EXPLAINING CHINA'S RENEWABLE ENERGY INDUSTRY GROWTH: AN ANALYSIS OF STATE CONTROLLED ENTERPRISE EXPANSION

Thesis

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Abstract

It is evident that today the global energy landscape is shifting from the traditional carbon-intensive sources towards more renewable alternatives. According to UNEP (2017), global investments in renewables in 2016 totalled $241.6 billion. It is therefore important to understand the shift and the ever-increasing investments in renewable energy (RE). The thesis focuses on China to challenge existing explanations based on traditional models of RE sector transformation. Furthermore, China is currently the world's largest investor in renewables. It is argued that instead of post-materialistic voter preference changes or environmental policy shifts, China's RE expansionism is grounded on strategic industrialism by enabling state-controlled enterprise market dominance. RE is deemed to be an important sector for the formation of future value-added jobs and strategically pivotal in the context of upgrading China's existing industrial infrastructure (REN21, 2014). The period examined ranges from 1990 to 2016. The following methods were employed: qualitative interviews and archive-based process tracing. It was found that state-controlled enterprise growth and pre-eminence over the last few decades can be largely explained by government intervention and funding throughout the 2000s, both of which created disadvantageous conditions for foreign manufacturers. This gradually led to the ousting of foreign competition on a domestic basis and later allowed Chinese producers to consolidate their position globally due to propitious manufacturing capabilities.

Keywords: renewable energy development, state-controlled enterprises, strategic industry theory, authoritarian environmentalism

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Introduction

Over the last decade, renewable energy (RE) has begun to overwhelmingly impact the global energy markets and has led nations towards a more sustainable development-oriented path. The increasing global pursuit of RE is largely grounded on its potential to meet the present and future growing energy needs, and its ability to enhance energy security (Chien & Hu, 2008; Dent, 2015). According to the IEA 'the global share of renewables in primary energy supply in 2016 was 9%. Renewable energy supply has grown by 4% per year since 2000, double the growth rate of total primary energy demand' (IEA, 2017a, p. 295). However, the specific pathways towards attaining RE development vary on a per case basis.

For the developed democratic world, the pursuit of RE has been based on voter preference shifts in response to green movements and parties serving the interests of the voter basis to gain office (Bayulgen & Ladewig, 2016). In Europe, these voter preference shifts came about during the industrial decline in 1960s (Lester, 1995). However, China has pursued RE development even during its industrialization stage – something that does not comply with the traditional industrialization model. Energy innovations have played a vital role in China's economic development by preventing energy shortages and reducing imported energy dependence (Martinot, 2010). The established consensus holds that energy is the key factor required for industrial development (UNIDO, 1984). However, traditionally it is met by carbon energy. With the introduction of renewables in the mix, China is unique in this regard.

Ever since 1978, China has pursued policies and institutional restructuring to revitalize S&T as economic drivers (Amesheva, 2017). Whilst throughout the 1980s RE pursuit was limited, China picked up the pace 1990s by releasing the '*Outline on New and Renewable Energy*

Development in China' – the first official policy document focusing specifically on RE development (Qianyu, 2015). Throughout the 2000s, China became a net importer of RE products. In 2005, the Renewable Energy Law (REL) was promulgated and since then the RE sector has been regarded as strategically important to the economy (Eynde & Chang, 2013). A decade later, China has become the world's largest manufacturer and exporter of RE products (Dent, 2015). The Chinese government has identified RE as strategically pivotal in the context of upgrading its existing industrial infrastructure. Furthermore, RE is perceived essential for the formation of future value-added jobs (REN21, 2014). Unsurprisingly, in 2017 China spent more in RE investments than the remaining 9 out of 10 top investors combined (UNEP, 2018). China is therefore a pertinent case to examine and thus begs the question: what determinants are accountable for China's unique historical RE development and current leadership?

Hitherto, two competing accounts have been primarily used by academics to interpret RE policymaking and institutional development in the Global North. Ecological Modernization (EM) advocates that because pollution is expensive and hinders long-term economic development, environmental protection (EP) is required – be it in the form of RE or other measures (Gibbs, 1998). EM claims that EP can be more economically favourable in the long run than the business-as-usual (BAU) paradigm (Hayden, 2014). Contrarily, Ecological Kuznets Curve (EKC) suggests that going green is a consequence of economic growth, which shifts citizens' preferences towards post-materialist values thus resulting in increasing pressure from the populace towards the government to go for EP (Amesheva, 2017). Both theories discuss possible determinants that have contributed towards more rapid RE development. However, China's unprecedented history of RE development is unique and thus a new approach of Strategic Industry Theory (SIT) is introduced. SIT postulates that because energy is a) a pillar industry that makes up a sufficient amount of the

GDP and b) RE is picking up momentum on the global stage, RE development is therefore deemed an important industry for future economic growth (Dent, 2015).

The political economy literature on renewables has focused on policymaking and some institutional factors behind RE development in China (Chen & Lees, 2016; Amesheva, 2017). However, an acknowledged yet understudied aspect of China's sectoral expansion is state-controlled enterprise (SCE) development. The Thesis examines how institutional foundations and policies have affected SCE transformation and domestic dominance in the RE sector, and how said dominance has contributed to RE development in China over the period 1990-2016. The reason behind focusing on SCEs is that traditional models of RE development, which have worked for RE expansion previously, have not included SCE expansion into the overall equation. Therefore, the addition of SCEs presents a new model. However, even with its unconventional model in place, China is still able to lead the race. This study will thus attempt to answer the following RQ: **to what extent does SCE expansion and the dynamics behind it explain China's RE development?** It is argued that SCE expansion does play a significant historical role in explaining the growth of China's RE industry.

1. Literature Review

In this chapter, two fields of theory covering government decision-making concerning RE development are examined. Multiple determinants from RE literature that have influenced policymaking are identified and elaborated upon thus providing possible insights as to why China might have chosen to invest in renewables. Some aspects of different theories discussed in the following subsections overlap. Furthermore, academic literature explaining the advancement of renewables largely revolves around energy science and engineering, offering a technical

perspective. However, in the upcoming subsections a social sciences-oriented approach is taken, which provides a better glimpse into the reasoning given by governments, institutions and policymakers (Dent, 2015). EM and EKC covered below are most frequently employed theories to explain government support behind RE policies.

1.1. Ecological Modernization

EM is a set of theories, which suggest that sustainable growth can be achieved with continual reform and modification of existing economic constructs through the environmental prism, e.g. more prudent use of energy, water and raw materials (Mol, 2002). The development and remodelling of the energy sector through cleaner alternatives falls amongst said constructs hence the advocacy for greater RE progress. Long term, EM is argued to be more economically favourable and sustainable due to resource efficiency and evading costly negative externalities compared to the BAU paradigm. BAU places economic growth above all else whilst neglecting environmental degradation (Hayden, 2014). Discussed below, are the key determinants that according to EM literature have affected China's push towards renewables.

EM suggest that there is money in RE for businesses (Langhelle, 2000). Early market penetration has allowed for the first mover's advantage (Hayden, 2014) thus providing China with sustainable future market development, employment growth – in 2014 alone the RE industry accounted for 3.4 million jobs (IRENA, 2016) – and export opportunities. Furthermore, RE has been a response to GHG emissions. Pollution hampers market efficiency as 'it costs human lives and reduces people's ability to work' (UNECE, n.d.). It impedes the ecosystems' capacity to perform functions societies need (Langhelle, 2000). The substitution effect provided by RE tackles said issue and offers prolonged market efficiency. It is also suggested that sustainable growth is

more beneficial in comparison to the often-sporadic growth provided by fossil-fuels (Hayden, 2014). The variation of costs concerning photovoltaics (PV) and wind has been steadily decreasing (Timmons et al., 2014) allowing prices to be more predictable compared to fossil-fuel shocks.

The public perception of the Chinese populace vis-à-vis environmental protection has also changed. The Chinese populace has become more environmentally conscious and vocal about pollution issues. Environmental degradation has spurred political instability, which has directly affected Chinese leadership and the policy-making apparatus (Amesheva, 2017). The continuous anti-smog protests across the country have resulted in the introduction of intermittent smog-alerts during which manufacturers, including the fossil-fuels industry, are ordered to cut output to reduce pollution levels (Smith, 2018). Pressure from the international community has also been significant (Toke, 2017). Whilst China's move towards RE is perceived as being based on internal self-interests, international entities such as the UNFCCC and the WTO have been recognized to have influenced China's foreign policy apparatus by providing incentives and more favourable ruling to tackle pollution quicker (Kennedy, 2013).

EM appears to comply with promoting economic growth via the environmental prism rather well. It outlines socio-economic, socio-political and solely economic determinants. Regardless, it has its limitations. EM fails to explain China's decision-making in the past and provide a reason for the shift. Furthermore, it suggests that institutions can be restructured along ecological lines and away from purely economic reasoning (Gibbs, 1998). However, the theory is predominantly silent on the extent to which and how precisely such institutions can be reformed, especially in a non-democratic state model. Therefore, it does not provide a solid institutional explanation. EM also espouses a shift from top-down to flexible regulatory regimes (Carolan, 2010) thus making it less applicable to China's rigid top-down model. As feasible as EM might

seem, any ecologically sound forms of energy transition without defined and independent government intervention, e.g. authoritarian environmentalism (AE), are bound to be blocked by powerful corporate interests (Hayden, 2014). The EU serves as an example. Despite spearheading many progressive RE policies, the presence of the fossil-fuel lobby remains tremendous. In 2016, the gas industry spent €104 million to win political and financial support from the European Commission for new pipeline construction (Chapman, 2017) thus consolidating future use of gas instead of greater RE development.

1.2. Environmental Kuznets Curve

EKC argues that opting for environmental mitigation is an inevitable consequence of economic growth. Economic growth shifts citizens' preferences towards more post-materialist values thus resulting in societal pressure towards the government to enact more environmentally stringent policies (Li et al., 2016). As income goes up, an increasing level of environmental degradation can be observed yet only up to a certain point. After the point is reached, environmental quality starts improving (Amesheva, 2017). Concerning energy specifically, citizens are less likely to tolerate pollutants related to the fossil-fuel industry and thus publicly voice their opinions, grounded on post-materialism, for such alternatives as nuclear energy and renewables. Due to the improving standard of living that comes with economic growth, more citizens are likely to expend an increasing percentage of their income on RE funding/support to validate their preferences (Amesheva, 2017). Like EM, EKC too identifies several determinants.

The key determinant is post-materialism – as China's average income grows, the citizen's willingness to pay for environmental abatement increases too (Amesheva, 2017). Post-materialistic attitude towards the environment is also greatly affected by contingent events, i.e. a

surge in oil prices. When oil prices rise, the consumer preference for clean energy does too. As mentioned, the increase in income also leads the economy to inevitably undergo a structural reform. This transformation results in the composition effect, observed at the inverted U-curve apogee (Sugiawan & Managi, 2016). However, the structural reform must specifically concern the transformation from being resource-intensive to being technology-oriented, rather than the industry shift from an agricultural to a resource-intensive economy. The aforementioned composition effect leads to cleaner industry development resulting in lower pollution levels. Similarly to EM, EKC also outlines increased efficiency – R&D becomes more affordable after the technological industry shift and thus more financially appealing (Chien & Hu, 2008). RE offers greater energy efficiency (Hayden. 2014), which means higher effectiveness in production of goods and services.

Li et al. (2016) point out that openness to trade is accountable for the RE development boom as open trade creates opportunities for the agglomeration of talents and tech-transfers, including clean technology such as RE. Lastly, EKC outlines the rising middle class as justification for the government's policy shift towards greater RE development (Dent, 2015). High-carbon economic activity results in unfavourable social welfare effects. In 2017, the costs of lives in China were a gargantuan 12% of GDP (Bhattacharya, 2017). Correspondingly, Chinese citizens are becoming more politically vocal about pollution mitigation y

The main shortcoming of EKC is that it is based on the factor of inevitability, be it in the form of industry shifts or income. It further relies on the preference changes of the voting populace, which in theory ought to imperil governmental stability and incentivise government officials to carry out respective policies adhering to said preference changes. Literature suggests (Biresselioglu & Karaibrahimoglu, 2012; Aguirre & Ibikunle, 2014; Cadoret & Padovano, 2016)

that it might be sufficient for Western democracies reliant on party competition, but not for single party rule in present day China. China's policymaking apparatus does not entirely adhere to the construct of post-materialism but rather market effectiveness and solely economic prospects (Bailey et al., 2011). Lastly, EKC akin to EM fails to directly account for institutional change that could be responsible for shifts in RE development.

Overall, both EM and EKC literature present a number of valid economic, socio-economic and socio-political determinants that help explain progress concerning RE development. However, a large share of outlined determinants are not unique to China's case specifically and can be applied more generally. Both theories seemingly fail to answer why China's progress explicitly has been more exponential in comparison to others and why China is currently in a leading position. Whilst both concepts provide a number of determinants accountable for policy changes, there is still a huge gap in covering the institutional sphere. It is therefore imperative to provide an answer catered specifically to China's case. Therefore, a new theory with a different set of explanatory factors is introduced in the following chapter.

2. Analytical Framework

The following chapter takes a top-down approach. First, SIT is covered and argued to be the best fit in explaining China's decision for opting towards RE development. Then, an overview of AE is provided in order to explain the precipitancy of the RE development in China and why it has been able to overtake its competitors on the global stage. Lastly, the causal mechanism derived from SIT and AE explaining China's RE development is discussed.

2.1. Strategic Industry Theory

SIT concerns the state's promotion of specific industries considered essential to the nation's long-term welfare, prosperity and economic security. Industrial planning has been an imperative component of many East Asian social market economies (Dent, 2015). It has helped to cope with resource distribution-oriented market failures and to 'use various measures to influence resource distributions amongst industries to control, restrain and promote certain economic activities of private sector companies' (Ministry of Economy, Trade and Industry, 2010, p. 2). Most measures concerning industrial policymaking have revolved around institutional coordination of complementary investments, infant industry promotion, regulation of FDI and technology imports, and financing by venture capital to incubate new technologies (Chang, 2010). Many of these government support measures have also been introduced in different China's RE sub-sectors over the last few decades. One of the key measures, which will be covered more extensively further on, has been the favourable treatment of SCEs in the RE industry. It is argued that if the RE sectors were left to purely market-based measures, many would fail to become sufficiently commercialised to provide competitive prices.

SIT suggest that energy is a pillar industry that makes up a sufficient amount of the GDP (Chen & Lees, 2016). It is also noted that RE is picking up momentum on the global stage indicating that the demand for manufactured RE products is increasing globally (Toke, 2018). These factors combined make RE a pivotal industry (Dent, 2015). RE is a sector in which China possesses a notable level of realistic potential and industrial capability necessary to meet the increasing global demand accordingly. The ability to manufacture RE products more cost-efficiently and at greater quantities than current and potential competitors puts China in an economically advantageous position (Andrews-Speed, 2018). More control over the market allows

for greater regulation of supply, pricing, taxation and other parts of the production chain, hence the strategic importance.

Since RE is perceived as an indispensable future high-growth industry, it is expected to form the backbone of the Chinese economy in the later years to come and transform China from a 'global factory' to an 'innovative hub' (Dent, 2015). The intellectual basis provided by SIT for China funding RE development is that the state provides funding for covering relatively high initial capital costs, e.g. infrastructure or technological progress, to help infant industry commercialization with adequate futures grounded on substantial long-term returns for the public welfare and the economy (Timmons et al., 2014). Many RE sub-sectors are still regarded to be in their infant stages or as having experienced stunted growth because of insufficient funding in the past (Dent, 2015). Further reasoning for this is based on government estimations that maintaining the existing carbon-intensive modernisation path would slow down economic growth more than RE-oriented sustainable development (Chen & Lees, 2016). A study by Chien and Hu (2008) finds that RE increases future macroeconomic efficiency by the following: a) business expansion and new employment brought by RE industries results in increasing capital formation and b) the energy import substitution provided by locally produced renewables increases trade balance. The established consensus is that increases in capital formation and trade balance lead to an increase of GDP. Doubling the share of RE in the global energy mix by 2030 would increase the global GDP by up to 1.1% (IRENA, 2016). A lot of the upcoming increase is attributed to China's potential capacity (Chen & Lees, 2016).

Furthermore, China's RE pursuit can be partially explained by the perception of the negative externality costs. Whilst China has a large fossil-fuel lobby, the energy prices of fossil-fuels have been argued to more accurately factor in the costs of pollution, land degradation and

diminishing welfare of the population as of late (Timmons et al., 2014). Regardless, China remains amongst the leading supporters of fossil-fuel subsidies, be it at a declining rate (IEA, 2017b). The phasing out of inefficient subsidies has allowed for greater RE subsidising and more realistic reflection of fossil-fuel costs. Ellis (2010) suggests that a complete subsidy reform would result in an average of 0.7% GDP increase per year in non-OECD countries until 2050. A subsidy shift is therefore grounded on economic self-interest. The industrial planning has been focused on internalizing externalities to reflect the social costs of each energy source thus levelling the playing field and providing a more so realistic image of the viability of RE. One of the most important determinants preventing global RE transition has been the failure to account for the aforementioned externalities (Timmons et al., 2014). The feigned ignorance of many developed nations has led to more stunted development of the RE industry, despite the capacity for RE development being present (Bogaert, 2010). However, discussing China's ability to better absorb the costs of externalities is outside the scope of this Thesis.

Several lesser determinants are responsible for China's RE development too. According to SIT, potential rural economic growth is accountable (Eynde & Chang, 2013). Increased RE availability promotes economic development in remote rural areas by bypassing the need for expensive electrical grid construction to promote sustainable economic growth. Similarly to EM and EKC, improving energy efficiency is also outlined under SIT as one of the factors. Greater efficiency achieved via RE development reduces energy demand resulting in lower pollution levels and allows for more effective provision of goods and services (Dent, 2015). The final reason is energy security (Meidan, 2014). High growth rates in energy demand are rapidly depleting China's indigenous energy resources and increasing the inherent risk of being dependent on foreign supply (IEA, 2017a). Therefore, new alternative sources that are available domestically, i.e. solar, wind,

hydro, have been increasingly perceived as necessary substitutes. Contrarily, Toke (2017) posits that the transition is more so focused on 'energy security through manufacturing', which is based on economic reasoning. The gains via RE manufacturing are estimated to amount to 3.4 % of China's GDP by 2050 – significantly larger than the contributions expected from the steel and agriculture sectors (Dai et al., 2016). Regardless of the different arguments, China is still the world's largest coal and oil importer (IEA, 2017a). Albeit in relativity to other nations China's energy import dependency ratio is rather low (16% in 2015), it is anticipated to increase thus making China more vulnerable to foreign supply.

In short, SIT focuses on promoting industries of strategic importance via institutions by controlling, restraining and endorsing certain economic activities and pertinent policies. In the case of RE, which has been recognised as a pivotal strategic industry, complementary government investments have been the primary employed measure. However, SIT on its own is insufficient to explain why SCEs have been so successful in China and not elsewhere hence the introduction of AE. AE has historically helped prevent lobbying and corporate interests from stunting RE growth – something that EM frequently fails to address.

2.2. Authoritarian Environmentalism

AE is defined as a 'public policy model that concentrates authority in a few executive agencies manned by capable and uncorrupted elites seeking to improve environmental outcomes' (Gilley, 2012, p. 288). AE argues that an authoritarian institution-oriented approach is more capable of tackling negative environmental externalities in the short run, and better optimized to carry out established environmental objectives such as meeting RE targets compared to the free market-oriented approach of democratic environmentalism. AE excludes business actors and other

groups from participation, because they are mostly opposed to environmental actions, especially ones that require rapid response, often incompatible with what is dictated by market forces (Gilley, 2012). China fits well within the AE framework as its political response to the global push for RE has revolved on the top-down regulatory powers of the institutions within the central state (Meidan, 2014). AE's effectiveness is grounded on the state's ability to immediately respond rather than allow market factors to determine the end outcome. More precisely, the state allows market activities to take place confined within the limits of the established framework (Gilley, 2012).

Evidently, AE provides a more stable foundation for both environmental and energy policy enactment, and rapidly tackling such issues as energy security or environmental degradation. Market forces alone are deemed too slow or too vested in self-interests to respond accordingly and on time (Gilley, 2012). AE therefore introduces the measure of state intervention in RE market. However, it is important to note that AE alone is not enough to explain China's RE development boom. Rather, it is but one of the supporting gears in the larger mechanism. As will be argued later, SIT is held accountable for China's reorientation from a heavily carbon-focused energy path to one that includes sustainability and RE. SIT essentially illustrates why China initially went for RE and AE explains why RE development has been more rapid and successful compared to China's Western counterparts.

2.3. China's Renewable Energy Development Causal Mechanism

SIT appears to provide the best answer for the SCE dominance in RE sector – RE is a pivotal industry whose state-backed expansion and further development is based on future economic growth, and potential global market domination rather than inevitability or post-materialistic values. It works for China specifically because of AE, which prevents powerful

corporate interests from meddling in the 'GDP-growth-induced' RE industry transition via government intervention. The industrial policy tools used under SIT primarily fall into three subsections. First, there is financial support for innovation and R&D, e.g. the commercialisation of 2-3 MW wind turbines and grants for wholly owned enterprises manufacturing RE (Zhang et al., 2013). Secondly, the state maintains financial backing of RE technology manufacturing via agencies by offering import tax exemptions for complete sets of equipment manufactured abroad and providing financial injections to top domestic solar PV and wind turbine manufacturers (Zhang et al., 2013). Lastly, there is the local content requirement, which forces RE manufacturers to source a specific share of products from local suppliers (Martinot, 2010). All of these policies combined fall in between government funding and state intervention in the RE market. It is expected that both complementary investments outlined by SIT, and government intervention outlined by AE, are contributing dynamic factors in explaining SCE expansion and will further be examined in the empirical part.

Depicted below in *Figure 1* is the expected causal sequence. It is anticipated that state intervention enforced by AE results in unfavourable conditions for foreign RE competitors. Both of these factors combined alongside increased state funding of domestic RE industry are expected to allow SCEs specialising in RE to make a domestic market breakthrough. Subsequently, the dominant domestic SCE market position created by government intervention, funding and the omission of foreign RE manufacturers is anticipated to lead to Chinese SCE pre-eminence globally. Note that SCE dominance in the RE market is but one of the many determinants of the complex framework accountable for China's RE development. Furthermore, the term 'SCE' is used to refer to both state-owned and private enterprises that have benefitted from government support. Using

solely state-owned enterprises would exclude RE beneficiaries that are not directly owned by the state yet play a vital role behind China's RE development.

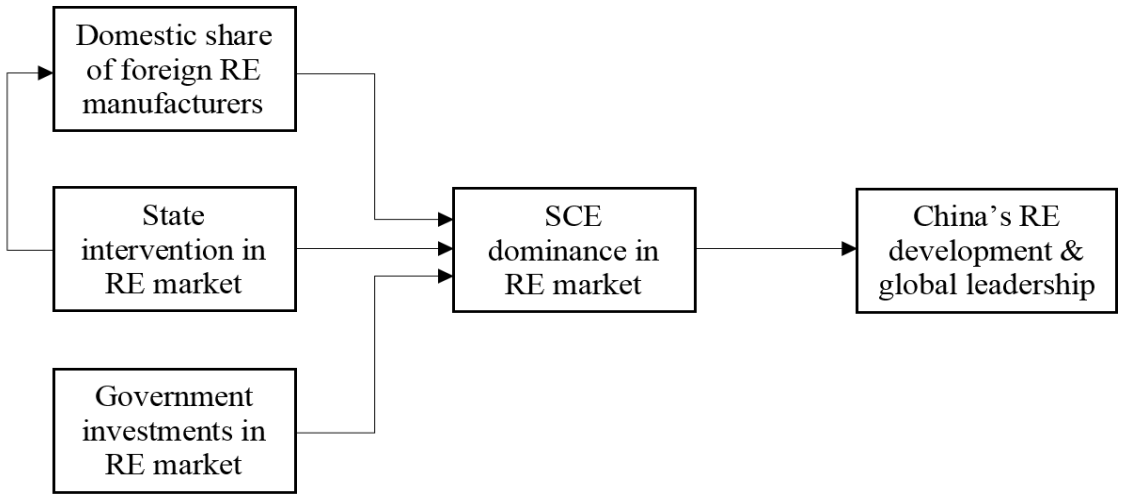

Figure 1: Causal mechanism for RE development in China. Source: Author.

Three primary causes for the current SCE market dominance of RE have been identified. First, as outlined by AE, state intervention via the National Development and Reform Commission (NDRC) has allowed China to actively mediate the market by controlling energy prices and reallocating resources when necessary (Chen & Lees, 2016). SCEs have also been sanctioned for failing to reach their tasked market shares, thus RE enterprises are obliged to follow a set path. Nonetheless, this has led SCEs to have an early comparative advantage over their foreign competitors. After REL of 2006, SCEs began receiving significant amounts of government support in forms of tax breaks, cheap financing from state banks and subsidised land (Kennedy, 2013) therefore also putting them on the track for more rapid growth. More precisely, this SIT-based funding allowed the currently dominant SCEs (e.g. Goldwind, Jinko Solar) to purchase foreign technologies for further innovation rather than to rely on the spill over effects. The last factor is

the gradual domestic decrease of foreign RE manufacturers. Although China encourages foreign investment in RE on paper, negative incentives on foreign participants in the past, such as localised protection measures, e.g. manufacturing localisation rate being at 70% (Chen & Lees, 2016), have gradually made more of the market share available for SCEs and increased the entry barriers to outside investors. The fact remains that the 'Chinese government has often tilted the playing field toward domestic firms, marginalizing foreign competitors (Kennedy, p. 919). It is argued that said factors combined have allowed Chinese SCEs to take up dominant positions in the domestic market and due to government backing consequently compete on the global stage.

3. Research & Methodology

The Thesis follows a single case study design which employs one of the three key variants of process tracing – 'explaining outcome' (Beach, 2012) – in order to explore the causal narrative. A single case study was chosen because China's historical RE development path is unique and difficult to apply on a broader scale thus making a multiple case study trivial. The chosen period is 1990-2016. That is because the 1990s are largely considered to be the starting point of the RE manufacturing in China (Toke, 2017) and the starting point of the liberalisation of energy (Andrews-Speed, 2018). One could argue that the 1980s would be a more suitable, however, the energy market was in a transitional phase, lacking in both energy regulation and legislation (Qiu & Li, 2012). In the early 90s, the market became competitive and inclusive of foreign rivals. However, in 2006, after the REL was enacted, RE was deemed a strategic industry by the Chinese government, and SCE market dominance became gradually more apparent. The study focuses on three dimensions of RE: (1) China's institutional foundations concerning renewables; (2) the

specific policies that have historically influenced RE development; (3) China's RE manufacturing market expansion and SCE dominance.

The following qualitative data collection methods, as covered by Marshall and Rossman (2006), are utilized: in-depth interviewing, context and review of documents, historical analysis. A single case study is chosen because China is an outlier with reference to market dynamics and SCE expansion in the RE sector. Some of the data was collected using the 'snowball method' via interviewing key informants. The interviews allowed to gather data about a) greater state intervention in the RE market and how that has affected SCE development and b) China's strategic industrial policy regarding RE development. Historical analysis and archive research is used to gather data on the remaining two dimensions about China's institutional foundations in relation to RE and specific policymaking concerning RE development. More specifically, China's NDRC and the National Energy Commission (NEC) will be examined as they are deemed the two key policy-making institutions for RE development (Gilley, 2012). To track China's RE development progress and accession to leadership the following will data is used: (1) Global Wind Energy Council Reports (GWEC) (2006-2016); (2) IEA Photovoltaic Power Systems Programme Reports (2006-2016).

The reports contain data concerning China's global market share changes in both wind and solar PV industries, and their yearly changes in installed and cumulative capacity vis-à-vis the global market. Data that are more precise could be obtained from 'GlobalData' or 'Statista'. However, financial limitations have prevented further access. Wind energy and solar PV were chosen based on having experienced the most significant overall growth and direct impact from RE policy reforms (Toke, 2017), and playing the most vital role in decarbonisation (Liu Xianbing, personal communication, May 8, 2018).

4. Empirical Analysis

The aim of this chapter is to establish the empirical validity behind the proposed analytical framework. In the following subsections the institutions responsible for RE progress in China are covered, after which the pivotal policies are be scrutinized. Lastly, reports from the IEA-PVPS and GWEC are be examined to assert the dominance of China's SCEs both domestically and on an international level.

4.1. Institutional Foundations of Renewable Energy in China

Historically, China's institutional development concerning RE has not followed a single fixed timeline. Even presently, no single governmental institution is in charge of the overall RE policy development and implantation (Liu, 2017) thus making the institutional restructuring proposed by EM even more difficult. This has resulted in separate governmental entities undertaking different yet sometimes overlapping functions thus making it challenging to identify the pivotal ones responsible for RE development correctly (Xinyu et al., 2011). However, two particular agencies can be outlined throughout the period chosen for the analysis – the NDRC (see Appendix A) and the NEC (Schuman & Lin, 2012).

The energy market's reform began in 1978. However, the government's primary focus until the 90s was tackling supply shortages across the country and solving grid inefficiencies thus leaving little space for technological development concerning alternative energy sources (Bogaert, 2010). Therefore, 1993 is chosen as the exploratory starting period. In 1993, after the discontinuation of the Ministry of Energy, the NDRC and the State Economic and Trade Commission (SETC) were assigned the ministerial responsibilities of managing the country's energy (Liu 2017). Nonetheless, in 2003, the SETC was dissolved (NPC, 2003). 2003 was an

important shifting point for RE policies due to the new incumbent president Hu Jintao. Much of Jintao's campaign was grounded on technological innovations, including the energy sector and exploration of alternative energy sources (Liu, 2017). With his arrival to power, the country shifted its focus towards energy diversification. The change in leadership was largely accountable for the shift rather than EKC's proposed economic growth apogee. Continuing, in between 1993-2003, SETC and NDRC were responsible for the energy policy coordination and implementation. However, after the dissolution of SETC, the NDRC was left to deal with the majority of the energy sector until 2010. This included the expansion and governmental support of the RE manufacturing industry. In 2010, the NEC was established and deemed the highest standing energy agency (Liu, 2017) 'responsible for the research and formulation of national energy development strategies … and coordinating domestic energy development and international energy cooperation (NEA, n.d.). The full framework for RE development under the State Council consists of the following: the NEC, the NDRC, the Ministry of Finance, the National Energy Agency (NEA), the Ministry of Science and Technology, and the State Electricity Regulatory Commission (Liu, 2017).

The NDRC is China's top policymaking body in charge of drafting and implementing strategies of economic and social development (NDRC, n.d.). As of 2009-2010, the NDRC has also been bestowed the responsibility of providing developmental aid to strategic emerging industries (Andrews-Speed, 2013). The '*Strategic Emerging Industries Key Products and Services Catalogue*' released in 2013 (NDRC, 2013) specifies that RE industry development is necessary to control GHG emissions (see p. 20). Further argumentation is based on the innovation factor – going in line with Dent's (2015) mentioned innovative hub claim – and the strategic necessity of the smart grid initiative (see p. 27; 73). The catalogue places focus on several other industries expected to be imperative to future economic progress (NDRC, 2016). It is evident that the NDRC

is responsible for the imperative, or as SIT suggests 'pillar' industry promotion. According to Geoffrey Chen (personal communication, April 22, 2018), favourable RE policymaking specifically has been grounded on providing assurance 'so investors have more capacity and trust in the future growth of the sector' (see Appendix A). Strategy implementation, however, has revolved around limiting foreign player participation (G. Chen, personal communication, April 22, 2018), be it via the local content requirement – 70% of the components used in manufacturing wind turbines must come from the domestic market (NDRC, 2007) – or other measures, thus making way for greater domestic SCE market dominance. Contrarily, EM and EKC covered earlier fail to address how domestic competitiveness might play a role in the expansion of the RE industry. As mentioned, the NDRC is also responsible for market intervention via energy price control and resource reallocation. Evidently, after the dissolution of the Ministry of Energy, the NDRC was the institution that laid much of the groundwork for the RE industry in the years to come.

Whilst the responsibilities of the NDRC primarily revolve around the energy industry on a broader scale, as of 2010, the NEC is in charge of specific planning for different energy sources (NEA, n.d.). Much of the RE development after 2010 is attributed to the NEC's industrial planning (Xinyu et al., 2011), and the distinct type of governmental support in comparison to the EU after the 2008 financial crisis (D. Toke, personal communication, April 25, 2018). The Ministry of Finance, however, is the key institution that has been in charge of the investments behind SCE's. It is stated that 'the special funds for the development of renewable energy shall be managed by the Ministry of Finance in conjunction with relevant departments'. Specifically, Article 8, Section 2 indicates that the special funds are meant for the 'development and utilization of renewable energy and capacity building' (Ministry of Finance, 2015). The two remaining institutions from the framework – the Ministry of Science and Technology and the State Electricity Regulatory

Commission – are responsible for the technological development of RE and price setting (Martinot, 2010).

Summing up, the sequential timeline is the following. Throughout 1993-2003, RE development was lethargic (Zhang et al., 2013) as the bilateral cooperation between the NDRC and the SETC was full of ambiguity due to lack of institutional structure. The leadership would frequently transfer authority from one agency to another and provide market uncertainty for investors (Liu, 2017). Furthermore, the projects in the early 90s were primarily small-scale, used for rural electrification and lacking in political support (Andrews-Speed, 2018). Foreign competitors in domestic market were commonplace and often more efficient than their domestic counterparts (D. Toke, personal communication, April 25, 2018) thus preventing national manufacturers from making a breakthrough. However, after the electrification of the rural-areas, the interests shifted to bulk RE generation on centralised grids (Martinot, 2010). Things took off from 2003 (see *Figure 5*) with the arrival of the of the Jintao government, which declared that their first priority for the development of renewables was industrial, grounded on the need to be an industrial leader at a global scale (State Council, 2006a). For the period of 2003-2010, the NDRC was chiefly responsible for providing support to the entire supply chain – R&D, manufacturing, deployment and exports. During this period, the most exponential RE development can be observed. The two focal points of this time-period were 1) the enactment of 2006 REL and 2) the 2008 financial crisis. After REL was passed, a clear framework was set in place, allowing for AE-grounded government intervention and energy price setting to help the emerging domestic RE manufacturers (Liu, 2017). This resulted in decreasing levels of foreign competition. Contrary to Western economies, where austerity measures were the chosen strategic path, the Chinese government eccentrically 'provided a stimulus package to subsidize a lot of … wind and solar

power projects' (see Appendix A) after the crisis via the special funds discussed earlier. This further helped SCEs both domestically and globally. More steady development can be observed throughout 2010-2016 (Statista, 2018a), after the formation of the NEC. SCEs had already consolidated their position as the prevalent force of the domestic market and had even greater annual investments set for future RE industry expansion (State Council, 2011) thus slowly expanding global RE market share.

4.2. China's Renewable Energy Policymaking

Much like institutional change, China's policymaking has historically played a substantial role in promoting RE development and the consolidation of SCEs. Despite previously outlining REL as pivotal, the country's policies on overall RE development date back before that. As mentioned, the '*Outline on New and Renewable Energy Development in China of 2010*' passed in 1995, is frequently considered as the first policy document to focus on RE entirely (Xinyu et al., 2011). Many policy documents leading up to 1995 have also been responsible for the ongoing though minimal RE development of that time (NREL, 2004). As discussed, much of the progress throughout 1993-2003 was limited. That is because policy documents concerning RE development were vague on the actions that needed to be taken to promote aforementioned development (Andrews-Speed, 2018). Furthermore, the focus was primarily placed on dealing with increasing energy demand and tackling power outages across the country.

The policies on RE development fall into three primary categories. The central government establishes the first two levels whilst provincial and local governments are left with setting up the third level with the overall direction from the previous two levels (NREL, 2004). *Figure 2* provides a basic overview of how policymaking and implementation works in China.

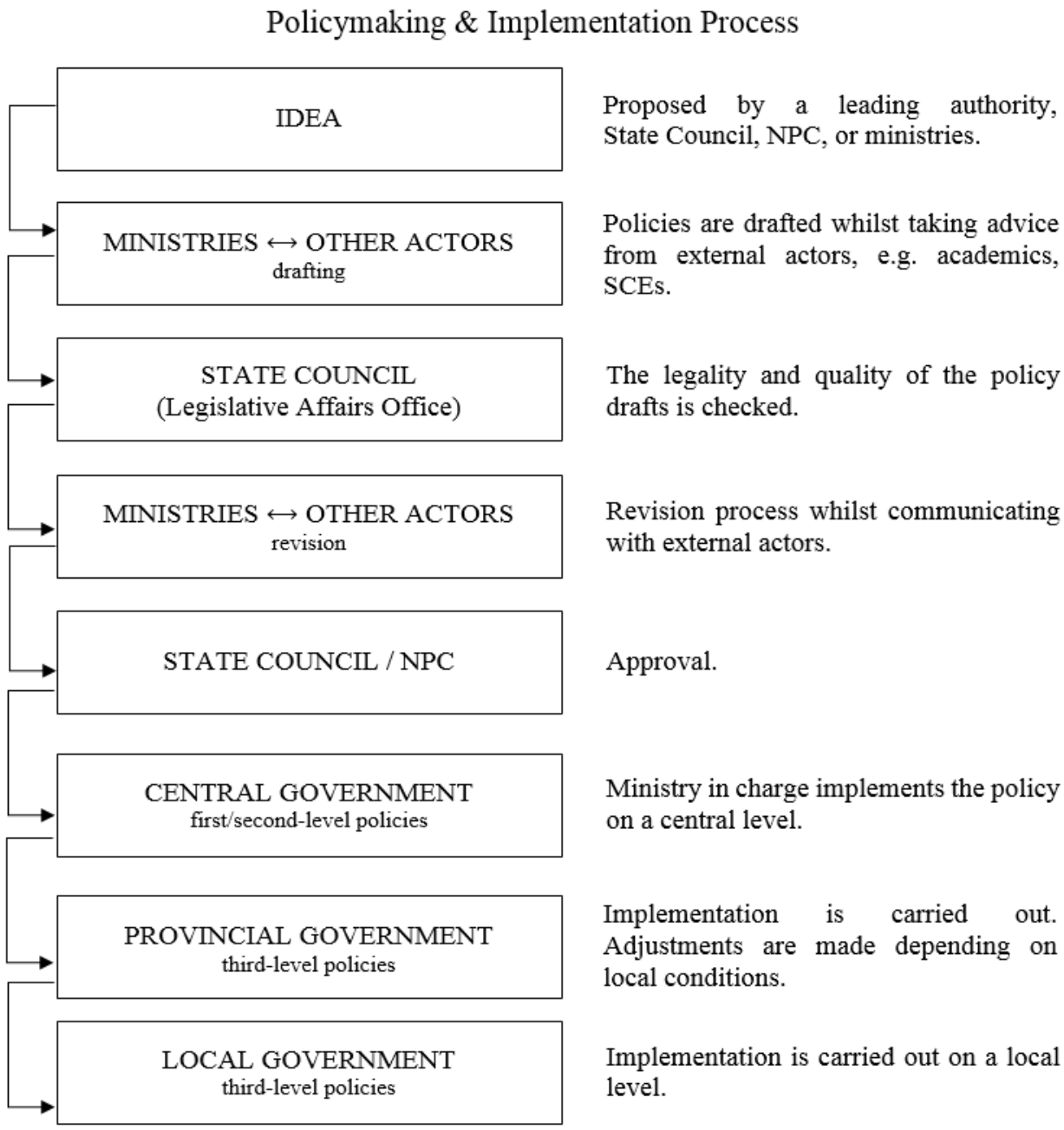

Figure 2: Policymaking & Implementation Process. Compiled by author, source: Kreab (2013)

First-level policies provide guidance, general direction and the government's overall standpoint. REL is a first-level policy, which was directed by the keystone RE agency of that time

– the NDRC (NREL, 2004). In 2006, when the policy was enacted, the country had a nearly non-existent capacity originating from biomass, solar and wind power, largely because the fossil-fuel industry was historically considered one of the economic pillars (Toke, 2018). Prior leadership was set on the BAU model and unwilling to risk facing large initial capital costs required to harness alternative energy sources that were yet to receive global acclaim (Eynde & Chang, 2013). The arrival of the Hu Jintao government changed that. New leadership perceived the fostering of the RE industry as a way of tackling increasing energy imports, pollution and energy shortages. By 2012, the capacity had grown to almost 70 GW in the respective energy sources, because of the changes that came about with the introduction of the law and its amendment in 2009 (Kennedy, 2013). More precisely, REL established a framework of responsibility – the national government was required to form non-ambiguous development targets, financial-guarantee measures that the market could use and strategic plans for RE development (Schuman & Lin, 2012). The law also provided economic incentives and penalties to SCEs to follow set targets thus rewarding them for progress and sanctioning in cases of failure (Chen & Lees, 2016). This was possible largely due to AE. EM's proposed flexible regulatory regime would not have worked with mandatory implementation or achieving strictly defined targets.

Several specific provisions are chiefly held responsible for REL's success. One of the key arrangements required electric utilities to purchase power from RE generators (NPC, 2009). This obligation did not exist prior to the enactment of REL. Furthermore, a national mandatory cost-sharing mechanism was also introduced whereby consumers were obligated to pay for the incremental costs of RE. The addition of the feed-in-tariff mechanism of fixed premium prices alongside with the mandatory local content requirement allowed for emerging RE manufacturers to have early market security. Lastly, with the introduction of the 'mandated market share' it was

specified that a defined portion of RE was required of national power generation companies (NPC, 2009). This meant that national power generating companies of that time were required to either generate a certain share of RE themselves, or 'purchase specific shares of their power from renewable sources' (Martinot, 2010, p. 289). The 2009 amendment provided better-defined guidelines for achieving set targets, and synchronised provincial level development with national development plans thus eliminating many present inefficiencies (Schuman & Lin, 2012).

Then there are the second-level policies, which work as specificities after the first level by establishing clearly defined goals, development plans and objectives (NREL, 2004). Second-level policies are considered primarily accountable for much of the developmental success. For example, REL introduced the mandated market shares of RE, yet it was the 2007 '*Medium and Long-Term Development Plan for Renewable Energy in China'* that set the specific shares for national power generators (Martinot, 2010). Several other second-level policy documents have to be acknowledged. According to Chen (personal communication, April 22, 2018), the '*National Medium and Long-Term Programme for Science and Technology Development*' for 2006-20 is chiefly responsible for the speed of RE development after 2006. The programme listed two priority topics, which were seen as 'critical to economic and social development and national security and in dire need of S&T support' (State Council, 2006b). Energy development was listed as first. The reasoning behind RE being a priority was the following:

> Our country is currently suffering from sharp discrepancies between energy supply and demand, an irrational energy structure, and low energy efficiency, with a predominantly coal-based primary energy consumption, resulting in severe environmental pollution. Over the next 15 years, meeting the fast growing demand for energy and for its clean and

> efficient utilization constitutes a major challenge for the development in energy-related science and technology. (p. 3)

In the document, multiple explicit targets along with the necessary funds required were identified. The Jintao government announced that the framework set up by the policy report is crucial for the growth of 'indigenous innovation' in China (Kennedy, 2013). Contrarily, Andrews-Speed (2018), argues that it was the '*11th Five-Year Plan Outline for the People's Republic of China on National Economic and Social Development*' that was responsible for the rapid developmental pace of the last decade. The plan provided insights into the mechanisms needed to utilise to achieve the set targets, e.g. local governments being required to provide cheaper access to land for RE manufacturers, cheap electricity and other loans (Andrews-Speed, personal communication, May 07, 2018). Andrews-Speed has stated (2018) that 'if the government wants something done it throws money, it gives orders, and it sets targets'. This closely depicts the proposed framework of SIT in combination with AE rather than the decision-making suggested by EM and EKC. In addition, whilst much of the support for RE manufacturers came from a local level, 'they would not have done it unless there was a push right from the top' (see Appendix C). Even so, there is a myriad of different second-level policy documents accountable for enabling innovation in the RE sector.

Lastly, there are third-level policies, which are currently less relevant in the grand scheme of things and 'consist of practical and specific incentives' on a local level (NREL, 2004). Most third-level policies were pivotal in helping RE sprout out from its early developmental stages in 1990s-2000s (Zhang et al., 2013). Unfortunately, since they were set on a local/provincial level, it is impossible to outline a single one responsible for the entirety of the developmental progress

without creating a completely separate framework, which is outside the scope of this Thesis. Overall, much of developmental success policy-wise over the period of 2003-2010 can be attributed to the framework set out by REL. REL helped provide market certainties for new entrants, oust foreign competition via local content requirement, and coordinate RE development on both national and provincial levels thus eliminating the then present inefficiencies. *Figure 3* demonstrates how after REL the market share of domestic wind turbine manufacturers began to grow more exponentially. This resulted in decreasing levels of foreign competitors due to higher entry barriers and thus led to joint-venture establishment.

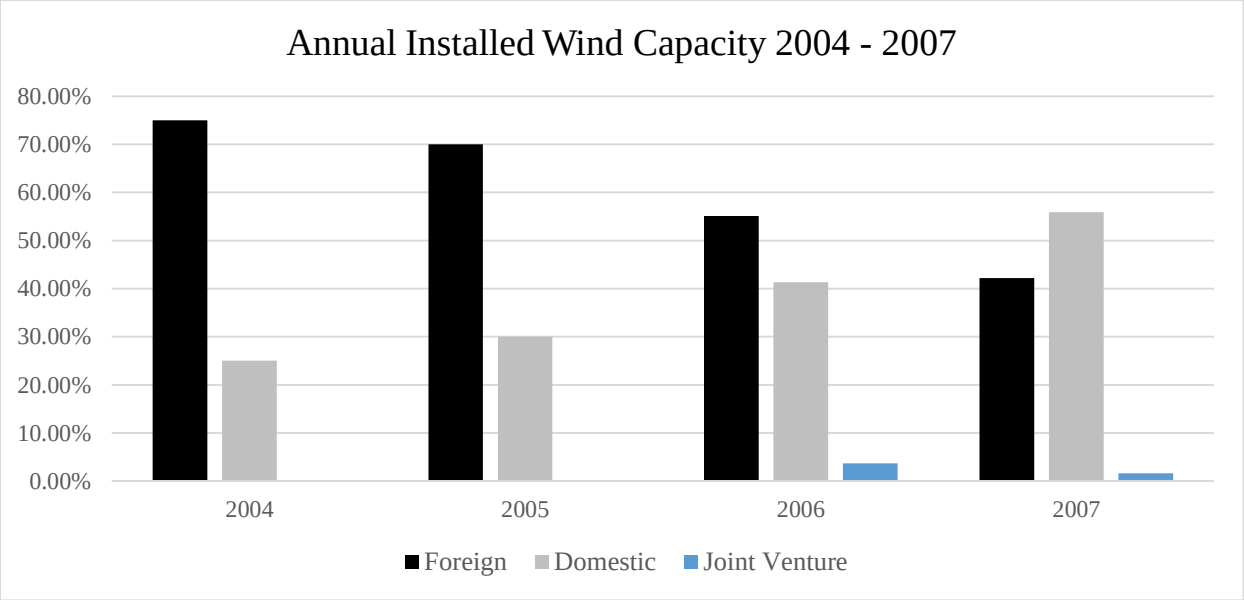

Figure 3: Annual Installed Wind Capacity 2004-2007. Compiled by author, source: GWEC (2013)

As a result, an abundance of more well-defined second-level policies followed, which established specific targets and detailed mechanisms of how said targets are to be achieved. Most importantly, the second-level documents brought about fund-management and rigorous investment allocation, which helped SCEs acquire the necessary financial backing to make a

breakthrough domestically. As Andrews-Speed has put it, 'state support has been critical particularly for the rapid nature of this [RE] growth' (see Appendix C).

4.3. State Controlled Enterprise Market Expansion

As outlined earlier, the 2008 financial crisis and the decision making of the Chinese government played a pivotal role in enhancing the dominance of RE manufacturers both domestically and globally (C. Chen, personal communication, April 22, 2018). On November 18, 2008, Premier Wen Jiabao stated that 'historical experience shows that economic crisis often breeds a new technological revolution' (State Council, 2009). Wen noted that other nations were 'accelerating the promotion of green and low-carbon technologies as a symbol of the energy revolution'. Similarly, vice chair of the NDRC Xie Zhenhua remarked that China was facing 'huge pressure from the developed nations' (as emphasised by EM earlier) as they 'are in a favourable position concerning international low-carbon economic competition due to their financial and technological superiority' (State Council, 2010). In 2010, Chinese SCEs specialising in RE manufacturing – particularly wind turbines – had already consolidated their market position domestically due to the previously enacted favourable policies and institutional decision-making. After the crisis, many Western nations imposed austerity measures to stop financial aid procedures, e.g. the feed-in-tariff for energy originating from renewables (C. Chen, personal communication, April 22, 2018), therefore consequently harming local RE manufacturers. Contrarily, China 'provided a stimulus package to subsidise a lot of the national infrastructure projects, and a lot of these projects were actually wind and solar power projects' (see Appendix A). The stimulus package totalled at 4 trillion RMB from which almost 0.6 trillion RMB were allocated amongst the RE industry (NDRC, 2009)

Whilst many of the foreign RE manufacturers lost momentum on the global stage, Chinese SCEs picked up the pace (D. Toke, personal communication, April 25, 2018). It was the Chinese government's investments in the RE market during a crucial timeframe that allowed SCEs, primarily solar PV manufacturers, to take up a dominant position after the crisis and obtain a larger market share (Kennedy, 2013). Particularly, the '*12th Five-Year Plan for Energy Science and Technology Development'* was responsible for establishing the funding available for research and development (Andrews-Speed, personal communication, May 7, 2018) that gave the already domestically consolidated SCEs the cutting edge globally. As mentioned, the majority of the momentum can be divided into two periods: 2003-2010 and 2010-2016. Since standardised data concerning wind turbine production prior to REL is unavailable, the periods for analysis have been divided into 2006-2010 and 2010-2016. Overall market share growth since the promulgation of REL in 2005 can be observed for both wind turbine and solar PV module manufacturers. However, the two industries differ. Solar PV module manufacturing has experienced growth over both periods. During 2006-2010, the growth was more exponential (see *Figure 4 & 5*) both in terms of achieving a larger global market share and total output. The latter period experienced more steady growth concerning global market share, yet total output levels remained much the same.

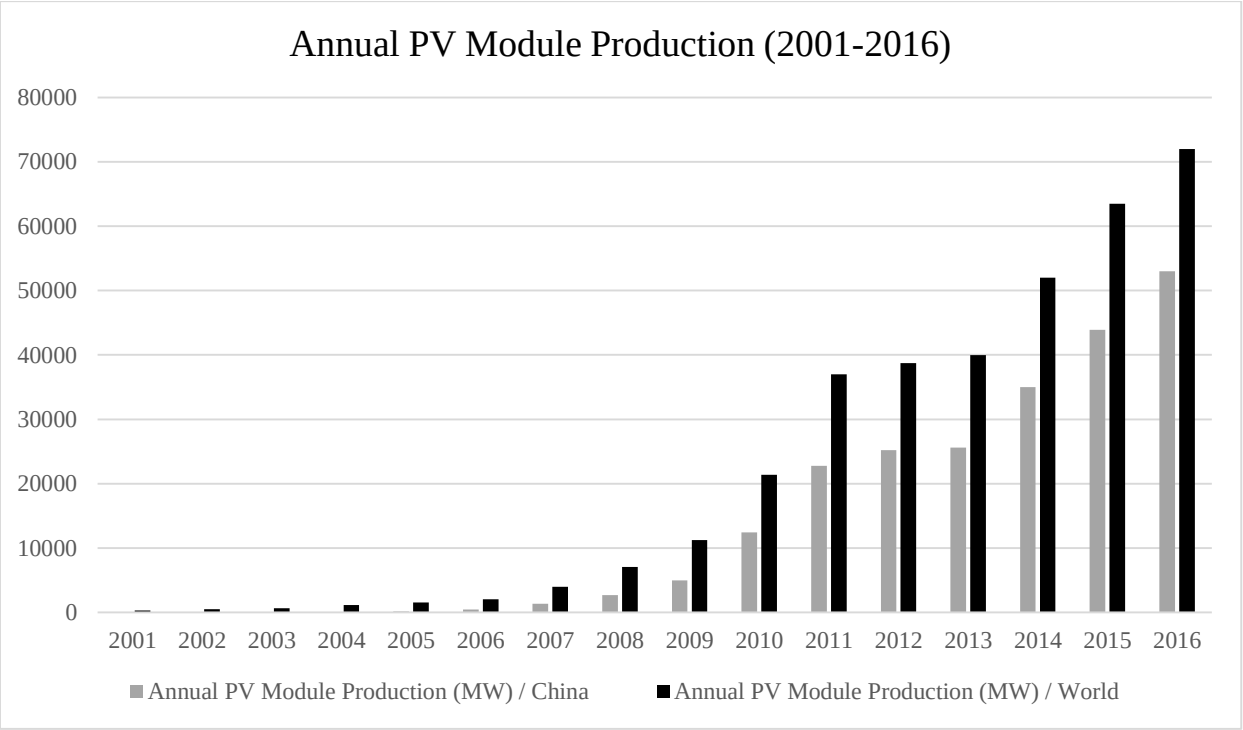

Figure 4: Annual PV Module Production (2001-2016). Compiled by author, source: GWEC

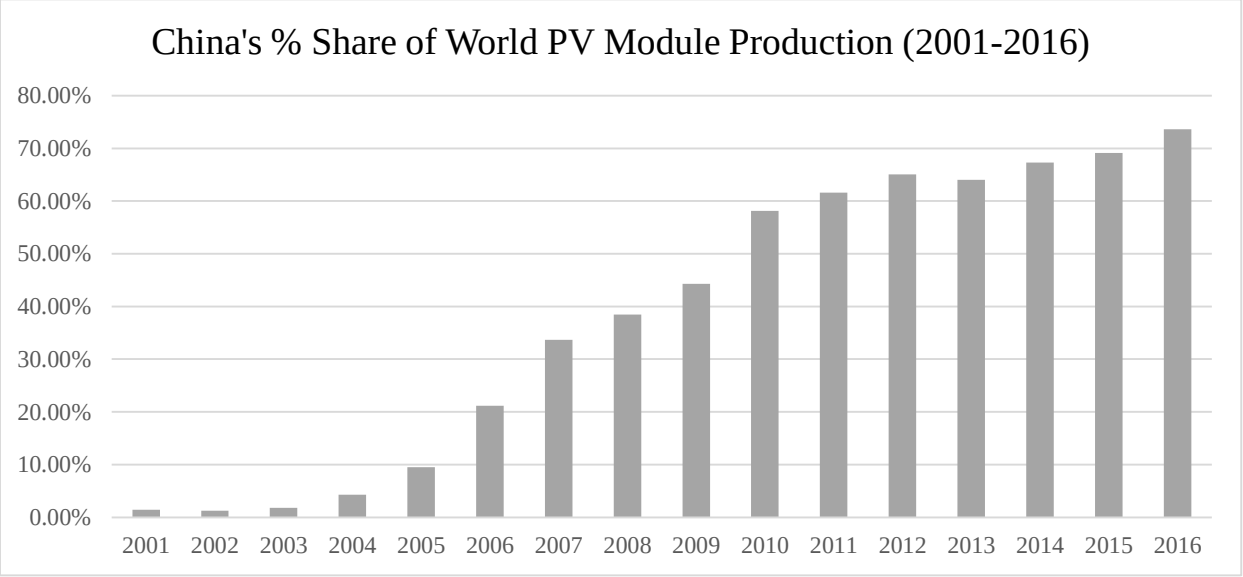

Figure 5: China's % Share of World PV Module Production (2001-2016). Compiled by author, source: GWEC

Concerning wind turbine manufacturing, a slightly different pattern can be observed after 2010. Much of the market expansion was analogous for the first period yet became more sporadic

later on (see *Figure 6* & *7*). This can be explained by the two factors. Firstly, the wind turbine market in the earlier years was domestically oriented – it managed to compete in quantity but not in quality (D. Toke, personal communication, April 26, 2018). When it became more export oriented, it faced difficulty remaining competitive quality-wise (Schuman & Lin, 2012). The second factor was overcapacity. Domestically, a point was reached (2012) where the supply of wind turbines vastly outnumbered the demand (Zhang et al., 2013; p. 347). This led to a temporary loss of global market share. However, growth followed soon after due to even greater funding and investments in technological development thanks to the Ministry of Science and Technology. Therefore, going in line with the established framework, China's RE development leadership can largely be explained by the three mechanisms that lead to SCE market dominance and thus global leadership: omission of foreign manufacturers, state-led intervention, and government funding.

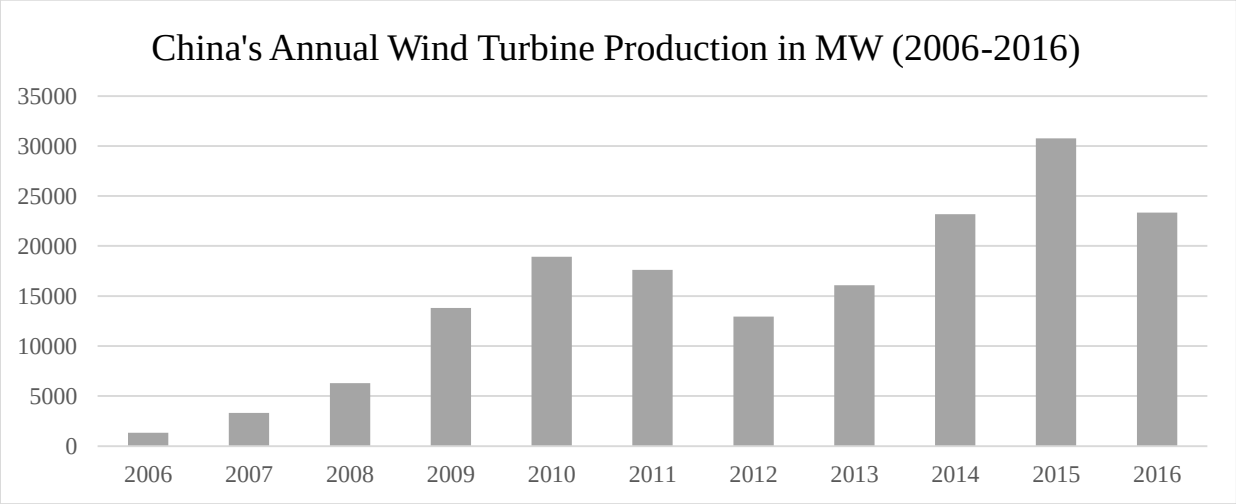

Figure 6: China's Annual Wind Turbine Production denoted in MW. Compiled by author, source IEA-PVPS.

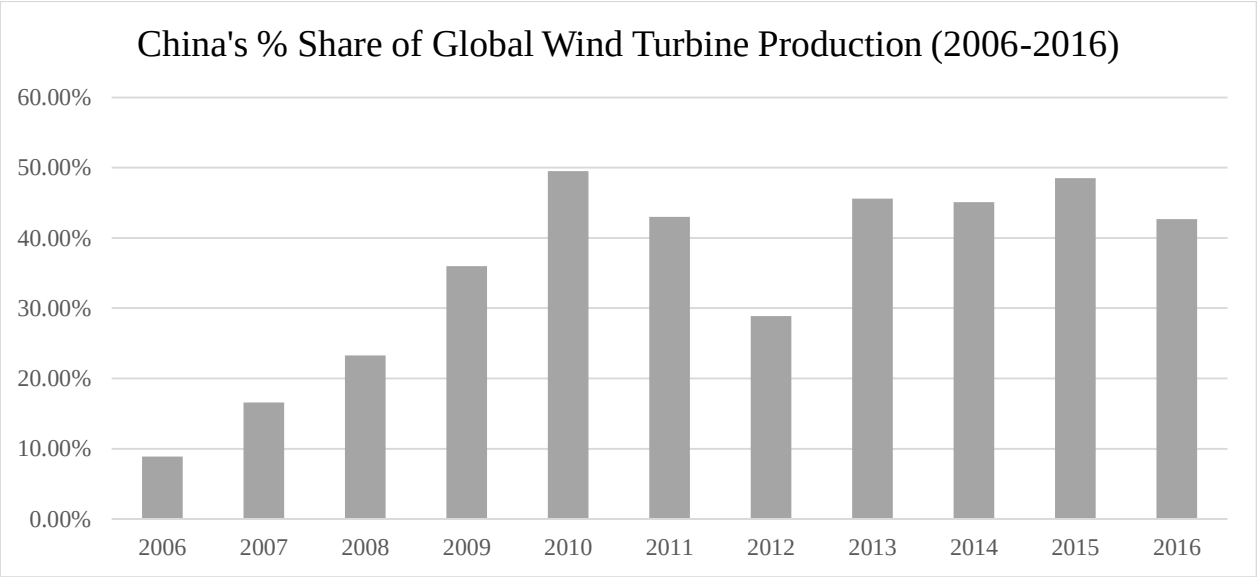

Figure 7: China's % Share of Global Wind Turbine Production. Compiled by author, source: IEA-PVPS.

Conclusion

The aim of this Thesis was to empirically examine whether SCE market dominance has affected China's RE development. The rationale behind examining this particular link revolves around the fact that China has went from having a nearly non-existent RE manufacturing industry in mid-2000s to being a global powerhouse in over a decade. However, academic literature regarding the issue has primarily hinged on matters of sustainability, implying that RE progress is voter-preference reliant and based on pollution abatement and attaining energy security (Amesheva, 2017; Toke, 2017), whilst leaving a large share of factors mainly untouched. Unsurprisingly, sustainability factors alone, as proposed by EM and EKC, fail to clarify why a developing nation such as China have pursued RE market expansion during its industrialisation stage. Therefore, in order to examine the conditionality of RE development and explore the

relationship between SCE market expansion and varying stages of RE development, relevant academic literature was covered, and the following RQ was examined:

To what extent does SCE expansionism and the market dynamics behind it explain China's RE development?

The main argument of this Thesis is that China's SCE expansion was caused by extensive state intervention and state-led financial support. Both of these factors manifested themselves in forms of policymaking and institutional transformation. This resulted in providing market certainties for new domestic entrants and ousting foreign competition both via the local content requirements and complementary investments for domestic manufacturers. Said policies also helped coordinate RE development on both national and provincial levels, eliminating extant inefficiencies and allowing for more rapid RE development. Because of this, Chinese SCEs were able to eventually consolidate their positions in the RE industry globally.

The role of SCE expansion in China's RE development was analysed and elaborated upon in three analytical stages. First, academic literature on the reasoning behind a global shift towards RE development was covered in Chapter 1. It was established that whilst EM and EKC provide some useful insights on the shift, primarily in Western economies, the offered rationale is less applicable in China's political setting (Carolan, 2010; Dent, 2015). Continuing, research concerning SIT and AE was analysed in Chapter 2. Academic findings imply that China's RE development and its rapid pace can be chiefly explained by industrial policymaking and China's political structure and AE-based decision-making (Andrews-Speed, 2018). RE development is considered a pillar industry and a necessary component for future economic shift from manufacturing to innovation (Dent, 2015). It is suggested that because of the top-down political

structure and the mechanisms that come with, Chinese RE manufacturers have been able to achieve set targets and attain market dominance. Primarily, the following factors responsible for China's current position were outlined: omission of foreign manufacturers, state-led market intervention, and government funding.

Lastly, an empirical examination was carried out by analysing government reports and publications of international institutions specialising in RE development. It is argued that from an institutional point of view the NDRC and NEC are primarily responsible for the establishment of the necessary dynamics that allowed for further RE development. With reference to policies, there is a myriad of different level documents that have contributed to the pace of RE development allowing SCEs to take up a dominant position domestically and thus eventually globally. However, REL is outlined to be the focal point due to establishing a defined framework of responsibility. Then, an overview was provided as to how said policies and institutions have – alongside with the 2008 financial crisis – affected China's market position in terms of RE manufacturing by analysis solar PV module and wind turbine production over 2006-2016. To answer the RQ – SCE expansion has played a pivotal role in the progress and development of RE manufacturing in China. However, it is but one of the many factors that have contributed to the overall growth of the market.

Despite the study's attempts to examine the relationship between SCE market dominance and RE development in China covering institutional foundations, policymaking and RE market development reports, several limitations need to be addressed. First, the study was limited to reports covering wind turbine and solar PV module markets without accounting for hydro manufacturers and others. Furthermore, the reports only indicate global market share of Chinese manufacturers whilst failing to provide precise numbers of annual domestic competition. This

creates a gap in the study's consistency, which cannot be currently solved due to lack of present data. There was also the issue of identifying specific enterprises that were state-controlled – many of the RE manufacturers in China do not publicly address the support they receive from the state. Additionally, documents and data on direct ownership has often found to be contradictory. Lastly, the chosen case of China is hardly generalizable as China's historical RE development is unique and lacks the comparative aspect. Future attempts undertaking a similar path of analysis ought to factor in how the SCE shift, from being state-owned to privately owned, has influenced market development and exporting capabilities and thus further RE development.

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Appendix A

Participant: Geoffrey Chen | Xi'an Jiaotong-Liverpool University | Department of China Studies

1) What do you believe to be the main reasons for China's shift away from a carbon-intensive industry to one that is more so focused on sustainability and thus renewable energy? In other words, why did China stray from the business-as-usual paradigm?

I think one of the bigger reason for that ... Sorry there is a noise in our conversation. If you want to, I can send you over the book I have recently published which somehow explains the biggest reason of that kind of shift. I think one of the reasons might be the new leaders. For example, the Xi-Li administration. They have been realising the issue, the urgency of the issue. So they have already put this onto the political agenda. So we can see a sort of top-down measure encouraging SOE's to cultivate the growth of the industries, by using a lot of different measures like, for example, local content requirement but also the use of feed-in-tariffs <...> learn from Germany, and also learn from Denmark and Spain. Particularly policy measures have been adopted from Europe. So investors have more capacity, and trust in the future growth of the sector.

2) What would you identify as the starting period for RE development in China?

The Renewable Energy Law of 2006. Since 2006, we can see a particular focus on the state providing a single law to encourage these so-called market dynamics in this sector. And I think since 2006 and afterwards, the law has been revised several times, and also local governments use different measures to compliment the central state's initiatives.

2) Cont. What about the 90s? The first policy document directly mentioning renewable energy was released back then. Could we outline the 90s as the starting period?

Yes, you are right. I think it depends on which type of energy you are talking about. If you are talking about the hydropower of course, in 1990s it was one of biggest focus amongst all different types of authority. However, since 2006 I believe that the shift of the focus has been turning to what we call, well a manufacturing style of renewable energy, which means slow solar power, wind power. These are the sources of the manufacturing industry.

3) In terms of RE development, do you believe that China's state intervention and market control-oriented model has been more successful than the more so liberal model present in much of the West? (primarily the EU)

Well yes, that is a very good question. I believe that it depend on what type of criteria you are using.

3) Cont. Let's say in terms of achieving set targets.

Yes, sure. I think these are certain, of course. China has been setting a lot of targets and these targets have been met. So in terms of scale and the speed it has been fantastic I would say.

4) In terms of RE manufacturing, China is leading in both photovoltaics (with 7 out of 10 top module suppliers coming from China) and wind (with having 3 out 10 top wind turbine manufacturers). However, almost all of China's RE manufacturers are state controlled. In your opinion, how has this historically affected the domestic share of foreign RE manufacturers? Could it be claimed that government funding could be outlined as one of the key factors for the current state controlled enterprise dominance in the RE market?

Yes of course. I think so far, if you see the participants of the expansion process, you might realise that actually, SOE's have been targeted as the main focus of these types of so called 'indigenous innovations'. This slogan has been widely used since Hu Jintao's era, and the reason they want to actually do that is they want to actually cultivate local technologies. However, it is difficult but they try to actually <...>. In the beginning of 2006, the players, the market was dominated by European manufacturers. For example Vistas, Gamesa. But since 2006, if you have checked the data, 10 years later, after the introduction of local content requirement, which means that through different bidding process, you know one of the binding requirements is that any manufacturers, any producers need to find local domestic companies, manufacturers to help them build wind farms but also solar panels. So it somehow kicked the international competitive players outside of the market, and also normally the huge plans, normally have to be approved by the central government, more in terms of the wind power. So using this kind of approval power and the NDRC, national development and reform commission, somehow discouraged the participation of international players.

5) What would you identify to be the pivotal institutions responsible for China's RE progress?

Do you mean like political institutions? Ok. If I want to say, one of the most important institutions is the combination of carrot and stick. Normally you have to have incentives like for example feed-in-tariffs and also need to <...> the state's coercive power to actually encourage local producers to participate in these gains. However, I think one of the measures, which people do not realise much, is the party mechanism, or what we call the 'discipline provided by the party state'. For example, it is actually a top-down mandate that is provided to us by the central government. Central party state has set targets, so the local government has to do whatever it can do to meet the targets. If they cannot do that, they will suffer from, for example – the appraisal year by year. You know, normally if you do not meet the target, economic target, it has been considered an economic target instead of an environmental target. That is why they try very hard to do so in wind power, solar power, mill and so. I think the subsidies are based on the performance of the region or province. Do you know what I mean?

6) What would you outline as the centrepiece policies that have enabled China's rapid RE development?

There are actually quite some of them but that is a bit too long. I think there is a policy, policy documents provided around 2010, I believe. It is called mid and long-term development of renewable energy (reference to 'Medium and Long-Term Development Plan for Renewable Energy). I think this plan has somehow facilitated the progress. On the other hand, I think there is another huge document, which is called; well it is a national document – 12 Year Guidelines (reference to the 12th Fire Year Plan 2011-2015). It is one of the biggest; it has provided the biggest push for this. Why? It is somehow linked to the stimulus package provided after the global financial crisis. The party provided a stimulus package to subsidize a lot of the national infrastructure projects, and a lot of these projects were actually wind and solar power projects. So for example when Europe; in the UK or in the US, when they start, you think about neo-liberal practice. They need to use austerity measures to stop the feed-in-tariff. China, on the other hand, uses a stimulus package to actually promote the policies. I think this is a huge difference of what happened after 2008.

Appendix B

Participant: David Toke | Aberdeen University | Department of Politics & International Relations

P stand for 'participant' and ***I*** – for 'interviewer'.
P: *You have developed an assertion and you are looking for evidence to support it.*
I: *Well I am still working off of Geoffrey Chen's assumptions, off of his findings.*
P: *They may have seen off foreign competition but what is your hypothesis that you are starting out with?*
I: *My hypothesis is that because of authoritarian environmentalism's presence in China, China has been able to finance the state controlled enterprises that revolve around renewable energy manufacturing. So my hypothesis would be that state controlled enterprises are responsible for the rapid development of renewable energy manufacturing in China.*
P: *I mean … yeah. Firstly, you have got to break down the industry into different parts. Because development of projects is one part of the industry, manufacturing is another part. So you are talking about manufacturing, are you?*
I: *Yes.*
P: *Well, manufacturing has been subject to a lot of investments by public authorities in China at different levels of government. The pattern is that you have local levels of government, cities or provinces, putting money into their own enterprises, into local enterprises that can boost jobs in growth industries as identified by the party leadership, as being things to go for. So solar PV is a very good example of that, and also wind turbines. And so that is certainly the case. Now, whether <…> It depends which way you want to spin this. Where you get your initial funding is one thing <…> It sounds like you are building up an argument 'well this gives solar PV an unfair point lead point of leverage compared to other Western companies, and this supports Western companies advocating high tariff walls in the US and the EU. I would not sort of take the argument there. That sounds where it is headed.*
I: *Well, no. What I am trying to do is <…> I have covered Ecological Modernisation, Environmental Kuznets Curve, and basically how China might be using renewable energy as a soft power tool. What I am trying to focus on is the Strategic Industry Theory, which basically says that China's move towards renewable energy manufacturing is much more strategic rather than*

adhering to some matters of sustainability. They are doing this because renewable energy is perceived as a pillar industry and that is basically what I ground my argument on. I think Christopher Dent discussed Strategic Industry Theory when comparing a lot of other Asian developing countries, and how their renewable energy markets are developing.
P: *I mean, renewable energy is seen as being a key industry, certainly. But you have got to remember that the energy systems are only developing, and they are looking, generally speaking, towards increases in use and production of electricity. So they are more likely to be interested in new technologies and particularly now that they have become cheaper. And solar PV prove to be a major a major export success of China, and it is built on their strengths, their industrial strengths of being able to mass manufacture things. They are very good at that once they have got a method of doing it. I mean <…> where you get investment from is secondary. Their large multinational companies are very cheap sources of capital so they can invest in things cheaply just as the Chinese state authorities can invest in things cheaply. I do not particularly that the Chinese industry, in that sense, has an unfair advantage, which is the way it is painted. You know that investment may come from different sources, certainly, the Chinese state has more to do with directing investment, more than happens in the case of the West in terms of strategic decisions. I am not familiar with Christopher Dent but anyway I assume this is the sort of thing he goes on about. In terms of the state's determined <…> that in general industries need to export stuff and this is part of their development process. I mean I write in the book I did about state capitalism and how state capitalist countries in their earlier development phase, which China is now ending I think, seek to develop their infrastructure. And they are churning out loads and loads of products to serve their own domestic markets for people who had not had before fridges or anything else. And so on the basis of that they have got a massive industrial base, which they can use to export things abroad. That is what they have been doing. They are very good at solar PV. Less successful on exporting wind turbines. And that's an interesting contrast. I think that blows the argument that somehow the Chinese are able to do well in solar PV because of all the state support. Well that is not the point at all. It is because they are good at it, much better at it than making wind turbines. Anyway, sorry, carry on.*
I: *Well, we started off in a bit of an odd way but I have six standardised questions that I have prepared, so we might as well carry on with that.*
P: *Yeah, I just wanted to summarise where I was coming from.*

1) What do you believe to be the main reasons for China's shift away from a carbon-intensive industry to one that is more so focused on sustainability and thus renewable energy? In other words, why did China stray from the business-as-usual paradigm?

Well, I mean to really inspect Chinese documents to look at what they are talking about, but you can see there is a lot of pressure for environmental improvement in China, particularly in the more affluent areas that are nearer the coast. They want reductions in air and water pollution and of course, they do not want growth to be based on building more and more polluting coal plans. So there is a lot of pressure for cleaner energy. Technology is not. And solar and wind power have received major boosts for that <…>. And of course you could argue that in fact the Chinese state envisaged electricity production to expand at a much more rapid pace than it actually has been

doing in recent years, which, I suppose, and this is something that I comment, and it is just an assertion on my part – you could argue the speed may have been initially done perhaps because of that. In fact, the electricity growth and the electricity production is rather more leisurely, and growth and energy consumption generally is very small because of the states of play as far as development patents are concerned. Well, they are coming to the end of this early development pattern. They have developed the main parts of the infrastructure and various basic consumer products. Anyway, I discuss that in the books I wrote. But sustainability is part of that, certainly part of its general industrial development, its industrial development, which in a way seems more sustainable and they have got a lot of internal pressures that support the sustainability notion.

2) What would you identify as the starting period for RE development in China?

Well there are books that have been specifically written about Chinese Renewable Energy development. I think you should look at that really. I mean, it is not something that I particularly <...> I did not really focus on the history. That is not my purpose when I wrote about it. Wait I have got the books, we can talk about this. Hold on a sec. Well, that is one. There are various actually. This is another. A couple of them come to mind really. Then there is this one by one of their big end entrepreneurs. It is by Le Hejun and it is China's New Energy Revolution. Published by McGraw Hill. And that is just three that I got on my hand. I am sure I have various other lying around here somewhere. I do some references for some books. Anyway, you want to consult those things to look at the history, but basically I suppose, you know China really followed <…> I mean wind power never really blazed any sort of trail, it just took up on following developments in Europe. Particularly, the Danes started off wind power earlier in its modern form. Denmark and then Spain; Spanish, German and then American manufacturers. Yeah you had a few Chinese companies pestering around in the 90s. You know solar PV, I think, again, they were not innovators originally in that. I think they bought up a lot of the equipment from the Germans. You know, some of the manufacturing patents, that sort of stuff. Though you have to look into that. But I think the difference between wind power and solar PV is that wind power was cheaper earlier than solar PV was, so they started wind power manufacturing for the domestic market, in a big way before solar PV. Initially, solar PV was much too expensive for the Chinese home market. It was the cost that were brought down, well largely because <…> ironically what the Chinese were doing was exporting, and very successful in doing that. And then their exports have been cut, to a certain extent, by the effective bans in the US and the EU. I find it quite amusing, since the West is all in favour of free market, competitive capitalism, and still someone does it better than them, and they throw out various ludicrous excuses. That is my opinion. Totally unjustified. That is about what I can say about that.

3) In terms of RE development, do you believe that China's state intervention and market control-oriented model has been more successful than the more so liberal model present in much of the West? (primarily the EU)

Well I do not think you are comparing likes with likes. It is like comparing whether orange tastes better than an apple. I mean, China has been, still is to a certain extent a developing economy and state capitalism <lost connection>. Ah, where were we? I was talking something about apples and oranges. Right? China is a developing economy so <…> a lot of the basic principles that involve its state-capitalist approach involves are actually broadly similar to that which you <…> were seen in Japan, even though Japan is formally a very capitalist country, well it still is, they do not have much state ownership. But a lot of principles are exactly the same in that the states underwrote a lot of investments in manufacturing, exporting capabilities, with low interest guaranteed loans to chosen companies. In the Japanese case by the Ministry of Industry and Technology, which was virtually a government of its own. And similarly in China, even though it has much more state ownership, although a lot less than it used to be. But the point is whether it is privately or publicly owned, you get some industries where companies are given state backing at various levels, to export stuff but also develop basic infrastructure at home, that is very important part of it. That is the other part of it. Everything from roads, to providing people with fridges in their homes. And so you have got that sort of development, and the Chinese so far have been very good, as I have said, at mass producing items, which they managed to achieve prominence for. In the home markets, for instance, mobile phones, things like that, and where you have got an agreed design, and you just churn it out in massive quantities and then you have got <…> It has nothing to do with cheap labour I do not think. It is to do with effective organisation and a lot of IT. There is a whole city of Shenzhen, which is dedicated to manufacturing IT. This should be seen as not a matter of state ownership, so much as a state capitalist strategy that some successful developing countries have employed. But of course it has natural limitations. In the case of Japan, when their initial advantages disappear, and you have produced enough infrastructure that the domestic economy can usefully absorb. China has gotten to that stage already or has arguably passed it. Just as Japan did at the end of the 80s. That is one part of it. The other part is that, as I have said, it depends on what you are talking about. Some things <…> China is quite good at, say mass manufacturing, would not say simple designs but subtle designs. But when it comes to dealing with a changing quality of environment, that means assembling a lot of different products and services together, like you have got with wind turbines, you have much greater difficulty. I would not say that China is <…> that the system is good or bad, it just, it works for some purposes and not others, which is a rather more complicated answer.

4) In terms of RE manufacturing, China is leading in both photovoltaics (with 7 out of 10 top module suppliers coming from China) and wind (with having 3 out 10 top wind turbine manufacturers). However, almost all of China's RE manufacturers are state controlled. In your opinion, how has this historically affected the domestic share of foreign RE manufacturers? Could it be claimed that government funding could be outlined as one of the key factors for the current state controlled enterprise dominance in the RE market?

We have already covered that previously.

5) What would you identify to be the pivotal institutions responsible for China's RE progress?

Well as I have said, state policy has had a lot to do with it. Part of it is state policy. Well, it is a rather big question.

6) What would you outline as the centrepiece policies that have enabled China's rapid RE development?

Well as I have said, well basically it is state policy is it not, at various levels? The communist party sets a set of strategic priorities and there are various policy instruments, which it deploys to achieve that. Some of which are the same sort of thing that you have seen in the West. Some of them are additional in that the state institutions at various levels direct investments in a state capitalist mode that I have described. I think people get very confused when they look at the Chinese economy. They say it is free market, or it is state dominated but it is neither really. It is a state capitalist economy where the large bulk of things are privately owned. Although in the energy sector that is one of those sectors that is still dominated by SOEs. But the point is – you have got a lot of private companies who have been given a lot of strategic support by state institutions, in particular local governments have been giving investments. You should read that book about Le Hejun about solar power and so. He actually complains about that. And I really, I talk about Ecological Modernisation and I say 'well this is not a European style Ecological modernisation, which is about altering the conditions of the market rather than picking particular companies that win. You have to be careful what you are talking about. They are picking technologies that <…> the West does that as well. You say 'we want these technologies to be promoted' but in China they actually pick which companies should succeed. It is not necessarily state owned companies – it can be private companies that get lots of investment.

Appendix C

Participant: Philip Andrews-Speed | National University of Singapore | Energy Studies Institute

1) What do you believe to be the main reasons for China's shift away from a carbon-intensive industry to one that is more so focused on sustainability and thus renewable energy? In other words, why did China stray from the business-as-usual paradigm?

I am going to press you on the question. At what time do you see this happening? Because then I can <…> depending if you are talking about the last few years, or ten or twelve years.

1) Cont. Right, well I focus on the time period spanning from 1990 to 2016. Essentially, what I argue for is that throughout the 90s, the expansionism was not very big and it was mainly

because the policies were ambiguous and not very well focused, and then most of the growth has happened after the Renewable Energy Law was passed. And then after the financial crisis.

Yep. Got you. Okay. I mean, I had to write a number of sort of chapters for handbooks on energy policy in China. So I am waffling a bit but I can share with you that my thinking is pretty similar to yours, is that I traced some of the wind energy and stuff back, and other renewables back to the 80s. Then it was actually about poverty reduction – solar PV in the countryside for the peasants. And then sustainable development agenda started to grow in the late 90s but they did not get their act together on wind policy et cetera and then only from 2005. Was it renewable energy? I mean if we just focus on the renewable energy, which was wind initially – it was a combination of industrial policy and energy self-sufficiency. Because if you remember at that time in 2005, energy demand was growing, the lights were going out. Okay. So I think in the short terms it was very much a combination of long term industrial policy, with short term 'Christ we need electricity of any sort'. But I agree, the sustaining thing for the support of domestic manufacturing industry has been industrial policy. But then again intensified by the air pollution. So once you get as we have seen in the last few days, there has been an order issued to dispatch renewable energy first – that has to do with clean air. So you got this sort of interaction of policies and you might have seen the 2013 paper that I wrote with Zhang Sufang primary interactions on <…> Ok. So yes, and if you ask what has been the most sustained element of the policies, of the motivations for the policies that have underpinned renewable energy since the early 2000s it has been industrial policy. And then at times – electricity of any type – and more recently clean electricity.

2) What would you identify as the starting period for RE manufacturing in China?

Christ, I am very bad at dates. Hang on. There is probably, is there not a science <…> Sorry, I am reading one of my own publications. The trouble is that as somebody who covers a wide variety of stuff <…>. What my colleague would pick out is 2006 – China's Mid and Long Term Plan for Science and Technology. And that's sort of stuff. So about 2006. The science and technology things and these various research funds that started to come out. So I am waffling – Mid and Long Term Plan for Science and Technology 2006 to 2020, top priority technology race. So yeah, 2006.

3) In terms of RE development, do you believe that China's state intervention and market control-oriented model has been more successful than the more so liberal model present in much of the West? (primarily the EU)

Well if you set aside Germany <…> Well except that the EU approach in many countries like Germany has been state-driven as well. Through very strong feed-in-tariffs, as has Spain. So for the deployment of renewables I guess the as opposed to <…> are we talking about the manufacturing or the deployment?

3) Cont. Manufacturing.

Manufacturing? Okay. Well then the answer is yes because they have <…> when it comes to quantity of stuff, they have clearly overwhelmed the world in many ways. In terms of quality – not yet. Yeah? Do you know what I mean?

3) Cont. But in terms of let us say, wind turbine market – I have spoken to David Toke – what he said was that, well solar has sort of overwhelmed the global market. Wind energy is very much so at a domestic level, because quality is just not there.

Yeah, yeah. So in fact I have just put together that sort of <…> I am giving a presentation on internationalisation of energy in China's energy. Sorry, ignore that. Wind and turbine exports only reached 1800 units, turbines last year. And I am thinking, hang on, that is quite small. So that explains that. So you are ahead of me in some of it. So the solar people have caught up – good enough. Wind has not. But I do not know why the difference. Do you know? Why have we not managed to get the quality?

3) Cont. Not exactly. I know that wind industry was very much so focused on producing everything domestically so they did not really focus on the exporting market. And because of the quality and the need of speed to develop the wind industry <…> basically it is not competitive with some of the other wind turbine manufacturers, despite the fact that China has 3 out of the top 10 turbine manufacturers at the moment.

Okay. That makes sense. Because I was struck, I was literally <…> My colleague Zhang Sufang sent me these statistic over the weekend and only this morning I made the graph of the solar photovoltaic material exports, you know: wafers, cells, modules. They are selling up 90 GW a year of this stuff. If the data is correct, which is a huge quantity. So go back to your question. The question was? Does the state driven model <…>? Yeah, it obviously does, but it does it in quantity, if we take solar as the example. But still it does not take them to the leading edge, the cutting edge.

4) In terms of RE manufacturing, China is leading in both photovoltaics (with 7 out of 10 top module suppliers coming from China) and wind (with having 3 out 10 top wind turbine manufacturers). However, almost all of China's RE manufacturers are state controlled. In your opinion, how has this historically affected the domestic share of foreign RE manufacturers? Could it be claimed that government funding could be outlined as one of the key factors for the current state controlled enterprise dominance in the RE market?

Okay. I will answer the question, and then I will ask you a question. Yes. I mean state support at national and local has been critical. At both. Do you want more than that? The local governments have been providing all sort of support like cheap access to land, cheap electricity, other loans, et cetera, et cetera. So yes, state support has been critical particularly for the rapid nature of this growth. So my question to you is: to what extent have you managed to – I just have not done the work – to disentangle how many of these top producers and exporters of solar and wind equipment are truly, mainly state-owned at central or local level, or mainly privately owned with state support on central or local level?

4) Cont. Right, that is why I used the terminology state-controlled enterprises. Most of the scholars use state-owned but I say state-controlled, because some of them are indicated as private companies and yet they receive backing from the state, or some sort of incentives or support. So whilst you cannot classify them as state-owned, they still receive some advantage.

Have you done that on a company-by-company basis?

4) Cont. Yes.

Sorry, I am going to ask a favour here. Have you made that into a table?

4) Cont. No, I just looked up individual reports and articles. I just did the research for this question specifically.

Right, ok. Fine. So I mean, are most of them actually state-owned or are most of them privately owned?

4) Cont. Most of them are state-owned.

5) What would you identify to be the pivotal institutions responsible for China's RE progress?

Well I think the focal point would have been the State Council pushing down on the NDRC to issue not only, and through the Ministry of Science and Technology, to issue the science plan. Although a lot of the support came at local level, they would not have done that unless there was a push right from the top; through the five-year plans, the formal five-year plans, the five-year energy plans and the long-term science plans. So it came right from the top.

6) Right, and the last question: what would you outline as the centrepiece policies that have enabled China's rapid RE development?

I would guess it is the support that would have come from the Science and Technology Plans that had funding available for research and development. Have you seen the paper that Sufang and I did in this book in Imperial College Press, Renewable Energy Finance?

6) Cont. I do not think so. Could I have that please?

I have put the chapter on my ResearchGate. It is there. Because we tried to add up all the sums there and we failed – because you cannot; strictly the local government stuff. But yeah, it is huge amounts of money from the research and development, and the loans from state banks to manufacturers. So it is the two things together – the R&D funds and the loans to manufacturers.

Appendix D

Participant: Liu Xianbing | Institute for Global Environmental Strategies | Kansai Research Centre

1) What do you believe to be the main reasons for China's shift away from a carbon-intensive industry to one that is more so focused on sustainability and thus renewable energy? In other words, why did China stray from the business-as-usual paradigm?

I think both internal and external factors are driving the shift of China toward low carbon development. Internally, high speed growth of economy and the irrational structure of industry

have caused serious pollution problems. The Chinese economy development so far has been a compacted process and dominated by heavy industries. In order to fundamentally resolve the pollution and environmental related social problems, the economic and energy structure have to be changed. Internationally, global warming has been commonly recognized. As the largest emitting country, the external pressure for China to take actions has been growing. China is now the second in the world by the overall economy volume and has a strong will to make presence as a responsible country. The consistency of efforts for climate change and solving domestic problems changed the position taken by China's political leaders on climate issues.

2) What would you identify as the starting period for RE development in China?

The development of renewable energies, particularly solar PV and wind power, may be traced back to the 11th five-year plan (FYP) period (2006-2010). Within one decade, wind and solar energy experienced a rapid growth, with the total capacity increased from zero to 5.7% of the national power generation capacity in 2012. In 2016, the share of wind and solar power capacity reached 8.9% and 4.6%, respectively. According to the '13th Five-year Plan on Energy Development', the country intends to accumulatively install more than 210 GW of wind power, and 110 GW of solar PV by 2020. Meanwhile, China holds the largest hydropower capacity in the world. Hydropower is the main renewable energy in China, accounting for 77% of renewable electricity capacity in 2012. More than 60% (62%) of the overall 400 GW economically exploitable hydro resources are already utilised, the rest will be exploited by 2035. Therefore, wind and solar power will play an irreplaceable role in decarbonizing electricity system of China.

3) In terms of RE development, do you believe that China's state intervention and market control-oriented model has been more successful than the more so liberal model present in much of the West? (primarily the EU)

It is difficult for me to compare the so-called two models and conclude that Chinese one has been more successful than the Western type. Till now, power sector in China are highly regulated and electricity market is still in the process of liberalization. The deployment of renewable energy in China has been hindered by various barriers. For example, power grid companies have few incentives to integrate renewables since the renewable energy target is set for generation capacity instead of the actual generation. Local governments may favour thermal power rather than renewables due to higher local tax revenues from the thermal power plant. The power supply system in China, dominated by coal-fired units, is suitable for providing base load but lacks interregional power grid connection. This leads to limited peak adjustment capacity and prevent large use of solar and wind energy. In addition, the deployment of renewable energies requires high upfront costs for their generation, transmission and distribution.

4) In terms of RE manufacturing, China is leading in both photovoltaics (with 7 out of 10 top module suppliers coming from China) and wind (with having 3 out 10 top wind turbine manufacturers). However, almost all of China's RE manufacturers are state controlled. In your opinion, how has this historically affected the domestic share of foreign RE manufacturers? Could it be claimed that government funding could be outlined as one of the key factors for the current state controlled enterprise dominance in the RE market?

I did not search about the market share of renewable equipment manufacturers in China by the company ownership. What is your reference to conclude that "almost all of China's RE

manufacturers are state controlled"? In my image – intuitively – the RE manufacturing companies shall be market-oriented with the capital from various sources. Government funding might be limited. This needs to be further confirmed. In order to boost economic growth, create new jobs and increase exports, the manufacturing of solar PV and wind turbine has been designated as the new strategic industry in China. They are eligible for preferential policy in land, loan and taxation.

5) What would you identify to be the pivotal institutions responsible for China's RE progress?

Government agencies: National Energy Administration; Ministry of Finance (Management of RE Development Fund); Ministry of Science and Technology (In charge of R&D). Renewable equipment manufacturing companies, renewable development and operation companies, power grid companies.

6) What would you outline as the centrepiece policies that have enabled China's rapid RE development?

Fixed Electricity Price and Fee Sharing System (Established in 2006, a kind of FIT system); Renewable Development Fund (Established in 2011, levying surcharge of renewable energies to subsidize the price of renewables, grid connection cost and the operation of independent renewable energy facilities)