

Table 2 around here

Discourse analysis focuses on different levels of engagement, ranging from the macro, through the meso, to the micro (Boje et al., 2004). We take the political debates and legislative texts as reflective of the macro level or the prevailing institutional logics of each long energy transition context. We take the annual company reports on operations and CSR as the meso level or how energy firms respond to the macro level continuities and changes in the long energy transition contexts. Because of our theoretical and empirical focus - namely, institutions (the macro) and firms (the meso) in long energy transitions - a multi-period phenomenon, we engage with the textual data with a mix of content and intertextuality analyses (Boje et al., 2004). The content analysis gives researchers the ability to dissect the text in relation to concepts and themes, and their relationships. Intertextuality, on the other hand, allows researchers to understand such relationships among multiple texts (Stubbs, 2015). To control for the so-called 'greenwash' in corporate texts (Lyon and Montgomery, 2015; Nyberg and Wright, 2016) - namely, the decoupling between what the corporate actors profess to be doing and what they actually do, we consult renewable energy investment statistics in both countries (Louw, 2018).

In dealing with large textual datasets for content and intertextuality, management researchers have used computer-assisted text and corpus analysis (Ocasio and Joseph, 2005; Illia et al., 2014). Also known as corpus-based linguistics, computer-assisted text analysis has a number of positioning text analysis and inferential statistical tools that measure the keyness and collocations of words in a body of texts. The keyness tool identifies keywords which are words that appear unusually frequently in a specific corpus (e.g., energy legislation) vis-a-vis a reference corpus (e.g., English language). The collocation as an inferential positioning tool identifies the words that are most likely to appear beyond chance alongside the keyword under investigation in a specific corpus (McEnery and Hardie, 2011). These tools, which are available via commercial (e.g., Wordstat) and non-commercial software (e.g., AntConc, which we use in this paper) allow researchers to explore how meanings of a word emerge in a 'semantic space', that is, with other words, and change in statistically significant and discursively meaningful ways across texts and time periods (Illia et al., 2014). They also help researchers go beyond descriptive statistics on words, such as simple frequencies, common to computer facilitated qualitative data analyses (e.g., Wolfe et al., 1993; Siano et al., 2017), and explore the statistical significance of relationships among words with standardized tests, such as log-likelihood, mutual information (MI), and T-test (Rayson and Garside, 2000; McEnery and Hardie, 2011). We explain our choice of tests in the finding sections.

To go beyond the identification and statistical testing of relationships among words, corpus-based researchers do not have any ready-made tools. However, time and thematic clustering of a corpus allows researchers to explore continuities and changes in the corpus (McEnery and Hardie, 2011). Our case histories inform this type of clustering. Historical analysis is frequently used in management and organization research, especially when the case phenomenon in question spans multiple time periods (e.g., Ocasio and Jones, 2005; Ansari and Philips, 2010). The historical analysis goes beyond mere chronology and presents historical narratives with

cause-and-effect relationships (Boje, 2001). In our case narratives, we rely on primary data (i.e., legislative, political and company corpora) and extant literature on energy and economic policies in respective countries. With this, we generate the time and theme clustering with regards to the political and legislative triggers, interventions and company responses framework. We then present hypotheses on how these historical clusters, including the institutional ambiguity and complexity they contain, might be reflected in the texts and their corpus-based analyses through the measures of keyness and collocations.

We use the measures of keyness and collocations to construct and test our hypotheses on institutional ambiguity and complexity for the following reason. Management and organization theory takes institutional ambiguity and complexity as a given and does not provide any established construct to measure it in textual data.This is unlike the style and content measures for textual data (e.g., sentiment, communication vagueness) (Guo et al., 2017). Legal texts, including classifications and standards, are characterized by their stylistic and substantive determinacy and all-inclusiveness, which exposes them to the problem of finitism – namely, the impossibility of accounting for and/or regulating all contingencies and outcomes (Bhatia and Engberg, 2005; Hatherly et al., 2008). For this reason, the stylistic vagueness measures created by Hiller (1969, 2005 cited in Guo et al., 2017) and increasingly used in management and other social sciences would not necessarily generate anything meaningful for the legal corpora in both cases. While such vagueness measures might be relevant for the political speeches and debates, it is the legal corpora that constitute the finitism and associated ambiguity and complexity to which the firms have had to respond in their long energy transitions. This we trace by the corpus-based analyses.

More specifically, we selected 20 entries from the keyness lists of the legal, political and corporate corpora from the UK and China. These entries, which constitute our LETs are present across the political, legislative and corporate corpora in the UK and China. They are also present in extant literature on not only energy and economic policies in each country but also long energy transitions elsewhere in the world. As such, they can be taken as the most relevant and generalist terms concerning long energy transitions and the energy transition trilemma (see Table 3). By most relevant and generalist, we also refer to these keywords' ability to act like a class to capture various specific concepts related to the transitions and the trilemma (e.g., emission capturing CO_2, GHG, N_2O as collocates; renewable or energy capturing solar, hydro, wind). With this, we could limit our LETs to the 20 most relevant and generalist terms. Although one could choose more LETs for the analysis (e.g., 40), such analysis would be partially redundant for the above reason. We are also wary of space restrictions, as corpus-based analyses generate plenty of tables.

Table 3 around here

The keyness measure for these keywords matters for our analysis as it shows the 'aboutness' of any corpus of documents (Gabrielatos, 2018, p.225-6). However, because the keyness is a 'fairly blunt measurement' of aboutness on its own (ibid.), we not only explore these entries' keyness rankings in the time thematic sub-corpora but also subject them to collocation analysis to explore their semantic space in each time thematic sub-corpus. With the two-level analysis, we capture how the long energy transitions in each country have textually evolved. More specifically, we explore how the LETs (e.g., Market, Price, Coal, Carbon), which we allocated to a specific corner of the energy transition trilemma (i.e., Affordability, Security, Sustainability) may be relevant to more than one aspect of the trilemma. These LETs and the

trilemma corners they represent may become each other's collocates and as such may signal ambiguity and complexity towards the resolution of the trilemma. For example, Coal might feature as a collocate with multiple LETs under Security and Sustainability. This may constitute ambiguity and complexity for energy firms as to what to do with coal in relation to energy production. Our two-level keyness and collocation measures for the long energy transition keywords therefore inform our hypotheses about the aboutness of the political, legislative and corporate corpora we analyse, and constitute a valid measure of the evolving ambiguity and complexity that the energy transition trilemma has been generating in the UK and China cases.

Case narratives: A brief history of long energy transitions in the UK and China

In this section, we start with our case narratives on the long energy transition processes in the UK and China. To put these in a global historical context, the discovery of thermo-industrial production - namely, the invention of the steam engine and subsequent advances of the Industrial Revolution first in the UK and then the rest of the world in the 18th century (Steffen et al., 2011) constitute the origins of the hydrocarbon-dominated world economy today. With that, the primitive and technology-constrained exploitation of hydrocarbons was gradually substituted with the industrial scale and technology-intensive exploitation of hydrocarbons, foremost among them, coal.

The transition to the thermo-industrial exploitation of hydrocarbons was intimately related with the population increase and associated economic growth, especially in the second half of the 20th century (Foquet, 2010; Steffen et al., 2011). However, since the 1970s, the effects of hydrocarbon-based energy systems on the biosphere have been recognized, which has engendered intergovernmental efforts and agreements to reduce GHG emissions. This started

with the UNFCCC in 1992, followed by two universally signed agreements - namely, the Kyoto Protocol (1997) and the Paris Agreement (2015). These have established and modified the broad global framework in which the UK and China have been institutionalizing their respective long energy transitions (Falkner, 2016).

In the following section, we focus on three transition periods that span from the 1980s to the end of 2017. We start each transition period narrative from the 1980s because this decade was witness to both pre-long energy transitions and significant changes in each case country. In the UK case, this period is marked by the transition to a market logic in previously state-controlled domains, including the energy sector (Jenkins, 2007). In the China case, the 1980s were marked by China's Reform and Opening-up of its strict political command structure in the economy into a state-guided and predominantly state-owned corporatization and marketization process (Ang, 2016). We then describe the subsequent periods in relation to the triggers and interventions of and organizational responses to the transition processes. We finish each period with hypotheses on how the political, legislative and corporate corpora would look in terms of their aboutness, more specifically the LETs' keyness and collocates.

The UK's long energy transitions

1980s to 2000: Energy market liberalization

The bulk of the privatization of the UK's energy supply system was completed in 1991 (Pearson and Watson, 2012). However, the political background to the privatization of the energy supply and other state-owned sectors was laid in the 1970s, when the post-WWII political consensus for the necessity of a hybrid-economy and welfare state in the UK and other western democracies was being undermined by widespread national economic stagnation and international economic and political turmoil. Accordingly, in the 1980s, the Conservative Party

under the leadership of Margaret Thatcher devised and implemented a programme of market reform and privatization of SOEs, modelled after neoliberal principles or the 'New Right Agenda' (Jupe, 2012) on the role of the state and markets in economy and society (Toke and Lauber, 2007; Heffernan, 2005). The UK government of the time was not alone in adopting such principles centred around free and self-regulating efficient markets and a minimalist state, other Western democracies did so too (Swank, 2005; Peters, 2011). However, the UK is generally credited with being the pioneering developed country, alongside the US, that has pushed back the so-called 'embedded liberalism' of the post-WWII period in the principles of welfare state and organized labour to pave the way for the rise of shareholder capitalism and concomitant financialization of the economy (Best, 2003; Dale, 2010; Dobbins and Dundon, 2017).

From the breakdown of the national electricity and distribution boards, which were state-owned monopolies of energy production and distribution emerged the forerunners of the Big Six (Helm 2003). The nuclear power plants, which provided a fifth of the UK's energy supply - the remainder was from coal, were spared from the initial privatization as the costs associated with nuclear energy management (e.g., waste, fuel reprocessing) was deemed too 'frightening' for investors (Jupe 2012, p. 120). However, the UK government attempted to deal with the costs through the 'Fossil Fuel Levy' in the Electricity Act 1989, which was later re-labelled as the 'Non-fossil Fuel Obligations' (NFFOs) until its revoking in 2002 (Helm, 2003). Despite their names, these levies did not constitute the start of renewable energy investments in the UK. Instead, more than 90 % of the £ 8.6 billion levy collected propped up the loss-making parts of the state-owned nuclear energy sector. The profitable parts were eventually privatized in 1996 (Pearson and Watson 2012).

The change of government from the Conservatives to Labour Party in 1997 did not change the UK's market-based deregulation approach to the energy sector. The sector had already accelerated the dramatic shift from previously subsidized coal to gas in electricity production, and this contributed to the considerable fall in retail prices (Jupe, 2012; Pearson and Watson, 2012). The Labour government, which also professed a belief in marketized solutions to socio-economic issues (Freeden, 1999) upped the previous government's legal and policy recognition of the need for GHG emission reductions (e.g., the UNFCCC membership in 1992) with its signing and ratification of the Kyoto Protocol. The latter committed the successive UK governments to a 12.5% reduction in the UK's 1990 GHG emissions (Pearson and Watson, 2012). As the fossil fuel levy provided miniscule funding to renewable capacity generation, and the previous Conservative government had insisted on the principle of a 'maximum of competition', only a small proportion of the renewable energy project bids were actually built (Toke and Lauber 2007), and they contributed to a mere 1 % increase in the renewables' share in the UK's total energy supply (Pearson and Watson 2012, p. 22). To continue the energy market reform of the previous governments and meet the UK's legal commitments, the Labour government were to introduce a series of market-based reforms, including one for renewable energy capacity building, with its first piece of energy legislation - namely the Utilities Act, in 2000. We therefore conclude this period with the introduction of the Utilities Act, whose reforms became operational from 2001 onwards.

In sum, the first period of the transitions in the UK was dominated by the transformation of the state-owned energy sector into a market-driven and publicly-traded one. However, this transformation did not lead to any significant renewable energy capacity building, despite different UK governments' successive commitments to combat climate change and reduce the UK's GHG emissions. This was mainly because of high set up costs for renewables and the governments' diversion of the fossil fuel levy to the ailing nuclear energy sector. Hence, the

first period of the UK's long energy transitions was characterized by a low uptake of renewable energy capacity investment (see Figure 1). We therefore hypothesize higher keyness rankings for the LETs related to Affordability (market and energy efficiency) in the political and legislative corpora over those that relate to Security and Sustainability. Moreover, we hypothesize the collocates of the Affordability LETs to come mainly from the Security LETs, keeping the Sustainability LETs at the sideline of the political and legislative focus. As the corporate corpora start from 1997, which coincided with an increased government focus on long energy transitions, we therefore hypothesize a dominance of LETs and collocates related to Sustainability in the corporate corpora.

2001 to 2007: Nascent steps towards a low-carbon energy supply system

Starting in 2001, the UK, under successive Labour governments advanced the long energy transitions by implementing a number of acts and statutory instruments. Initially, a Climate Change Levy on business energy users was introduced in 2001, the revenues of which were then transferred to a Carbon Trust that would fund the decarbonization projects of business energy users. Later, the NFFOs were substituted with the Renewables Obligations (ROs) in 2002. These constituted the first market mechanisms introduced by the UK to incentivize the Big Six to invest in renewables (Pearson and Watson, 2012). The initial target of a 3 % share for renewables in energy production for each firm in 2003 was to be gradually taken up to 10% in 2010 with a corresponding fine of £30 per Megawatt hour for non-obliging firms, in 2003 (Toke and Lauber, 2007).

In the following years, the UK laid out its vision of achieving significant cuts in its CO_2 emissions - 60 % by 2050 (Mitchell and Connor, 2004) and passed a number of acts and statutory instruments that addressed all three corners of the energy policy triangle, albeit,

without formalizing the 60 % emission reduction target nor adding any other mechanism onto the ROs. The latter remained as the only major mechanism, based on a market for 'green certificates' for the UK's long energy transition process (Pearson and Watson, 2012, p.22).

Given the limited renewable targets set within the ROs, the Big Six had unsurprisingly opted for generating the majority of energy supply from fossil-fuels, especially from natural gas, just as in the previous period, as it had been the most cost-effective way to do so (Pearson and Watson, 2012). In fact, by the end of 2007, the share of eligible renewables was around 5 % of the UK's energy mix, appreciably below the RO target of around 8 % but well above its 1.8 % share in 2002 (DTI, 2007).[3] Moreover, the ROs were criticized by the state energy market regulator, the Office of Gas and Electricity Markets (OFGEM) on the grounds that they did not take into consideration the time it would take to build up the renewable energy sites. This, according to an OFGEM press release in January 2007,[4] led to its slow uptake but simultaneously increased energy bills for consumers owing to the fines. Another reason why the bills became less affordable for consumers was the continuously increasing global energy prices from the early 2000s, which would reach their peak points in 2008 (Pearson and Watson 2012, p. 27). The 2007 White Paper (2007, p. 146) acknowledged the renewable energy 'bottlenecks' stemming from set-up and network connection costs and times. To resolve these bottlenecks related to renewable energy and energy costs, the Labour government put in motion the preparations for the 2008 Climate Change Act. We therefore conclude this period at the end of 2007, after which the UK entered a new period in its long energy transitions.

[3] Unless otherwise stated, all statistics on the UK's energy mix are from the OFGEM website, available at https://www.ofgem.gov.uk/data-portal/all-charts

[4] The press release was made on the 22nd of January, available here at https://www.ofgem.gov.uk/ofgem-publications/76523/16662-r5pdf

In sum, the second period was characterized by a greater political and legislative focus on triggering and intervening in the long energy transition process. However, overall, the investment in renewable energy remained limited (see Figure 1) because investments in the hydrocarbon-based energy, especially natural gas, provided a continued opportunity for firms to derive easier and far less risky profits, despite the non-obligation fines. Given all these, we hypothesize higher keyness rankings for the Sustainability LETs in the political and legislative corpora over those for Affordability and Security. However, owing to the slow growth of renewable investments and concomitant issues with energy prices, we hypothesize the collocates of the Sustainability LETs to come mainly from Affordability, keeping Security at the sidelines of the political and legislative focus. In the corporate corpora, we hypothesize a similar dominance of the Sustainability LETs, qualified by Affordability LETs as their collocates.

2008 and beyond: A quandary among decarbonization, affordability and security of supply

The UK's Climate Change Act 2008 heralded the start of the third and most recent transition period in the UK. Through this legislation, the UK is legally bound to cut GHG emissions by 80% below the 1990 levels by 2050 (Pearson and Watson, 2012). The Act and subsequently schemes such as the ROs, feed in tariffs for small renewable installations, Carbon Capture and Storage Competitions (CCSCs), five-year carbon budgets for the UK, and the carbon price floor (Pearson and Watson, 2012; Advani et al., 2013) have led to substantial investments in renewables or what one might call a renewables rush by the Big Six and others (see Figure 1). It is important to observe here that these schemes emerged or continued despite the change in government in May 2010, when the Conservatives and the Liberal Democrats ended Labour's 13-year rule (Toke, 2011). The renewables rush has also led to a considerable pushback on fossil fuels in the UK's energy mix. By the end of 2013, the share of the renewables in the mix reached around 13 % from its 5 % share at the end of 2007. Moreover, owing to the decreasing

market demand for hydrocarbon-based energy generation assets on the back of transition regulations and increased renewable capacity a considerable number of hydrocarbon plants were mothballed in the UK (Hope, 2013; Foster et al., 2017).

While one can argue that the change of government has not affected the UK's long energy transition process path, the coalition government's commitment was quickly qualified by another principle - namely, austerity in public spending in the aftermath of the government bailout of the UK's financial system in 2007 and 2008 (Clarke and Newman, 2012). Concomitantly, the coalition government delayed and reduced financing and subsidies for some of the schemes (e.g., feed in tariffs, financing for energy efficiency in retail consumption units) (Pearson and Watson, 2012). Moreover, as the momentum for renewable energy production started to peak, the UK was faced with the adverse effects of a declining energy capacity reserve margin and the prospect of countrywide blackouts in coming seasons (OFGEM, 2013). The coalition government therefore prioritized safeguarding energy supply security over its decarbonization. The single most important manifestation of this policy prioritization has been the Capacity Market Mechanism (CMM), which was put into effect via the Energy Act 2013 and has since incentivized the continuation of hydrocarbon-based investments towards energy supply security. Nevertheless, the Energy Act 2013 has also replaced the ROs with a Contracts for Difference (CfDs) system, which, while being criticized for being a stealth subsidy for nuclear energy (Toke, 2011), is described as a system that better recognizes the long-term nature of renewable energy investments and guarantees market prices as such (Bolton and Foxon, 2015).

These contradictory signals from the government have not been limited to the sustainability and security corners of the trilemma. The affordability concerns, with which the coalition

government and the subsequent Conservative government since 2015 have invariably justified their policy reticence to deploy and continue any substantial government investment in and/or subsidy for renewable energy and energy efficiency (Gillard and Lock, 2017), have also undermined the Sustainability corner. In fact, the first Conservative government of the current period announced a number of stops on existing subsidies for renewable investments shortly after it came to power in May 2015 (Vaughan and Macalister, 2015). Perhaps, one of the most significant examples of this policy preference was the cancellation of the decarbonization of coal- and gas-fired power plants - still the two most dominant combined sources of energy supply in the UK, through CCSCs. These were cancelled due to concerns over the technology's affordability for retail consumers (NAO, 2017). In this period, the Big Six have been managing these political and legislative ambiguities by pursuing contradictory goals (e.g., bidding for CCSCs and CMMs, and trading CfDs to continue investing in the UK's renewable energy capacity) and thus re-enacting an energy supply market that has failed to keep the momentum in GHG emission reductions. Unsurprisingly, this legislatively induced ambiguity and complexity led to a significant drop of 56 % in renewables-investment in the UK between 2016 and 2017 (Louw, 2018).

In sum, the current transition period has so far been characterized by the UK's ambitious and ongoing legal commitments to GHG emission reductions, which have been moderated by the previous coalition government's and current Conservative government's political and legislative market interventions to deal with the affordability and security corners of any long energy transition triangle in a marketized context. Given all these, we hypothesize higher keyness rankings for the Sustainability LETs in the political and legislative corpora over Affordability and Security LETs. However, because of the energy security and affordability issues, we hypothesize the collocates of the Sustainability LETs to come mainly from Affordability and Security LETs. In the corporate corpora, we hypothesize a similar dominance of the LETs

related to Sustainability, qualified by the LETs from Affordability and Security as their collocates.

China's long energy transitions

1980s to 2001: Rapid economic growth and the struggle to meet rising energy demand

In the early 1980s, China's entire electricity system was still hierarchically and politically managed (Ang, 2016). As the Reform and Opening-up for economic modernization led a boost in manufacturing industries, the capacity of electricity supply became a major obstacle for China's socioeconomic development. In such a challenging context, the state made continuous investments in energy supply and started to diversify the coal-dominated domestic electricity generation technologies by devising hydropower and nuclear energy projects, such as the Three Gorges Dam, and the Qinshan nuclear power station (Levine et al., 1992).

In the 1990s, such efforts towards energy security were consolidated by further market reforms towards the formation of energy SOEs and the introduction of market competition and shareholder investment in the energy sector. For example, there was a piloting of corporatizing and floating of SOEs in 1993. In the meantime, the Chinese leadership started to pay attention to GHG emissions and climate change by becoming a signatory to the UNFCCC in 1992 and the subsequent Kyoto Protocol in 1997. There was also a white paper and a number of policy statements on the issue of global warming and the necessity to reconcile economic growth with environmental protection. Nevertheless, these political moves and international treaties firmly positioned developed countries as the main culprits and solvers of climate change, and limited China's energy transition ambitions, like other developing countries, mainly to receiving international financial and research aid on emission mitigation, short of anything on renewable energy investments (Cooper, 1999). Coming back to the economic modernization and

marketization process in the energy sector, in 1998, an important vestige of the political command logic, the Ministry of Electricity Industry was abolished. In 2002, the State Power Corporation of China (SPCC), the first energy SOE founded in 1997, was disassembled into two grid companies and five energy supply companies. These events are usually considered as the beginning of China's electricity market reform (Gee et al., 2007; Bai and Qian, 2010). We therefore conclude this period right before the introduction of a marketized, albeit SOE-based energy sector in 2002.

In sum, the first period of the long energy transition process had been characterized by the state's coordinated efforts to increase the energy supply capacity rapidly. The foundations for energy SOEs and a proto-market for energy supply were laid in the latter part of this period. We therefore hypothesize higher keyness rankings for the Security LETs vis-a-vis the LETs from the remaining corners of the energy transition trilemma in the political and legislative corpora. Moreover, we hypothesize the collocates of the Security LETs to come mainly from the Affordability (market and energy efficiency) LETs with one exception - namely Coal from the Sustainability LETs. We do not, however, expect Coal or any other Sustainability LETs to denote anything meaningful about the transition to renewables. Although the corporate corpus starts from 1997 and is thus rather limited for this period, we hypothesize a similar dominance of the Security LETs, qualified by Affordability LETs plus Coal as collocates.

2002 to 2014: An energy transition in turbulence

China started this period with a flourishing albeit still state-guided market mechanism in energy production and distribution (Gee et al., 2007). The economy, on the other hand, was to grow by

an average of 10% per annum in this period.[5] This spectacular performance yet again underlined China's energy challenges around the trilemma of energy affordability, security and sustainability. For example, high energy usage per unit of economic output was possible partly by imported hydrocarbons (e.g., oil, coal) (Zhang, 2011). Ironically, such inefficient reliance on domestic and imported hydrocarbons not only led to frequent energy supply shortages (Cherni and Kentish, 2007) but also helped China surpass the US as the biggest emitter of CO_2 emissions in 2007 (Jones, 2007).

To address the security and affordability (market and energy efficiency) issues, the Chinese leadership continued to reform the domestic electricity market with the institutional separation of infrastructure construction, power generation, transmission and distribution entities (Rosen and Houser, 2007). Moreover, a new energy pricing mechanism to be implemented by a new energy market regulation body, the State Electricity Regulatory Commission was set up in 2003. This regulatory body aimed to encourage more private investment in the sector (Cherni and Kentish, 2007). Relatedly, the leadership also passed a renewable energy law in 2005 and incorporated energy sustainability and efficiency targets (i.e., reduction of coal-reliance and energy intensity - namely, CO_2 emission reduction targets per unit of economic output) into its 11th and 12th Five Year Plans in 2006 and 2011, respectively (Zhang, 2011; Qi et al., 2014). The aim of these legislative and planning moves was firmly focused on diversifying away from the country's reliance on hydrocarbons and dealing with its resurgent energy inefficiencies and supply shortages (Cherni and Kentish, 2007). Such a focus on the security and affordability (market and energy efficiency) aspects of the energy transition trilemma was evident in the Chinese leadership's reticent stance on any internationally binding emission reduction targets during the intergovernmental negotiations leading up to the post-Kyoto framework that was due

[5] Unless otherwise stated, all the GDP data on China come from Trading Economics, available at https://tradingeconomics.com/china/gdp-growth-annual

to start in 2012 (Christoff, 2010). In fact, it was in the 12th Five Year Plan (2011-2015) that the climate change and GHG emissions were recognized as separate issues to be addressed in a planning period for the first time. The same plan also specified environmental pollution as an urgent national challenge in the face of increasing street protests over air and water pollution in cities and rural areas (Zhong and Hwang, 2016).

Accordingly, the amendments to the renewable energy law in 2009 and the directives to implement the five-year plans (e.g., the 2014 National Plan for Tackling Climate Change) were designed to incentivize renewable capacity investments by the SOEs and bourgeoning private energy firms, with clear targets for renewable capacity building and GHG emission reductions (Qi et al., 2014; Zhang, 2015). These interventions by the state in renewable energy capacity helped China leap to the top of the international renewable energy capacity table. For example, in 2014, the country contributed over 40% to the newly installed renewable energy capacity around the world, with its total investment in that year exceeding that of the US and EU combined (REN21, 2015). The emissions, energy efficiency and renewable energy targets were also to lead to a moderation in CO_2 emission growth and coal demand in 2015, in parallel to a slowing economic growth rate, albeit still spectacular at around 7% per annum (Peston, 2015; IEA, 2018). We therefore conclude this period at the end of 2014, several months before a new energy market reform aimed at addressing the growing affordability (market and energy efficiency) issues was put into force in March 2015 (Zeng et al., 2016).

In sum, this period is characterized by major state plans, interventions and reform in terms of targets, incentives and investments to deal with the perennial issues of the Chinese energy sector - namely, security and affordability (market and energy efficiency). It was only towards the end of this period that sustainability started to become a concern in specific relation to GHG

emissions and climate change. In the political and legislative corpora, we therefore continue to hypothesize higher keyness rankings for the Security LETs vis-a-vis those from the remaining corners of the energy transition trilemma. However, we hypothesize that some of the Sustainability LETs would make significant leaps in their keyness rankings in this period. For the collocates of the Security LETs, we expect them to come mainly from the Affordability (market and energy efficiency) LETs. As major SOEs in the energy sector, the Major Five and Minor Four were instrumental in the implementation of the state's laws and development plans in this period. We therefore expect the LETs' keynesses and collocates in the corporate corpus to be similar to those in the political and legislative corpora.

2015 and beyond: The new normal

As it became clear that China was in a so-called 'new normal' of slower, albeit still remarkable single digit economic growth period, the leadership's policy focus turned to favouring ‘innovation and optimization' or market and energy efficiency instead of 'rapid growth' or energy security in the economy (Song et al., 2018). Relatedly, the 2015 Reform of the Power Industry (Zeng et al., 2016) and the 13th Five Year Plan put into effect several policy frameworks. The Reform aimed at deepening the role of market mechanisms in electricity generation, and wholesale and retail pricing, previously shaped to a large extent by the national planning body and its generous subsidies to industrial and retail consumers (Zeng et al., 2016). One of the reasons behind the reform has been the increasingly palpable electricity oversupply in the current new normal period, partly thanks to the spectacular expansion in China's renewables capacity, mainly seized by the Major Five and Minor Four through the state investment subsidies. Confounding the renewable oversupply problem has been the topography of China’s energy landscape, which has engendered significant transmission and distribution challenges between the renewable capacity-rich western and northern China to the high consumption, high demand eastern (coastal) China (Cheung, 2011; Vest, 2017; Yuanyuan,

2018). Although the Reform did not make any reference to climate change and GHG emissions (Zeng et al., 2016), it was the 13th Five Year Plan announced in March 2016 and the preceding political statements and specific plans (e.g., China's de facto leadership during the 2015 Paris Agreement, the 2014 Plan) that have gravitated China to the centre of global climate change politics. To be specific, the Chinese leadership increased the country's GHG emission reductions targets for the UNFCCC to 60-65% of its 2005 level by 2030 - a 20 % increase on the 2014 Plan targets. This target was also kept in the 13th Plan (GRI, 2016).

In sum, the most recent period in China's long energy transitions has so far been characterized by a combined political and legislative focus on affordability (market and energy efficiency) and sustainability at the expense of security in the energy transition trilemma. In the political and legislative corpora, we therefore hypothesize higher keyness rankings for the Affordability and Sustainability LETs vis-a-vis the those from Security. Given this double focus, we also expect these LETs to be each other's collocates. We expect the corporate corpora to reflect the Major Five's and Minor Four's key role in the energy sector - namely, the implementation of the state's policies. We therefore expect the LETs' keynesses and collocates in the corporate corpus to be similar to those in the political and legislative corpora.

Corpus-based findings

UK

Our keyness tables on the UK political, legislative and corporate corpora show how the LETs appear within the top 100 keyness list. We generated this list by using the log-likelihood statistics in the AntConc software (McEnery and Hardie, 2011). Each keyness is statistically significant at $p < 0.05$ in relation to a representative or reference corpus of written British English. We use the Lancaster-Oslo-Bergen corpus for this reference corpus (Leech, 2007).

Each LET's presence and changes in rank across periods can be taken to signify the changing importance given to the specific dimensions of the long energy transitions in the UK.

Table 4 and Table 5 around here

Contrary to our hypothesis for the first period for political and legislative corpora , none of the LETs we take as related to the Affordability (market and energy efficiency) corner of the energy transition trilemma appear in the top 100 keyness ranks with the exception of LET Price in the political corpus in that period. In fact, none of the Affordability LETs appear in the top 100 table at all throughout the period of analysis for the legislative corpus, despite the fact that Market and Price enter the keyness list and go up the ranks in the political corpora in the second and current periods. As such, these absences and ranks help partially confirm our hypotheses on the Sustainability LETs in these two periods (i.e., being above the Affordability and Security LETs in the keyness ranks). The Sustainability LETs have also higher keyness ranks than the Security LETs (e.g., having more LETs in the top 20) in the political corpus in the second period but this is reversed considerably in the legislative corpus in the same period. In the current period, contrary to our hypothesis for the Sustainability LETs being higher in keyness ranks than other LETs, it is the Security LETs that have higher ranks in the keyness lists of the political and legislative corpora collectively (e.g., having more LETs in the top 20, and in the top 100). However, these differences among the Security and Sustainability LETs are negligible in the current and second periods. In general, the UK legislative corpora are characterised by higher keyness ranks of the Security LETs, followed by those of the Sustainability LETs. The UK political corpora, on the other hand, are more evenly distributed in terms of the keyness ranks for trilemma specific LETs, albeit with an overall Security LETs' dominance in the keyness ranks, closely followed by the Sustainability LETs.

Table 6 around here

Our hypotheses for the Sustainability LETs' higher keyness rank for each of the periods are not confirmed in the Big Six corpus. Overall, in terms of the keyness ranks, this corpus is dominated by the Security LETs and shows a much greater focus on the Affordability domain than the Sustainability domain in the keyness ranks across the periods. However, it should be noted that it is the LETs Sustainab*, Carbon, and Renewable that have the most noticeable increases in ranks, by making their debut in the top 100 (but not in the top 50) in the current period. Another prominent Sustainability LET- namely, Emission is present across all the periods, albeit with a drop in the keyness rank in the current period, after its rise in the second period. Between the current and previous periods, it is the Security LET Supp* that makes the biggest leap by 30 ranks in the current period, which can be taken as reflective of the increased energy supply security concerns in the current period. Another observation worth noting here is the failure of Affordab* as a LET to appear in the keyness table for the Big Six corpus.

The keyness tables of our LETs by themselves do not tell us much about how each LET appears in the political, legislative and corporate corpora. The collocate tables, however, give us a more nuanced and still statistically measurable view on how these LETs appear in a semantic context. We used the mutual information (MI) value (Stubbs, 1995) to measure whether the collocates of LETs are statistically significant or how exclusively each LET appears with its collocate in the specific corpus. Compared to T-tests, the MI value is a more robust measure of relationship strength between frequent collocates. A value of three or above for the MI value is taken to be statistically significant (Stubbs, 1995), with higher MI values showing stronger relationships. For a focused analysis, we analysed the top three most frequent collocates around the LETs. To begin with, none of the top three collocates in the UK political, legislative and corporate corpora had a value below three. In fact, the average MI values are near double digits, signalling very strong relationships. However, there were few collocates with single digit frequencies. Such collocates' MI values, and hence the collocates themselves are categorized as 'linguistically

[un]interesting' (Stubbs 1995) or showing statistically weak relationships in the semantic context of a given corpus.

Table 7 and Table 8 around here

One way to explore what LETs and their collocates tell us about the state and direction of the UK's long energy transition process, including its ambiguities and complexities is to check how LETs become each other's collocates. In the UK's political and legislative corpora for the first period, as we hypothesized, the Affordability (market and energy efficiency) LETs have outside collocates that all come from the Security LETs, leaving the Sustainability at the sideline of the political and legislative focus. However, there is not a meaningful focus on the affordability of energy to customers in this period with single digit "uninteresting" frequencies for relevant collocates (i.e., Warmth, Access, Make) for the LET Affordab*, in the political corpus, and with a No Hit -namely, no occurrence of the LET Affordab* in the legislative corpus. In the second period, contrary to what we hypothesized, the political and legislative corpora's Sustainability LETs collocate predominantly with their own LETs and their relevant concepts, followed by the Security LETs – namely, Energy, Electricity and Fuel, and with only one Affordability LET- namely, Trading. It seems that it is the Affordability that was sidelined in the political and legislative focus in the second period. In the current period, partially in line with our hypothesis, the Sustainability LETs were collocated mainly with the Security LETs, without any LETs from the Affordability domain.

Table 9 and Table 10 around here

Table 11 and Table 12 around here

We hypothesized a dominance of Sustainability LETs as the collocates in the Big Six corpus in the first period. Our findings, however, show some of the Security LETs as the statistically significant collocates of the Affordability and Sustainability LETs. These are Gas, Electricity, and Energy. Moreover, the Security LETs' collocates are mainly internal, that is, they are from

other Security LETs and relevant concepts. For the second period, we hypothesized the dominance of Sustainability LETs in the keyness rankings, qualified by the Affordability LETs as their collocates. However, our findings show the Affordability LET related concepts as more significant collocates for the Security LETs, and the latter dominating the Affordability LETs as their collocates. The Affordability LET related concepts there included Distribution, Poverty, Efficiency, and Marketable. More significant outside LETs as collocates for Sustainability actually came from the Security LETs - namely, Gas, Power, Energy, Electricity, in the second period for the Big Six corpus. For the current period, we hypothesized a continued dominance of the Sustainability LETs in the keyness rankings, qualified by the Affordability and Security LETs as their collocates. We could partly confirm this as the Security LETs were the most significant outside collocates for the Sustainability LETs, however, with no Affordability LETs as a collocate for the former. On the other hand, the Affordability LETs continued to be dominated by the Security LETs as their collocates in the Big Six corpus in the current period.

Table 13, Table 14, and Table 15 around here

China

The keyness tables for the Chinese political, legislative and corporate corpora are generated by using the Lancaster Mandarin Chinese Corpus (Leech 2007). The ranks are calculated in the same manner as the UK corpora ranks. They are statistically significant at $p<0.05$.

Table 16, Table 17 around here

As we hypothesized, the Security LETs have higher keyness rankings than the LETs of the other energy trilemma corners in the first two periods for the political, legislative and corporate corpora. In the current period, contrary to our hypothesis, it is the Security and Sustainability LETs that have very similar high keyness ranks. Relatedly, some absences in the keyness tables are worth noting. Similar to the UK legislative corpora, the legislative keyness table, plus the

political speeches table for China do not have any hits from the Affordability (market and energy efficiency) LETs in any of the periods. This is also contrary to what we hypothesized for the current period. However, as we hypothesized, Climate, Coal, and Renewable, as three of the Sustainability LET made either their debut or significant leaps in the political and/or legislative corpus in the second period. However, Climate and Renewable then disappear from the keyness tables in the current period. Coal remains, albeit with a significant drop in the rankings. Emission makes its remarkable debut in the current period. However, it does so only in the legislation corpus.

Table 18 around here

When it comes to the keyness ranks in the Chinese corporate corpus, what is maybe the most striking is the lack of any Affordability LETs in any of the periods, including the current one, despite the fact that the Major Five and Minor Four have been operating in a gradually marketized energy system that strives to address macro (economy) and micro (retail) needs, especially with the latest round of reforms since 2015. Nevertheless, as we hypothesized, the Security LETs dominated the first and second periods' keyness rankings for the corporate corpus. They have continued this domination in the current period, which is contrary to our hypothesis for the current period. It should be noted here that we attribute the very significant keyness ranks for Power in the corporate corpus to company naming style in China. Most energy sector companies in China, unlike those in the UK, have the word "power" in their titles. Overall, the keyness tables for China corpora are more sparsely populated than the UK tables.

The keyness tables for the LETs by themselves do not tell us much about how each LET appears in the political, legislative and corporate corpora. The collocate tables, however, give us a more nuanced and still statistically measurable view on how these LETs appear in texts that relate to the Chinese long energy transitions. To begin with, almost all the collocates have double digit

MI values, denoting statistically very strong relationships, although a few happen in only single digit frequencies, and thus do not signal any linguistically interesting results (Stubbs, 1995). Irrespectively, partially confirming our hypothesis for the first period, the Security LETs' collocates are mainly concerned with Affordability, however, there is a twist. To begin with, there are no Affordability LETs as collocates of the Security LETs for the political and legislative corpus in the first period. However, unlike the UK corpora and its word collocates, the Chinese corpora have phrase collocates, so we are able to read them as a sentence, which allows us to interpret their meaning. The reason for sentence-like collocates is because of the Chinese language's lack of 'wordbreaks' in its 'character-based' system (Huang et al., 1994). With this, we are able to interpret whether the collocates of the Security LETs in the political and legislative corpora in this period are concerned with market and energy efficiency (i.e., Affordability). While the Security LETs in the legislative corpus have a number of collocates referring to energy management, saving and planning, the political corpus Security LETs are surprisingly collocated with Sustainability related collocates (e.g., pollution types, and renewable energy types, such as firewood and oceans) more than any Affordability ones. As hypothesized, we also observe Coal as a collocate from Sustainability, however only in the legislative corpus, and without denoting anything regarding long energy transitions (e.g., the curbing of coal's role in electricity production). It should also be noted that the frequencies of all these collocates are at single digits, despite their high MI values, which together undermine their linguistic significance.

Table 19 and Table 20 around here

In the second period of the transitions, our hypothesis on the collocates of the Security LETs coming mainly from the Affordability (market and energy efficiency) LETs is partly confirmed because in the legislative corpus a similar number of Sustainability collocates are observed alongside those of Affordability, i.e., 'biomass energy', 'clean and environmentally friendly',

'gradually establish a carbon emission trading', 'vigorously develop non-fossil energy'. However, some of these collocates have low frequencies. In the political corpus, the Security LETs, as hypothesized, are mainly collocated with Affordability (market and energy efficiency) collocates (e.g., ‘expand the scale of transmission from west to east’, ‘improve the energy saving’, ‘optimize energy structure’, etc.), some of which have double digit frequencies. As a collocate to Security LETs, there is only one Sustainability collocate (i.e., ‘biomass generation’) in the political corpus.

Table 21 and Table 22 around here

In the current period of the transitions, our hypothesis for the Affordability and Sustainability LETs as each other's collocates is hardly confirmed as it is the Sustainability LETs that have only one Affordability collocate in the legislative and political corpora (i.e., 'economic competitiveness', 'intensive use of resources'). Moreover, the Affordability LETs do not have any collocates from Sustainability in either corpus. In fact, reflecting the reversal of energy shortages in the current new normal, it is the Security LETs in this period, especially in the legislative corpus that are dominated by Affordability and Sustainability collocates, compared to the previous periods, albeit with a mixed picture on these collocates' frequencies. In the political corpus, although at single digits, most outside collocates of the Security LETs concern nuclear energy and its security. It is also worth noting that in the current period, one of the top collocates of the LET Sustainab* was 'iron fist management', while the other collocates had phrases such as 'fighting' and 'unremitting efforts'.

Table 23 and Table 24 around here

All in all, the Chinese political legislative corpora are characterized by sparsely populated keyness tables and weak collocate frequencies. While these might be due to the Chinese

language's character-based system without word breaks, they might also textually attest to a logic of the state and governance that tries to be all-encompassing and thus overstretched without sufficient focus on each corner of the trilemma. For example, between 1988 and 2017, the number of texts in the Chinese legal corpora was half that of the UK's. However, this text number proportion did not translate into a similar proportion of word numbers between the China (n=750,000) and the UK (n=12.55 million) corpora. We call this textual overstretch and attribute it to the Chinese language's character-based system and what we call the governance overstretch. In fact, such an overstretch can be textually detected in the Chinese LETs' high P numbers (i.e., number of collocate types) comparable to those for the UK LETs, but their considerably lower frequency top three collocates, compared to very high collocate frequencies for most of the UK LETs. In actual practice, such a logic of the state and governance may imply ambiguity and complexity for SOEs, including the Major Five and Minor Four, which we investigate further below.

Table 25 , Table 26 , Table 27 around here

We developed similar hypotheses for the Major Five and Minor Four as they are the main SOEs responsible for implementing the Chinese leadership's energy policies. Before presenting our findings on these hypotheses, several observations are worth making. The SOEs' collocate tables show us similar single digit low frequencies for a considerable number of the collocates in all corners of the energy triangle. Moreover, there is no single reference to Consumer in the Chinese political, legislative and corporate corpora, perhaps because retail energy prices have been continuously subsidized by the national planning system (Zeng et al., 2016). Contrary to our hypothesis for the first period, the Security LETs' collocates seem to be concerned with energy production and distribution without any meaningful reference to Affordability (market and energy efficiency) with the exception of 'power automation' with double digit frequency. Coal does not appear anywhere as a collocate either. In the second period, our hypothesis is partly confirmed, as three Affordability collocates (i.e., 'cost method', 'operating cost',

'operating income') feature in the Security LETs alongside five Sustainability collocates related to renewables, and waste and emission responsibility. The majority of these collocates from Sustainability have double digit frequencies, too. In the current period, we partly confirm our hypothesis, as the collocates of Sustainability LETs mainly relate to Affordability, albeit mostly with single digit frequencies. Those Sustainability LETs with or nearing double digit frequencies in their collocates show us that the LETs Coal and Carbon are paired with Affordability collocates concerning operating and financial efficiency and performance. Only in the LET Emission, we observe similarly frequent collocates that are unequivocally concerned with the reduction of GHG emissions. On the other hand, the Affordability LETs' collocates, despite having low frequencies, are internally oriented and firmly concerned with market and energy efficiency, not Sustainability LETs.

Discussion and Conclusion

Our case narratives and corpus-based discourse analyses reveal two institutionally divergent backdrops for long energy transitions and how energy firms respond to the energy transition trilemma and these institutional contexts. The UK and China are among the leading states in global long energy transitions owing to their economic and political power and authority, and their very considerable rankings in the GHG emissions. Both countries, China more recently (Worland, 2017) have also committed significant economic and political resources for national and global long energy transitions.

The UK's long energy transition process has been embedded in the broader institutional transformation of its politics, society and economy since the late 1970s. This inter-institutional system is characterized by some scholars as 'the retreat of the state' (e.g., Strange, 1994). Accordingly, the successive UK governments from different political persuasions have in the

last three decades been divesting the state from various sectors and institutions, including energy, by promoting the market and corporate logics. However, given their overarching principles or logics, the market and the corporation as two intimately related institutions have a tendency to generate dilemmas or even trilemmas, when they come into interaction with other institutions and overarching principles (e.g., politics, economy and sovereignty - see Rodrik, 2011; sustainability - see Nyberg and Wright, 2016; Szulecki et al., 2016).

Our case history and corpus-based analyses on the UK's long energy transitions demonstrate how UK governments have been dealing with the energy transition trilemma as one specific manifestation of the inherent institutional ambiguity and complexity within inter-institutional systems (Thornton and Ocasio, 2008; Greenwood et al., 2011). Successive UK governments have been committed to the market logic in the UK's long energy transition process. Nevertheless, when faced with trilemma-related challenges and short-comings of market mechanisms, they have made substantial interventions (e.g., ROs and CfDs) in the very same market-based transition mechanisms that they originally triggered and have since then operated and/or taken part in. Foremost among these interventions is the EU's Emission Trading Scheme, which has, owing to market design issues and arbitrageurs, generated depressed unit emission prices (MacKenzie, 2009). The unilateral UK-based carbon price-floor legislation introduced in 2013 is considered a successful reaction to this EU wide market failure (Edenhofer et al., 2017). The UK case also shows that the long energy transition process can have prohibitive innovation costs, especially when the governments leave the solution to the markets by reducing subsidies. Relatedly, the energy transition process is prone to the energy security challenges stemming from the renewables' intermittency. In such cases, the UK governments have not hesitated to act at the expense of sustainability in the energy transition trilemma. With these institutional complexities, they have turned on and off the incentives for the Big Six and others to make substantial investments towards the decarbonization of the UK energy supply (See

Figure 1). Our corpus-based textual analysis also shows this ambiguity and complexity generating long energy transition process, with the significantly growing presence of the Sustainability LETs in the keyness tables, moderated by their collocates from the Security and the Affordability corners of the energy transition trilemma.

Figure 1 around here

Similar to the UK, the Chinese long energy transition process has been embedded in the bigger institutional transformation of the Chinese state, economy and society since the late 1970s. This is characterized by liberalization and marketization at fast-growing margins when the state still retains significant power and authority in the Chinese economy and society (Rodrik, 2007). The Chinese state has been exerting this power and authority via the overarching governing principles of socialism, centralization and authoritarianism in pursuit of national economic and political goals (Thornton, 2009), including economic and environmental sustainability (Lo, 2013). Such an approach has been capable of producing significant economic and social transformations since the late 1970s, as measurable by the remarkable average double digit economic growth in most of this period. Yet, unsurprisingly, the Chinese long energy transition process was triggered more than a decade ago, partly because of the dilemmas and externalities (e.g., energy supply shortages, world-leading GHG emissions, unprecedented industrial pollution and environmental degradation in urban and rural areas (Smil, 2015) exacerbated by China's spectacular economic transformation. Our case narrative and corpus-based analyses show the manifestations of the successive Chinese leaderships' overarching governing principles as well as desire to introduce market-based mechanisms into the Chinese long energy transitions, too.

Figure 2 around here

The spectacular investments by SOEs and private companies in the renewable energy supply capacity in recent years (see Figure 2) have been made to tackle the sustainability challenges in a spectacularly growing hydrocarbon-based economy. Nevertheless, these investments have been legislatively sanctioned and monitored by the successive Chinese leaderships and their planning arms without much consideration given to the energy transition trilemma, especially to the domain of affordability (market and energy efficiency), not to mention the prevalent disregard for retail consumers, at least in the legislative and corporate corpora, thanks to generously subsidized retail prices (Zeng et al., 2016). These trilemma-related challenges have now become the focus of the next reform phase the Chinese long energy transition process is currently going through. One of the issues that the current phase will have to address is the renewable energy overcapacity and transmission issues. For example, it has been recently reported that some renewable energy installations in China's northern and western regions have been sitting idle for lack of transmission grids that can transfer clean energy from these regions to the energy hungry eastern regions (Vest, 2017). This is not unlike the hydrocarbon-based power plant shut-downs by the Major 5, Minor 4 and others, and consequent industrial and urban black-outs in some provinces, to meet the energy efficiency targets towards the end of the 11th Five Year Plan period (Lo, 2013, p.73). We also observe in the Chinese political and legislative corpora what we call a textual overstretch - namely, relatively shallow treatment of a comprehensive scope of issues, which generates ambiguity and complexity for the Major Five and Minor Four. These ambiguities and complexities are textually detectable also in the discontinuing and disappearing LETs and collocates in the corpora across thematic time clusters.

With this study, we make several contributions to management and organization theory and to the long energy transitions literature. To begin with, we provide contextualized explanations (Welch et al., 2011) on how the state and its political and executive bodies actually play an integral role in the institutional evolution of business domains and the economy. Extant institutional perspectives overlook the role of the state in institutionalization and institutional work in the context of institutional multiplicities and conflicting logics (Lawrence and Suddaby, 2006; Greenwood et al., 2011; Bello and Kostova, 2012). The state as an institutional actor is capable of doing institutional work and engendering institutional change and dynamism, even in maximum variation cases like the UK and China, whose inter-institutional backdrops are generally taken to be static within their liberal and socialist market economy, respectively. We also show that the state can and should play an integral institutionalizing role, especially in issues as grand and challenging as long energy transitions. A better-contextualized understanding of the institutional work by the state generates better understandings of *how* and *why* firms respond to the grand challenges of our times such as climate change as they do.

Relatedly, we provide an application of a novel but well-established discourse analysis methodology, that is, corpus-based discourse analysis. The collection and analysis of hundreds or thousands of texts and millions of words are possible by corpus-linguistic methods and computer-assisted tools (Illie et al., 2014). These analyses can provide unique ways of measuring institutional ambiguity and complexity as ever manifest in the institutional multiplicities and inter-institutional systems in which managers, national and international companies are embedded.

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UK legislations and political debates (England and Wales, Scotland) Source: Legislation.gov.uk, Hansard.parliament.uk	**China legislations and political speeches** Source: State Council of People's Republic of China (PRC), National People's Congress, National Development and Reform Commission, State Council Information Office, HKBU Corpus of Political Speeches
Acts: Core pieces of legislation that shape the energy production and distribution markets Statutory instruments: Specific government orders to implement specific aspects of acts - e.g., climate change levy, renewables obligations Political speeches and debates: House of Commons	Laws: Core pieces of legislation that shape the energy production and distribution markets Plans: Five-year master- and sub-plans as tools to implement laws to reach specific socioeconomic development targets Electricity reform documents: Administrative orders to implement the energy market reforms in 2002 and 2015[1] Political speeches: Annual Report on the Work of the Government, White Papers
Areas/names of legislations, plans, instruments, orders, political debates and speeches	
Atomic /Nuclear energy acts	Cleaner production
Climate change (levy) acts, Greenhouse effect, Carbon	Coal industry
Electricity acts, Privatization	Electricity industry
Energy acts/Energy Conservation acts, Renewable Energy, Solar, Affordable	Energy saving, Energy conditions and policy, Economic development
Fossil fuel levy acts, Coal acts, Coal mining,	Environmental protection (air pollution)
Gas acts, Shale, Privatization, North Sea, Greenhouse gases	Greenhouse gas control & reduction, Climate Change,
Utilities acts	Renewable Energy, Nuclear Energy and Emergencies,
Time & Number of texts & Language	
1979-2017 & 2783 texts in English	1980-2017 & 172 texts in Chinese Mandarin

Table 1 Political and Legislative Data Sources

[1] These are the 2002 Electricity System Reform Plan (founding the so-called Major Five, see Table 2 for explanation) and the 2015 –'Opinions on further reforming the electricity institutions [further marketization of the energy sector for pricing, sales, and electricity generation]'

UK- Big Six 91 % of the energy supply market in the 1st quarter of 2018 Data sources: Company websites, Companies House UK	**China – Major Five and Minor Four** 46.6% of the electricity supply market in 2017 provided by Major Five. 9.1 % of the market was provided by Minor Four in 2015. Data sources: Company websites
Types of reports	
Annual accounts, including Financial statements and Director's strategic report from the Companies Houses for the delisted holding companies based in the UK in charge of power generation, trading and others[2] Annual reports issued by parent companies for shareholders[3] Corporate social responsibility, sometimes titled sustainability reports that address corporate, social and environmental governance matters for stakeholders	Annual reports: Major Five and Minor Four are State Owned Enterprises in the energy sector with home and overseas investments. These enterprises are the top nine energy producers in China. Major Five's and Minor Four's core subsidiaries are listed on Chinese and/or international stock exchanges. We collected the legally required annual reports of these enterprises' core power generation subsidiaries in China. These reports, written for shareholders[4], have directors' comments, strategy, operational information and financial statements. Corporate social responsibility, sometimes titled sustainability reports that address corporate, social and environmental governance matters for stakeholders
Time & Number of texts & Language	
1997-2017 & 252 texts (English)	1999 – 2017 & 77 texts (Chinese Mandarin) 6 (English)[5]

Table 2 Corporate data sources

[2] After their privatization, some of the energy supply companies were taken-over by European energy suppliers in the early 2000s. Four of the Big Six- namely, E. ON, EDF, Scottish Power, and NPower were then delisted from the UK stock market. We used the statutory annual accounts for these UK based companies whenever they did not publish any annual reports.

[3] We collected the parent holding company annual and corporate social responsibility reports for the Big Six. All the parent companies, including the British Gas' parent company Centrica PLC have European and international operations, except for the Scottish and Southern Energy PLC.

[4] These companies' majority shares are state-owned, but their remaining shares are traded in the Chinese or international stock markets.

[5] Although the Major Five and Minor Four have operated as corporatized SEOs from 2002 onwards, these companies had operated in one form or another in the previous period, but under the direct command of ministries and/or committees. We use these companies' six available reports in English for the first period of our Chinese corporate corpora analysis (1999-2001) as there were not sufficient Mandarin texts to run the analysis in Chinese.

Affordability	**Security**	**Sustainability**
Affordab*[6]	Electricity	Carbon
Customer	Energy	Climate
Market	Fuel	Coal
Price	Gas	Decarboni*
Trading	Power	Emission
	Secur*	Fossil
	Suppl*	Renewable
		Sustainab*

Table 3 LETs (Keywords)

[6] We present the lemmatized versions of some keywords here to capture the inflectional variations (e.g., affordable, affordability) (see Illa et al., 2014). We take the keyness rankings of the first inflectional variation, and also the first appearance of a countable keyword (e.g., price, prices; renewables, renewable).

Affordability	1979-2000	2001-2007	2008-2017	Security	1979-2000	2001-2007	2008-2017	Sustainability	1979-2001	2001-2007	2008-2017
Affordab*	-	-	-	Electricity	11	21	28	Carbon	-	10	8
Customer	-	-	-	Energy	5	1	1	Climate	-	8	7
Market	-	99	42	Fuel	41	32	23	Coal	3	13	53
Price	34	100	43	Gas	10	11	9	Decarboni*	-	-	-
Trading	-	-	-	Power	32	28	44	Emission	-	17	24
				Secur*	-	67	96	Fossil	-	-	-
				Suppl*	43	48	85	Renewable	-	16	32
								Sustainab*	-	59	-

Table 4 Keyness ranks of LETs in UK political speeches and debates in the top 100

Affordability	1979-2000	2001-2007	2008-2017	Security	1989-2000	2001-2007	2008-2017	Sustainability	1989-2001	2001-2007	2008-2017
Affordab*	-	-	-	Electricity	11	8	14	Carbon	-	-	29
Customer	-	-	-	Energy	-	8	13	Climate	-	-	64
Market	-	-	-	Fuel	30	48	45	Coal	-	-	-
Price	-	-	-	Gas	12	-	31	Decarboni*	-	-	-
Trading	-	-	-	Power	-	-	-	Emission	-	-	46
				Secur*	-	-	-	Fossil	75	55	71
				Suppl*	13	14	45	Renewable	-	35	32
								Sustainab*	-	-	-

Table 5 Keyness ranks of LETs in UK legislation corpus in the top 100

Affordability	1997-2000	2001-2007	2008-2017	Security	1989-2000	2001-2007	2008-2017	Sustainability	1989-2000	2001-2007	2008-2017
Affordab*	-	-	-	Electricity	11	8	14	Carbon	-	-	74
Customer	22	22	24	Energy	3	2	2	Climate	-	-	-
Market	57	42	52	Fuel	-	-	-	Coal	-	-	-
Price	-	-	-	Gas	6	5	7	Decarboni*	-	-	-
Trading	-	64	-	Power	30	14	21	Emission	65	45	52
				Secur*	-	-	-	Fossil	-	-	-
				Suppl*	39	84	54	Renewable	-	-	86
								Sustainab*	-	-	72

Table 6 Keyness ranks of LETs in Big Six corpus in the top 100

Affordability	**1979-2000**			**2001-2007**			**2008-2017**		
	Collocate	**F#**	**MI**	**Collocate**	**F#**	**MI**	**Collocate**	**F#**	**MI**
Affordab* P1[7]=57 P2=293 P3=1052	Warmth	2	14.83	Energy	31	6.24	Energy	186	5.75
	Access	2	11.79	Secure	9	9.47	Secure	108	9.93
	Make	2	7.80	Supplies	7	8.69	Warmth	70	12.49
Customer P1 =1786 P2 = 701 P3=2389	Electricity	115	7.26	Payment	23	9.47	Energy	199	4.07
	Captive	100	6.94	Meter	21	10.13	Companies	124	5.92
	Industrial	70	8.90	Pay	21	8.218	Vulnerable	105	8.09
Market P1=3558 P2=1710 P3=4284	Coal	513	7.27	Energy	139	6.82	Energy	1420	12.61
	Energy	207	6.32	Electricity	62	7.91	Electricity	529	13.82
	World	189	9.47	Gas	43	7.13	Competition	484	15.00
Price P1=4526 P2=1546 P3=4411	Gas	1313	6.84	Gas	122	7.21	Energy	1485	5.87
	Electricity	1073	6.66	Electricity	117	7.53	Gas	828	6.88
	Oil	902	7.39	Energy	96	4.99	Wholesale	633	9.59
Trading P1=993 P2=631 P=1254	Fair	67	9.53	Emissions	148	8.83	Emissions	336	8.91
	Fund	55	10.15	Scheme	101	9.19	Scheme	244	9.42
	New	39	6.07	electricity	53	7.16	EU	133	8.72

Table 7 Collocates of Affordability LETs in UK political speeches and debates corpus. In this and all subsequent tables, F# refers to frequency of each collocate and MI refers to each collocate's MI value.

[7] P1, P2, P3 represent the number of collocate types in the period specific corpus (e.g., Affordab* appears with 57 different collocates in Period 1 - P1)

Affordability	**1979-2000**			**2001-2007**			**2008-2017**		
	Collocate	**F #**	**MI**	**Collocate**	**F#**	**MI value**	**Collocate**	**F#**	**MI**
Affordab* P3=18	No Hit			No hits			Strengthens	1	16.00
							Built	1	14.22
							Clean	1	13.42
Customer P1 =351 P2 = 155 P3=373	Potential	68	12.16	Electricity	71	9.04	Domestic	82	10.64
	Electricity	40	5.71	Supplied	43	12.12	Electricity	63	7.40
	Tariff	38	11.24	Obligation	27	9.00	Supplier	59	9.13
Market P1=71 P2=138 P3=499	Gas	23	8.99	Electricity	46	7.06	Electricity	231	8.54
	Electricity	18	8.31	Authority	45	7.41	Gas	11	8.62
	Authority	17	9.09	Gas	43	9.91	Authority	98	7.66
Price P1=200 P2=233 P3=375	Maximum	27	11.41	Retail	39	11.25	Strike	73	12.03
	Premium	14	12.01	Index	35	10.35	reference	35	8.02
	Arrangement	14	10.87	Year	33	7.93	Electricity	23	4.81
Trading P1=126 P2=103 P=277	fair	44	12.04	Transmission	18	9.05	Scheme	122	8.08
	Act	34	5.66	Losses	14	11.39	Regulations	49	5.49
	General	24	8.95	New	13	6.53	Emissions	45	6.74

Table 8 Collocates of Affordability LETs in UK legislation corpus

Security	**1979-2000**			**2001-2007**			**2008-2017**		
	Collocate	**F#**	**MI**	**Collocate**	**F#**	**MI**	**Collocate**	**F#**	**MI**
Electricity P1=4987 P2=1839 P3=3419	Industry	1720	5.18	Gas	181	6.25	Generated	470	7.22
	Supply	1370	7.25	Generation	133	7.24	Act	370	4.18
	Board	861	6.07	Supply	84	6.17	Gas	314	5.52
Energy P1=6490 P2=4423 P3=8446	State	3590	6.27	Renewable	739	6.67	Act	1371	6.07
	Secretary	3471	6.31	Efficiency	673	7.10	Renewable	367	6.24
	Efficiency	2046	7.54	Policy	374	5.78	Efficiency	343	7.79
Fuel P1=3484 P2=1734 P3=3866	Fossil	563	10.00	Poverty	340	9.82	Fossil	322	9.73
	Poverty	404	8.39	Fossil	125	10.02	Renewable	111	6.69
	Nuclear	217	5.87	Energy	59	3.40	Sources	92	7.67
Gas P1=5757 P2=2436 P3=4859	British	2331	12.41	Oil	232	7.76	Greenhouse	381	8.80
	Corporation	1096	13.42	Electricity	181	8.93	Electricity	329	5.59
	Oil	1050	12.17	Greenhouse	177	6.25	Emissions	272	6.90
Power P1=4598 P2=2423 P3=4434	Nuclear	2182	7.97	Nuclear	569	7.36	Nuclear	1674	7.83
	Stations	1848	8.84	Stations	322	8.62	Stations	1351	8.99
	Coal	775	4.34	Wind	254	6.74	New	760	5.85
Secur* P1=2152 P2=1458 P=3086	Supply	328	11.40	Supply	297	9.34	Energy	1551	8.82
	Social	229	12.74	Energy	176	5.69	Supply	605	10.82
	Future	150	10.05	Debate	96	7.32	Debate	306	9.49
Suppl* P1= 4380 P2=2105 P3=4165	Electricity	1740	11.23	Energy	324	5.86	Energy	1476	6.14
	Gas	1004	10.33	Security	293	9.32	Security	555	8.58
	Industry	937	9.44	Gas	219	7.17	Electricity	472	7.13

Table 9 Collocates of Security LETs in UK political speeches and debates corpus

Security	1979-2000			2001-2007			2008-2017		
	Collocate	**F#**	**MI**	**Collocate**	**F#**	**MI**	**Collocate**	**F#**	**MI**
Electricity P1=1287 P2=987 P3=1592	Act	443	4.36	Supplier	468	5.99	Generated	470	7.22
	Supplier	424	5.90	Generated	299	6.45	Act	370	4.18
	Public	342	5.74	Sources	271	6.14	Gas	314	5.52
Energy P1=413 P2=1025 P3=2099	Act	111	10.99	Act	579	5.79	Act	1371	6.07
	Authority	76	6.44	Renewable	207	6.38	Renewable	367	6.24
	Atomic	63	10.16	Schedule	193	5.38	Efficiency	343	7.79
Fuel P1=362 P2=495 P3=746	Fossil	219	10.00	Fossil	425	8.97	Fossil	322	9.73
	Generating	165	8.39	Electricity	151	4.83	Renewable	111	6.69
	Station	114	8.76	Sources	148	7.12	Sources	92	7.67
Gas P1=1045 P2=468 P3=1235	Public	482	6.57	Electricity	107	5.43	Greenhouse	381	8.80
	Transporter	318	7.24	Act	84	5.24	Electricity	329	5.59
	Supplier	293	5.69	Authority	49	4.68	Emissions	272	6.90
Power P1=399 P2=493 P3=960	Conferred	49	8.83	Combined	46	9.62	Heat	102	7.77
	Scottish	48	8.89	Make	41	6.76	Make	101	5.69
	Act	38	3.73	Heat	40	8.60	Exercise	95	7.20
Secur* P1=399 P2=389 P=639	Company	30	7.79	Company	27	7.23	Energy	74	7.75
	Compliance	24	10.49	NDA	21	7.20	Nuclear	49	9.60
	Purpose	24	8.11	Nuclear	18	7.11	Act	49	6.72
Suppl* P1=1385 P2=1073 P3=1526	Electricity	1013	7.66	Electricity	982	9.23	Electricity	807	7.85
	Gas	656	7.36	Designated	239	9.73	Energy	196	5.53
	Public	555	7.83	Licensed	189	10.32	Obligation	159	6.46

Table 10 Collocates of Security LETs in UK legislation corpus

Sustainability	1979-2000			2001-2007			2008-2017		
	Collocate	**F#**	**MI**	**Collocate**	**F#**	**MI**	**Collocate**	**F#**	**MI**
Carbon P1=1251 P2=1835 P3=4516	Dioxide	479	12.32	Emissions	413	7.89	Low	2177	8.38
	Emissions	227	10.66	Dioxide	216	9.28	Capture	1304	8.85
	Energy	42	3.82	Low	158	8.12	Emissions	1195	7.20
Climate P1=1340 P2=2218 P3=4351	Change	462	10.90	Change	1568	8.62	Change	7272	8.63
	Levy	100	10.0	Levy	225	8.48	Energy	2680	5.46
	Programme	34	6.69	Bill	116	5.19	State	1636	6.58
Coal P1=7558 P2=2083 P=2968	Industry	5594	5.71	Industry	286	6.40	Power	583	6.79
	British	5334	6.61	UK	181	6.40	Fired	578	9.75
	Board	2152	6.23	Clean	178	8.50	Stations	484	8.36
Decarboni* P1=84 P2=28 P3=1413	Target	11	12.28	Societies	1	17.08	Target	288	9.60
	Power	6	8.02	Linked	1	13.20	Energy	131	4.68
	Sector	5	9.41	Adaptation	1	12.27	Sector	121	8.02
Emission P1=1470 p2=1646 p3=3291	Carbon	248	10.79	Carbon	424	7.93	Carbon	1248	11.04
	Reduce	117	9.38	Trading	149	8.84	Reduction	403	12.11
	Sulphur	103	10.62	Dioxide	121	8.75	Reduce	369	11.71
Fossil P1=1003 P2=434 P3=1326	Fuel	372	9.82	Fuel	67	11.47	Fuel	412	11.87
	Non	229	11.27	Non	20	9.72	Energy	59	3.35
	Obligation	138	10.98	Obligation	18	8.42	Carbon	49	4.95
Renewable P1=1798 P2=2517 P3=4155	Energy	889	7.61	Energy	856	6.89	Energy	2269	6.53
	Sources	436	10.26	Obligation	271	9.32	Obligation	811	9.36
	Development	168	7.96	Sources	166	8.45	Heat	426	8.54
Sustainab* P1=536 P2=1087 P3= 1596	Energy	51	6.45	Energy	160	5.91	Energy	160	5.02
	Development	47	9.09	Development	131	8.52	Development	116	8.21
	Policy	16	7.09	Policy	31	6.15	Future	60	6.64

Table 11 Collocates of Sustainability LETs in UK political speeches and debates corpus

Sustainability	1979-2000			2001-2007			2008-2017		
	Collocate	**F#**	**MI**	**Collocate**	**F#**	**MI**	**Collocate**	**F#**	**MI**
Carbon P1=9 P2=100 P3=1144	Emissions	1	16.99	Emissions	37	11.43	Emission	348	7.10
	Dioxide	1	16.99	Reduction	27	11.58	Units	284	8.33
	Atmosphere	1	16.99	Substitute	27	9.07	Dioxide	271	8.65
Climate P2=229 P3=741	No hit			Change	169	10.81	Change	797	9.28
				Levy	113	9.38	Act	392	6.17
				Act	41	5.28	Scotland	179	7.30
Coal P1=97 P2=54 P=134	Act	65	6.09	Lignite	11	13.72	Authority	18	6.68
	Opencast	6	13.75	Natural	11	12.27	Powers	11	8.76
	Produced	4	9.96	Gas	11	8.98	Additional	10	9.07
Decarboni* P3=140	No hits			No hit			Range	22	15.48
							Target	19	12.72
							Order	12	9.98
Emission P1=22 P2=143 P3=995	Temperature	3	15.41	Carbon	37	14.50	Carbon	368	7.18
	Maintenance	3	15.12	Reduction	31	14.54	Reduction	300	8.47
	Control	3	12.24	Substitute	26	11.77	Gas	292	8.78
Fossil P1=237 P2=255 P3=373	Fuel	220	9.95	Fuel	370	8.77	Fuel	303	9.64
	Non	141	10.22	Non	144	8.77	Derived	60	9.59
	Generating	122	8.35	Electricity	135	5.47	Renewable	52	6.50
Renewable P1=102 P2=541 P3=1359	Obligation	18	11.88	Obligation	389	7.94	Obligation	622	8.23
	Sources	12	11.99	Sources	340	8.71	Sources	387	6.31
	Electricity	12	6.72	Electricity	292	6.18	Energy	302	8.84
Sustainab* P2=193 P3= 490	No hits			Energy	206	8.83	Energy	43	6.40
				Act	122	7.5	Report	31	8.39
				Sources	58	8.61	Act	31	5.49

Table 12 Collocates of Sustainability LETs words in UK Legislation corpus

Affordability	**1997-2000**			**2001-2007**			**2008-2017**		
	Collocate	**F#**	**MI**	**Collocate**	**F#**	**MI**	**Collocate**	**F#**	**MI**
Affordab* P1=39 P2=331 P2=927	Services	2	7.97	Energy	54	7.16	Energy	344	7.36
	Stability	1	14.6	Customers	19	7.25	Supply	107	7.86
	Promotes	1	13.84	Secure	18	11.44	Secure	76	10.74
Customer P1=2279 P2=5159 P3=7009	Service	270	7.41	Energy	1082	5.93	Energy	3326	5.51
	Electricity	150	5.59	Service	858	8.06	Business	1584	5.51
	Gas	148	5.25	Electricity	823	6.45	Gas	1515	5.40
Market P1=1754 P2=5052 P3=6288	Gas	138	5.53	Energy	1010	4.94	Energy	2132	5.07
	Electricity	132	5.79	Electricity	778	5.48	Prices	1274	7.31
	Energy	131	5.29	Gas	770	5.23	Electricity	1259	5.71
Price P1=1362 P2=3694 P3=4823	Market	140	7.26	Market	923	7.20	Market	1784	7.47
	Share	102	5.81	Electricity	747	6.23	Gas	1300	6.09
	Pool	98	8.86	Gas	714	5.93	Commodity	1266	8.83
Trading P1=817 P2=2609 P3=3200	Energy	105	6.32	Energy	892	5.63	Energy	1412	5.57
	Gas	90	6.26	Electricity	413	5.44	Supply	709	6.76
	Electricity	75	6.31	Gas	338	4.92	Gas	646	5.47

Table 13 Collocates of Affordability LETs in UK Big Six Corpus

Security	1997-2000			2001-2007			2008-2017		
	Collocate	**F#**	**MI**	**Collocate**	**F#**	**MI**	**Collocate**	**F#**	**MI**
Electricity P1=2028 P2=4978 P3=6121	Gas	240	5.55	Gas	2657	6.35	Gas	4624	6.67
	Supply	223	6.46	Generation	1121	6.27	Generation	2711	6.62
	Electricity	192	5.54	Distribution	864	6.60	Supply	1760	6.44
Energy P1=2513 P2=7872 P3=11313	Supply	303	6.42	Efficiency	1388	6.61	Supply	3556	6.06
	Efficiency	224	7.14	Renewable	1184	6.88	Renewable	3213	6.87
	Gas	143	4.32	Services	1008	7.11	Services	2740	5.83
Fuel P1=924 P2=2619 P3=3702	Gas	72	8.88	Nuclear	371	6.88	Nuclear	1106	5.83
	Fossil	55	13.46	Poverty	271	5.44	Poverty	553	10.49
	Coal	54	10.97	Gas	236	5.08	Spent	523	7.66
Gas P1=2367 P2=5729 P3=7261	Electricity	241	5.55	Electricity	2666	7.94	Electricity	4630	10.50
	Energy	144	4.32	Natural	909	10.47	Power	2412	9.97
	Supply	126	5.31	Storage	899	5.09	Storage	2010	6.67
Power P1=2519 P2=6083 P3=7932	System	431	7.67	Station	1457	6.36	Generation	3195	5.44
	Station	296	8.29	Plants	1254	7.92	Stations	2863	7.42
	Generation	171	6.22	Generation	1140	7.33	Gas	2401	6.57
Secur* P1=718 P2=6083 P3=3371	Other	34	7.03	Other	353	8.09	Supply	984	8.35
	Costs	37	7.37	Supply	333	7.20	Energy	773	5.44
	Social	36	10.97	Marketable	317	6.17	Other	426	8.53
Suppl* P1=2077 P2=4593 P3=6420	Energy	422	6.89	Energy	1526	7.10	Energy	5028	5.92
	Electricity	328	7.01	Electricity	1312	8.64	Electricity	2549	6.03
	Water	206	5.97	Gas	1091	12.23	Gas	2243	9.71

Table 14 Collocates of Security LETs in UK Big Six Corpus

Sustainability	1997-2000			2001-2007			2008-2017		
	Collocate	**F#**	**MI**	**Collocate**	**F#**	**MI**	**Collocate**	**F#**	**MI**
Carbon P1=206 P2=1780 P3=3770	Dioxide	36	12.76	Emissions	306	8.23	Emissions	1383	7.91
	Emissions	18	8.92	Dioxide	241	11.03	Low	1344	9.11
	CO2	16	9.27	Low	182	8.66	Energy	868	4.72
Climate P1=289 P2=1851 P3=3125	Change	67	10.80	Change	702	9.80	Change	1486	9.19
	Global	21	11.10	protection	186	9.38	Protection	817	9.56
	Levy	9	11.10	Emissions	154	7.35	Energy	646	5.05
Coal P1=729 P2=2368 P3=3019	Fired	103	10.22	Gas	588	6.29	Gas	1255	6.82
	Powered	70	6.28	Fired	534	9.43	Powered	1158	6.78
	Oil	67	8.38	Power	484	6.12	Fired	1032	9.75
Decarboni* P2=8 P3=615	No hits			Reclaimed	2	1.81	Energy	1.82	8.89
				Sludged	2	1.64	Electricity	1.65	9.51
				UF	1	1.83	generation	1.84	9.78
Emission P1=810 P2=2788 P3=4359	Co2	97	8.88	CO2	834	8.78	CO2	2198	8.44
	energy	75	5.61	Trading	377	7.13	Carbon	1522	8.05
	NOX	69	9.26	Gas	347	5.24	Scope	1080	8.35
Fossil P1=196 P2=949 P3=1311	Fuel	26	9.48	Fired	239	10.53	Fuel	244	8.58
	Emissions	18	8.68	Plants	128	8.39	Power	243	6.53
	Generation	16	7.45	Generation	117	7.37	Plants	229	8.48
Renewable P1=539 P2=2810 P3=4621	Energy	96	8.73	Energy	1346	7.07	Energy	3903	7.42
	Generation	44	8.93	Generation	473	7.40	Generation	2246	8.37
	new	19	7.51	Electricity	313	5.88	Electricity	802	6.53
Sustainab* P1=641 P2=2952 P= 4920	Development	135	10.65	Development	918	9.50	Development	1660	8.79
	Issues	37	9.66	Energy	418	6.13	Energy	1128	5.85
	Strategies	31	9.29	Environmental	236	7.26	Standard	730	8.98

Table 15 Collocates of Sustainability LETs UK Big Six Corpus

Affordability	1980-2001	2002-2014	2015-2017	Security	1980-2001	2002-2014	2015-2017	Sustainability	1980-2001	2002-2014	2015-2017
Affordab*	-	-	-	Electricity	-	-	-	Carbon	-	-	-
Customer	-	-	-	Energy	-	-	-	Climate	-	82	-
Market	-	-	-	Fuel	-	-	-	Coal	-	-	-
Price	-	-	-	Gas	-	-	-	Decarboni*	-	-	-
Trading	-	-	-	Power	-	-	-	Emission	-	-	-
				Secur*	-	-	-	Fossil	-	-	-
				Suppl*	-	-	-	Renewable	-	-	-
					-	-	-	Sustainab*	-	-	-

Table 16 Keyness ranks of LETs in Chinese political speeches and white papers corpus in the top 100

Affordability	1980-2001	2002-2014	2015-2017	Security	1980-2001	2002-2014	2015-2017	Sustainability	1980-2001	2002-2014	2015-2017
Affordab*	-	-	-	Electricity	37	44	68	Carbon	-	-	-
Customer	-	-	-	Energy	44	70	34	Climate	-	-	-
Market	-	-	-	Fuel	-	-	-	Coal	43	35	66
Price	-	-	-	Gas		68	73	Decarboni*	-	-	-
Trading	-	-	-	Power	-	-	-	Emission	-	-	34
				Secur*	-	-	-	Fossil	-	-	-
				Suppl*	-	-	-	Renewable	-	81	-
					-	-	-	Sustainab*	-	-	-

Table 17 Keyness ranks of LETs in Chinese legislation corpus in the top 100

Affordability	1980-2001	2002-2014	2015-2017	Security	1980-2001	2002-2014	2015-2017	Sustainability	1980-2001	2002-2014	2015-2017
Affordab*	-	-	-	Electricity	30	-	-	Carbon	-	-	-
Customer	-	-	-	Energy	-	56	48	Climate	-		-
Market	-	-	-	Fuel	89	-	-	Coal	-	37	90
Price*	-	-	-	Gas	-	-	-	Decarboni*	-	-	-
Trading	-	-	-	Power	1	9	8	Emission*	-	-	-
				Secur*	-	-	-	Fossil	-	-	-
				Suppl*	-	-	-	Renewable*	-	-	-
					-	-	-	Sustainab*	-	-	-

Table 18 Keyness ranks of LETs in Chinese Major Five and Minor Four Corpus in the top 100

Affordability	**1980-2001**			**2002-2014**			**2015-2017**		
	Collocate	**F#**	**MI**	**Collocate**	**F#**	**MI**	**Collocate**	**F#**	**MI**
Affordab* P1=152 P2=59 P3=	This inevitably produces a country	3	17.31	Full charge	1	14.91	No hits		
	Government	3	17.31	Gradually establish the ability to reflect the scarcity of resources	1	14.91			
	Business and people	2	17.31	Tune structure to create a stable environment	1	14.91			
Customer P1 =10	No relevant hit			No hits			No hits		
Market P1=4554 P2=2817 P3=868	Improve product quality	12	18.05	System	7	6.82	No relevant hits		
	Further develop the production materials market	10	18.05	Legal Rights	6	14.91			
	Strive to promote the factor of production	10	18.05	simultaneously	6	10.78			
Price P1=1585 P2=956 P3=245	Continue to expand the market	6	14.73	New employment in the town	8	13.91	Point	6	13.87
	Step by step energy	6	14.73	Reform	7	14.72	Promote agricultural water price reform	5	15.93
	Gas	6	14.73	Set	7	14.72	New employment in the town	5	13.93
Trading P1=1204 P2=915 P=222	No relevant hit			Improve fair trade policy	12	15.18	Further integration and optimization of customs special supervision	6	16.19
				China	11	11.73	Tube area	6	16.19
				In the future for a long time	10	14.91	Single window	6	15.19

Table 19 Collocates of Affordability LETs in Chinese political speeches and white papers corpus

Affordability	1980-2001			2002-2014			2015-2017		
	Collocate	**F#**	**MI**	**Collocate**	**F#**	**MI**	**Collocate**	**F#**	**MI**
Affordab* P1=20 P2=32	Gradually improve the city	1	13.04	Actively promote natural gas thermal power cooling	2	15.38	No hits		
	Social relief	1	13.04	Central city with high heat local demand	2	15.38			
	Promote the socialization of social welfare	1	13.04	Support the use of coalbed methane to generate electricity	2	15.38			
Customer	No relevant hit			No hits			No hits		
Market P1=660 P2=3392 P3=1919	Deepen the reform of land use system	7	15.85	National Energy Board	19	13.59	Promote the construction of natural gas trading centres	10	16.88
	Development of Industry Investment Fund	7	15.85	Deepen the reform of coal circulation system	10	15.12	Sound market exit mechanism	10	16.30
	System	7	13.26	Realize the integration of key contract coal and market coal	10	15.12	Promote energy investment diversification	9	16.73
Price P1=125 P2=944 P3=547	Beneficial	4	15.04	Based on the experience of the pilot in Guangxi	11	16.84	Perfect peaking	14	17.37
	Strengthen the supervision of construction projects	4	15.04	Gradually rationalize the relationship between natural gas and alternative energy	10	16.71	Release power	13	16.26
	Increase inspection efforts	4	15.04	Natural gas price formation mechanism reflecting the relationship between resource scarcity and market supply and demand	10	16.71	Interruptible load price	12	17.15
Trading P1=180 P2=587 P3=315	Design consultation	5	15.36	Optimize energy import and export varieties	15	18.29	Service trade	7	17.37
	Technology transfer	5	15.36	Promote diversification of trade entities	14	18.19	Consolidate and enhance traditional export advantages	7	17.37
	Deepen reform	4	15.04	Encourage more qualified companies to participate in international energy trade	12	17.97	The proportion of foreign trade reached	7	17.37

Table 20 Collocates of Affordability LETs in Chinese legislative corpus

Security	1980-2001			2002-2014			2015-2017		
	Collocate	**F#**	**MI**	**Collocate**	**F#**	**MI**	**Collocate**	**F#**	**MI**
Electricity P1=254 P2=424 P3=63	More than 10,000 kw	3	14.41	Expand the scale of power transmission from west to east	4	13.46	Telecommunications	3	13.20
	Crude	3	12.93	Implement energy saving scheduling	4	13.46	Railway	3	12.20
	Steel	3	12.73	Telecommunications	4	10.65	Oil	2	12.61
Energy P1=1444 P2=3156 P3=213	Traffic	24	14.41	Optimize energy structure	22	16.79	Nuclear power is a clean	4	14.61
	Simultaneously	10	11.48	Make	18	16.79	Developing nuclear power is an important part of China's nuclear energy industry	4	14.61
	10,000 tonnes	9	11.88	Improve the energy legal system	17	14.23	China's nuclear energy industry has achieved greater development	4	14.61
Fuel P1=89 P2=127 P3=10	Year	2	9.39	Moderate development of forest biomass power generation	2	18.00	Simultaneous common mode accidents for multiple units	2	12.61
	First of all, focus on building a firewood forest	1	15.73	Cogeneration technology	2		Cross-regional nuclear emergency preparedness	2	12.61
	Prevent forest fires and pests	1	15.73	Economical and efficient hydrogen storage and distribution technology	2	15.92	Analysis of source items of serious accidents in nuclear power plants	2	12.61
Gas P1=10 P2=274 P3=10	Some areas and cities	1	15.73	Trial	4	15.92	Take a substantial step	1	13.61
	Research and development of new energy such as ocean energy	1	15.73	Release	4	15.33	Improve quality and efficiency	1	13.61
	The growth rate of pollutant emissions is significantly lower than the rate of economic growth	1	15.73	Organizing China	3	14.92	Continue to promote state-owned enterprises to lose weight	1	13.61
Power P2=27 P3=20	No hit			Encourage the development of oil and gas exploration	2	15.91	High temperature gas cooled reactor nuclear power technology	2	13.61
				Drilling equipment	2	15.91	Nuclear power technology demonstration project put into construction	2	13.61
				Support large offshore oil engineering equipment	2	15.91	Nuclear safety and nuclear emergency synchronization have been strengthened	2	13.61
Secur* P1=961 P2=1869 P3=1022	Promote efficiency	3	14.51	Heavy loss	7	15.92	Coordination	9	14.84
	Conduct national soil pollution survey and pollution prevention demonstration	3	14.51	Construction and safety infrastructure	7	17.72	Nuclear safety concept	8	15.61
	Establishing agriculture	3	14.51	Continue to increase coal mine safety supervision	7	17.72	Advocating rationality	6	16.42
Suppl* P1=1014 P2=442 P3=50	No relevant hit			Resource constraints	3	16.50	Conducting radioactive pollution detection and control for postal parcel shipments, etc.	2	13.61
				Low energy efficiency	3	16.50	goods	2	13.61
				Low level of energy technology and equipment and relatively backward management level	3	16.50	Luggage items	2	13.61

Table 21 Collocates of Security LETs in Chinese political speeches and white papers corpus

Security	1980-2001			2002-2014			2015-2017		
	Collocate	**F#**	**MI**	**Collocate**	**F#**	**MI**	**Collocate**	**F#**	**MI**
Electricity P1=615 P2=2342 P3=1577	Self-supplied power plan not connected to the grid	9	16.22	Electricity regulation	25	13.99	Autonomous region	12	8.57
	Protected area establishment sign	8	16.05	National Energy Board	24	13.93	Implement energy-saving and low-carbon scheduling mechanism	10	12.89
	Career management	8	16.05	Power regulators ordered to correct	20	14.80	Self-supplied power plant not connected to the grid	9	13.74
Energy P1=387 P2=5385 P3=4262	On the basis of companies economic and environmental arguments	8	16.05	Development and Reform Commission	54	14.68	National Development and Reform Commission	28	13.85
	Energy Development Investment Project	7	15.85	Biomass energy	53	14.68	Actively participate in global energy governance	20	16.98
	Optimal energy savings	7	15.85	Natural gas	51	15.48	Building clean low carbon	16	16.98
Fuel P1=85 P2=1095 P3=405	Violation of the provisions of Article 28 of this Law	2	14.05	clean and environmentally friendly	11	15.48	Biomass gasification power generation	6	16.15
	Violation of the provisions of paragraph 2 of Article or paragraph 1 of Article 29 of this Law	2	14.05	high combustion efficiency	10	17.85	Promote biogas power generation	6	16.15
	Transportation enterprises and power production enterprises shall comply with the relevant provisions of the State Council	2	14.05	Transport	10	17.71	Strengthening the regulation of vehicle and ship exhaust emissions and purifications facilities renovations	6	16.15
Gas P1=145 P2=225 P3=193	Gas and coal coking	7	14.85	Design	4	16.39	Should be repaired or updated in a timely manner	4	16.57
	Production of synthetic ammonia	6	14.63	Gradually establish a carbon emissions trading market	2	13.69	Effectively prevent intervention in power market competition	4	15.57
	Refining oil	6	14.63	Save energy and improve energy efficiency	2	16.39	Pollution prevention should be carried out	3	16.15
Power	No hit			No hit			No hit		
Secur* P1=538 P2=2488 P3=1634	Significantly reduce significant	6	14.63	People's Republic of China Coal Law	22	14.99	Water supply	7	17.37
	Prevent casualties and other safety production accidents	5	14.37	Comprehensive governance	14	16.87	Power grid	7	15.78
	Procedure	5	14.37	Take effective action	11	16.85	Economic	7	15.05
Suppl* P1=168 P2=739 P3=549	Planned electricity management		14.63	Focus on improving safety and security	4	16.39	Focus on resolving and preventing overcapacity	4	15.56
	Save electricity	3	14.63	Strive to break through coalbed methane	4	16.39	Improve energy efficiency	4	15.56
	Implement safe use of electricity	3	14.63	Vigorously develop non-fossil energy	4	16.39	Strong energy reserve emergency response capability	4	15.56

Table 22 Collocates of Security LETs in Chinese legislative corpus

Sustainability	1980-2001			2002-2014			2015-2017		
	Collocate	**F#**	**MI**	**Collocate**	**F#**	**MI**	**Collocate**	**F#**	**MI**
Carbon P1=15 P2=682 P3=40	Boundary average	36	16.73	Organizing low-carbon industrial parks	10	18.24	Intensive use of resources	1	13.61
	Whether it is now or at the end of the century	18	16.73	Combine China's national conditions	9	18.09	The yellow label car to be shipped will be completely eliminated this year.	1	13.61
	But in a state of responsibility for protecting the global climate	16	16.73	Take the lead in forming a policy system and institutional mechanism conducive to low carbon development	9	18.09	Promotion and application of transportation equipment and energy-saving and environmentally-friendly transportation vehicles	1	13.61
Climate P1=91 P2=1097 P3=40	Adopted the principle of saving energy and developing energy industry	2	16.73	Convention	13	14.81	Major ecological repairs in the Yangtze River Economic Belt	1	12.61
	Boundary average	2	16.73	Carry out China's low carbon development strategy	10	17.23	The yellow label car to be shipped will be completely eliminated this year.	1	12.61
	Strive to improve energy efficiency	2	16.73	Autonomous region	10	17.24	Raising energy and environmental protection industry	1	12.61
Coal P1=365 P2=627 P3=106	10,000 tons	6	11.30	Capital intensive	5	15.05	crude	3	14.20
	Carbon	5	15.47	Implement coal mine upgrading and elimination	5	14.43	Iron ore	2	14.61
	Shaanxi	5	14.73	Prevention of ecological damage and environmental pollution	4	14.43	Exceeding the annual target task	2	14.61
Decarboni*	No hits			No hits			No hits		
Emission P1=263 P2=601 P3=165	Standard	4	16.15	By standardizing voluntary emission reduction transactions and emissions trading pilots	6	17.50	Sulphur Dioxide	5	14.35
	Whether it is now or at the end of the century	3	17.32	Gradually promote the construction of carbon emissions trading market	6	17.50	Focus	4	15.61
	And eliminate old motor vehicles	3	17.32	Combine China's national conditions	6	17.50	Regional fine particles	4	15.61
Fossil P1=10 P2=270 P3=	Low-pollution natural gas	1	15.73	Unit GDP carbon dioxide emission ratio	4	15.33	No hits		
	And developed the national	1	15.73	China is no exception	3	16.50			
	National sales stop	1	15.73	Economical and efficient hydrogen storage and distribution technology	2	15.92			
Renewable P1=36 P2=486 P3=	Part of the average selling price of the net	4	17.73	Fund	4	16.92	No hits		
	Part of the benchmark price of sulphur coal-fired units	4	17.73	Support resource survey	4	16.92			
	Solved by charging electricity users to electricity users	4	17.73	Promoting environmental protection plays an important role	4	16.92			
Sustainab* P1=308 P2=457 P= 40	Gradually improved legal system and management system	2	16.73	Saving priority	6	14.50	Need long-term and unremitting efforts	1	13.61
	Accelerate scientific and technological progress	2	16.73	Economic	4	12.46	Iron fist management	1	13.61
	Ozone layer protection	2	16.73	The eradication of poverty	3	13.92	Fighting atmospheric smog and water pollution	1	13.61

Table 23 Collocates of Sustainability LETs in Chinese political speeches and white papers corpus

Sustainability	1980-2001			2002-2014			2015-2017		
	Collocate	**F#**	**MI**	**Collocate**	**F#**	**MI**	**Collocate**	**F#**	**MI**
Carbon P2=402 P3=609	No hits			Strengthen its economic competitive advantage	6	16.97	Control non-CO2 greenhouse gas emissions	4	17.15
				Trade barrier	5	16.71	Implementation of near zero carbon emission zone demonstration project	4	17.15
				New energy	5	14.90	Various low carbon pilots	4	17.15
Climate P1=10 P2=321 P3=158	Actively participate in global environmental and development affairs	1	13.04	Productivity layout	6	16.12	Win-win	6	17.15
	Mapping and other work	1	13.04	Forestry	5	16.12	Global climate governance system	5	16.88
	Improve service capacity and level	1	13.04	Improve agriculture	5	16.12	Implement emission reduction commitments	4	16.56
Coal P1=561 P2=3148 P3=1163	Autonomous region	28	12.53	Autonomous region	30	14.25	People's Republic of China Coal Law	10	14.19
	High ash coal mine	21	15.11	People's Republic of China Coal Law	19	13.77	Distribution for small and medium-sized coal mines	9	17.73
	Province	21	13.43	Building a large coal base	18	15.97	Promote low-temperature pyrolysis of low-rank coal	8	16.56
Decarboni* P2=10	No hits			Implement comprehensive energy-saving renovation	1	15.38	No hits		
				Energy-saving technology such as top circulation recirculation heat transfer	1	15.38			
				The ammonia industry promotes advanced coal gasification technology	1	15.38			
Emission P1=536 P2=1061 P3=1479	Autonomous region	33	12.76	Conservation of ecosystem	7	16.61	Violation of the provisions of this law	38	14.20
	Province	24	13.63	Fine particles produced by energy development and utilization	6	16.97	Ultra-low emission modification of coal-fired power units of 10,000 kW and above	10	15.88
	National atmosphere	15	15.95	NOx emission	6	16.97	Annual emission reduction ratio	10	15.56
Fossil P1=40 P2=269 P3=427	Encourage and support the use of low sulphur	1	11.46	Energy structure optimization	4	16.38	Gradually reduce the proportion of coal consumption	6	16.15
	Change to use sulphur-fixed coal or use other clean energy within a time limit	1	11.46	Scientific implementation of traditional energy substitution	4	16.38	Energy development momentum accelerates conversion	6	16.15
	Important water conversation area	1	11.46	Oil dependence on foreign countries is controlled	4	16.38	Non-fossil energy and natural gas consumption will increase significantly	5	16.15
Renewable P1=53 P2=2071 P3=1199	Used to support energy	2	14.05	Renewable energy law	39	16.76	Renewable energy law	9	15.88
	Arrange energy-saving funds in technical renovation funds	2	14.05	Development goals	20	15.18	Establish a renewable energy quality supervision and management system	8	16.56
	Feasibility study report on fixed asset investment project	2	14.05	Reduce environmental pollution	12	16.97	Economic competitiveness	7	17.37
Sustainab* P1=60 P2=543 P= 203	High school education and higher education gross enrolment rate strive to reach	1	13.05	Economic	6	12.48	Formulating this law	3	13.83
	Focus on processing and transformation of agricultural products	1	13.05	Clean modern energy industry system	4	12.74	Face to the future	2	14.56
	Quality improvement	1	13.05	Increase energy supply	3	13.06	High value-added downstream products	2	14.56

Table 24 Collocates of Sustainability LETs in Chinese legislative corpus

Affordability	1999-2001			2002-2014			2015-2017		
	Collocate	**F#**	**MI**	**Collocate**	**F#**	**MI**	**Collocate**	**F#**	**MI**
Affordab* P2=29 P3=30	No hits			Rapid growth in demand and tight supply and demand of electricity	1	18.08	Further effectively enhance the group's risk management and control capabilities	1	15.58
				Small capacity	1	18.08	Increased compared to 2014	1	15.58
				Lower fuel costs	1	18.08	Finance	1	15.587
Customer P1 =10	No hits			No hits			No hits		
Market P1=71 P2=3424 P3=1108	High-tech industry	1	12.86	Market price	139	18.88	Promote fair and orderly competition in the electricity market	5	15.90
	Through the expansion of the company's share capital	1	12.86	Contract price of the two parties based on market price	26	18.78	Quotes in this active market are those that are east to get regularly form the exchange	4	16.58
	Restructuring and restructuring for equity diversification and listing	1	12.86	Settlement by contract	24	18.49	Power system reform	4	16.587
Price P1=111 P2=2040 P3=211	Yuan	13	7.81	Market price	134	19.82	Can better use its regional advantages to effectively reduce fuel costs	3	17.17
	Share	6	6.78	Yuan	98	13.32	Yuan	3	8.271
	Accounting for total sales revenue	2	11.28	Purchase goods	24	17.53	Through scientific and rigorous cost assessment management mechanism	2	16.58
Trading P2=302 P3=26	No relevant hit			Limited	16	12.89	Investment establishment	3	10.68
				Contractor	7	16.49	Accounts receivable	2	12.06
				Yuan	4	7.125	Project not fully settled	1	15.58

Table 25 Collocates of Affordability LETs in Major Five and Minor Four corpus

Security	1999-2001			2002-2014			2015-2017		
	Collocate	**F#**	**MI**	**Collocate**	**F#**	**MI**	**Collocate**	**F#**	**MI**
Electricity P1=2790 P2=13756 P3=3228	Yuan	78	11.98	Yuan	380	14.28	Accounts payable	83	16.50
	Power automation	44	15.15	Electricity production	318	18.15	Responsibility	39	15.59
	Power equipment production and distribution	42	15.09	Unit	131	15.01	Social	36	16.00
Energy P1=20 P2=7243 P3=3416	Power grid operation	1	12.86	Wind power	71	16.42	Strong	33	16.38
	Development and application of environmental protection industry	1	12.86	Cost method	59	14.27	Infrastructure	17	16.87
	Accelerate the expansion of the company's power generation scale	1	12.86	Hydropower	57	15.87	Installed capacity	13	15.12
Fuel P1=121 P2=3488 P3=875	Yuan	7	7.50	Yuan	180	12.20	Accounts payable	18	14.30
	Power automation	5	11.02	Purchase goods	58	16.81	Fuel purchase	8	15.78
	Sales revenue of power products accounted for all sales revenue	2	12.86	Cost methods	42	13.37	Actively promote capital operation	4	16.59
Gas P2=301 P3=47	No hits			Emissions of ozone-depleting substances by weight	9	17.93	Emission	2	14.58
				The amount and volume of major spilled substances in total waste according to type and treatment	8	19.08	Increase pollution discharge standards	1	14.58
				Environmental responsibility	8	14.25	Total direct and indirect greenhouse gas emissions by weight	1	14.58
Power	No hits			No hits			No hits		
Secur* P1=50 P2=5895 P3=2436	High-tech companies based on restructuring	1	12.86	Safety responsibility	69	18.02	Comprehensive governance	22	16.72
	Cost of expenses	1	12.86	Prevention	67	18.98	Safety first	21	16.17
	Adapt	1	12.86	Comprehensive governance	66	18.95	Safety responsibility	20	15.20
Suppl* P1=34 P2=1819 P3=444	Sales revenue of power products accounted for all sales revenue	4	14.86	Electricity production	16	13.84	Accounting for total annual sales	4	14.26
	Yuan	3	7.28	Operating cost	11	14.22	Account for total annual purchases	4	14.26
	The main product is electricity	2	12.86	Operating income	10	13.49	Fully secure electricity	3	13.26

Table 26 Collocates of Security LETs in Major Five and Minor Four corpus.

Sustainability	1999-2001			2002-2014			2015-2017		
	Collocate	**F#**	**MI**	**Collocate**	**F#**	**MI**	**Collocate**	**F#**	**MI**
Carbon P2=1176 P3=563	No hits			CCS (Carbon capture and storage)	9	18.66	Advance the construction of statistical accounting systems	7	18.39
				Test	8	19.08	Exhibition concept and strategy are effectively integrated into the company's medium and long-term planning	7	18.39
				High energy consumption	6	17.86	Use carbon asset operations to promote the development of the main business	7	18.39
Climate P2=232 P3=18	No hits			Coverage of institutional fixed benefit plans	5	16.08	Active push	1	15.59
				Opportunity	3	17.08	We integrate the green operation concept into the whole process of production and operation	1	15.59
				Adhere to energy saving	3	17.08	Opportunity	1	15.59
Coal P1=21 P2=3711 P3=799	Hydroelectric power	2	11.86	Yuan	38	10.37	11.77	34	11.77
	Holding subsidiaries and joint ventures	2	11.86	Hydropower	31	14.99	17.90	5	17.90
	investment ratio	2	11.86	Financial	28	16.44	17.91	5	17.90
Decarboni* P2=33	No hits			Environmentally friendly coal-fired power generation project	28	16.45	No hits		
				Built the first super-supercritical technology in the country and even in the world	2	18.08			
				Energy reduction data	1	18.08			
Emission P2=2396 P3=1188	No hits			Environmental responsibility	14	18.08	Reconstruction completion rate	10	17.91
				Reduce CO2 emissions	11	13.74	Greenhouse gases	7	17.39
				Power supply coal consumption	11	17.22	Sub-unit ultra-low emission transformation work	7	16.39
Fossil P2=76 P3=55	No hits			Need us to face together	2	13.76	Thermal power equipment utilization hours are further reduced	2	15.59
				Facing the contradiction between rapid growth of electric energy and limited environmental carrying capacity	1	18.08	It is expected that the new installed capacity will be slightly higher throughout the year	1	15.59
				Development and utilization of traditional coal resources	1	18.08	Reduce pollutants and greenhouse gas emissions per unit of electricity generation	1	15.59
Renewable P2=536 P3=326	No hits			Wind power	14	18.08	Front runner	5	15.59
				Thermal power	10	14.66	Promote the important task of ecological civilization generation	3	17.17
				Hydropower	8	14.60	Vigorously develop wind power	3	17.17
Sustainab* P2=1805 P= 1059	No hits			Stakeholder communication and participation	45	13.62	Concentrate on the development and utilization of energy-saving and emission reduction technologies	14	7.38
				Sustainable development strategies and actions	31	18.25	Actively promote major environmental protection	9	11.36
				Social responsibility	16	17.45	Actively carry out forward -looking research on technical topics	8	11.36

Table 27 Collocates of Sustainability LETs in Major Five and Minor Four corpus.

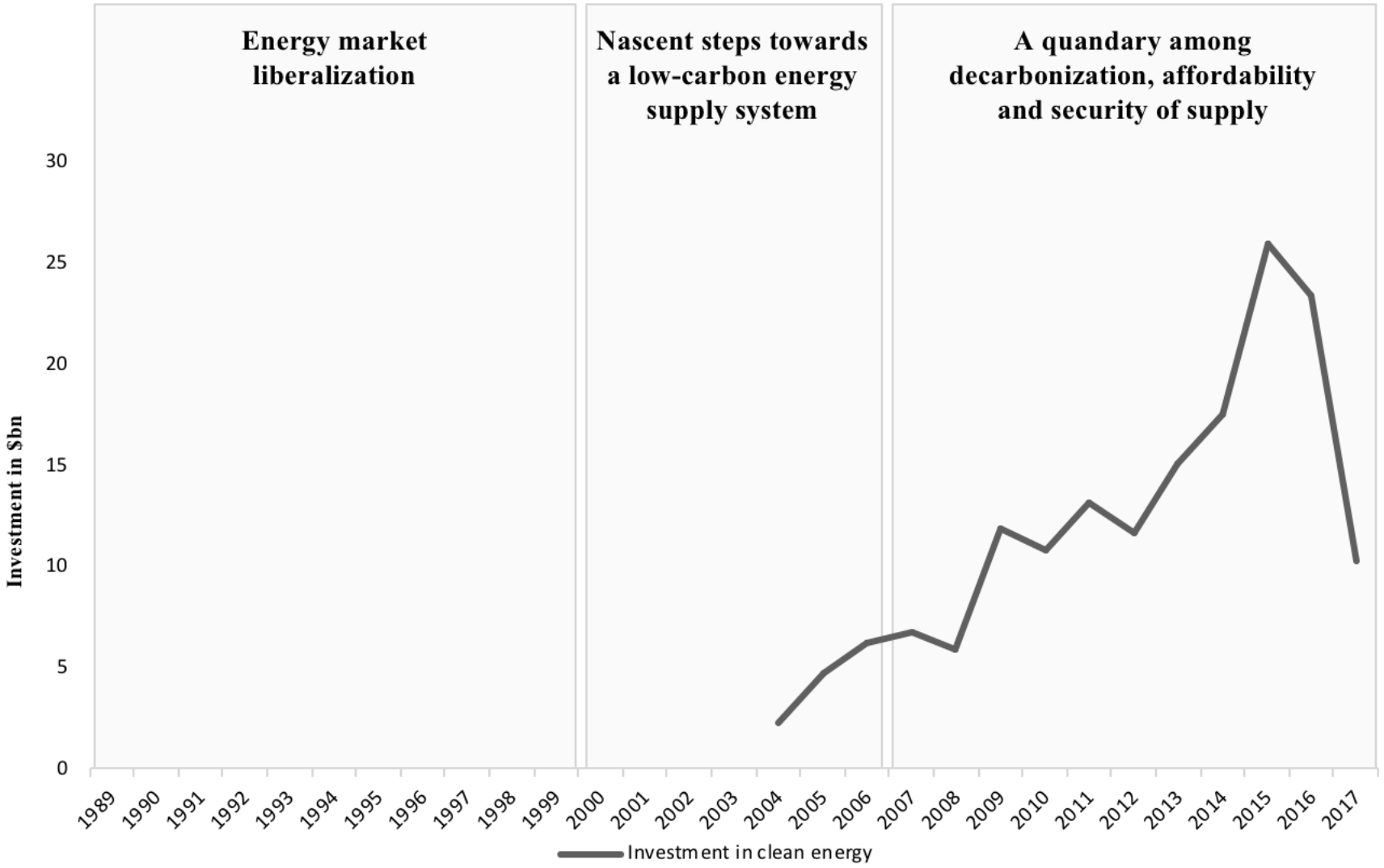

Figure 1 Renewable Energy Investments in the UK - Source: Louw (2018)

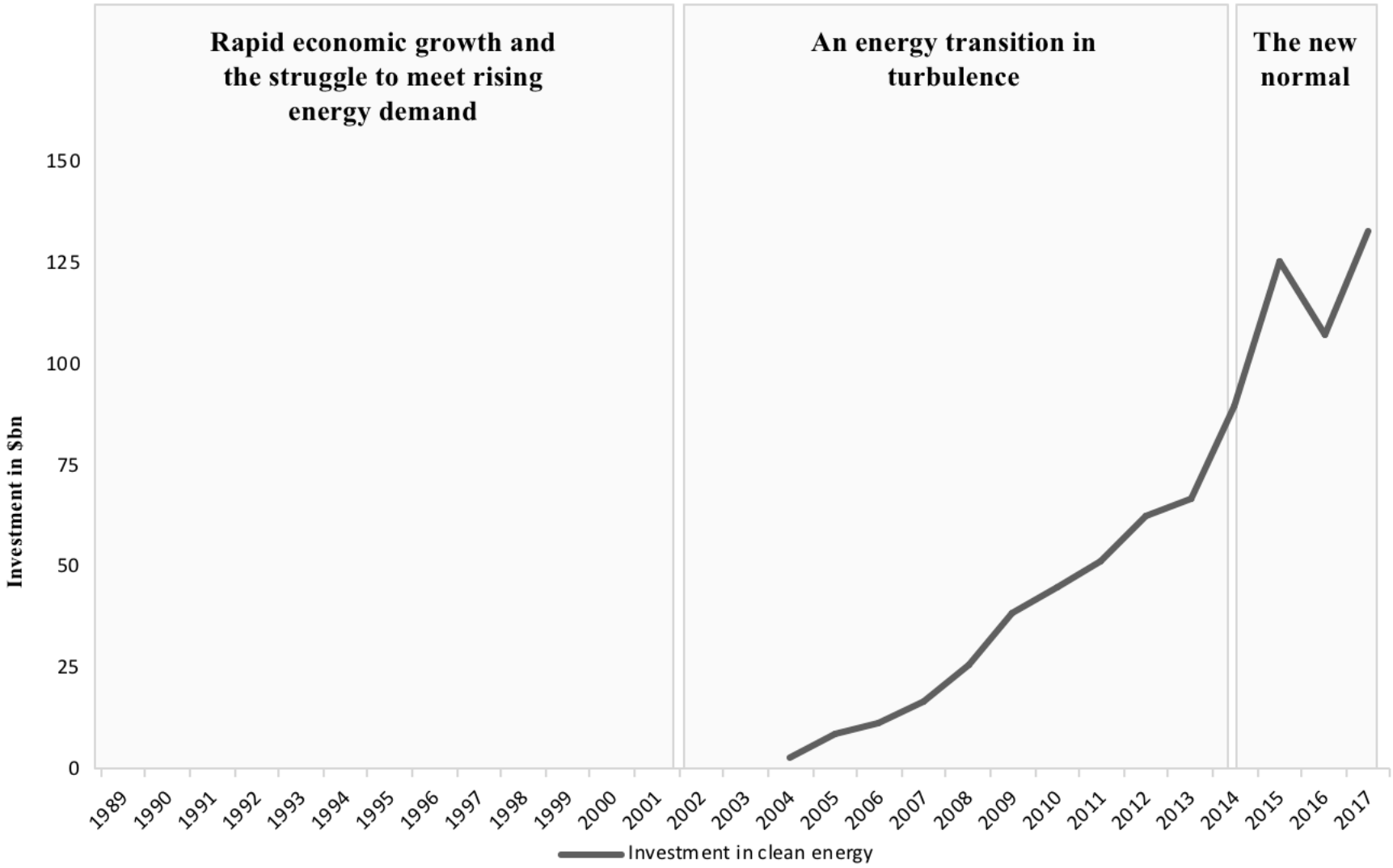

Figure 2 Renewable energy investment in China. Source: Louw (2018)