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Student Number	31716982
Surname	Sinclair-Heddle
Given name	Melanie
Email	msinclairheddle@yahoo.com.au

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Thesis Supervisor	Dr. Jeffrey Wilson

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The Political Economy of China's Nuclear Energy Expansion: A Faustian Bargain for Energy Security?

By Melanie Sinclair-Heddle - 31716982

Submitted in Partial Fulfilment of the requirements for the Master of International Affairs degree, Sir Walter Murdoch School of Public Policy and International Affairs, Murdoch University

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Declaration: I declare that this thesis is my own account of my own research. It contains as its main content work which has not been previously submitted for a degree at any university

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Abstract

China's economic rise over recent decades has led to a corresponding increase in China's domestic energy consumption and requirements, and import of fossil fuels. This, coupled with international pressure to reduce fossil fuel consumption and seek alternatives, has led China to seek strategies to diversify its energy mix and provide long-term solutions to the seemingly intractable energy security challenges it is currently facing. In response, China has sought to expand its operational nuclear power capacity, with a goal of becoming energy self-sufficient. This thesis examines the reasons why China has chosen nuclear power to over-come its energy security challenges, and whether this strategy will pose challenges of its own. Some argue that China does not possess sufficient known domestic uranium reserves to be able to fulfil its nuclear expansion ambitions, and may be in danger of placing itself in a position of greater resource-dependency vis-à-vis uranium – effectively providing the foundations for a 'Faustian bargain' to occur, along with geo-political risk-taking. With increasing improvements being made to nuclear reactor design, and advancing uranium detection, exploration, and extraction technologies, however, this thesis argues that China's current known uranium reserves will be more than sufficient to enable these plans to be realised and secure China's energy future.

Key Words

Energy security; Faustian bargain; geopolitics of energy and resources; neomercantilism; nuclear power; uranium

List of Abbreviations

CCP – Chinese Communist Party

CGN – China General Nuclear Power Group

CNNC – China National Nuclear Corporation

CPIC – China Power Investment Corporation

FDI – Foreign Direct Investment

GWe – Gigawatts of electricity (one billion watts)

IAEA – International Atomic Energy Agency

IEA – International Energy Agency

IPE – International political economy

KWe – Kilowatts of electricity (one thousand watts)

MWe – Megawatts of electricity (one million watts, sufficient to power five hundred homes)

OECD – Organisation for Economic Co-operation and Development

OPEC – Organization of the Petroleum Exporting Countries

PWR - Pressurised water reactor

SEO – State Energy Office

SOE – State-owned enterprise

TWe – Terawatts of electricity (one trillion watts)

U.S. – United States of America

Introduction

Background to the Research Problem

China is facing increasing pressure from the international community to reduce its dependence upon fossil fuels, as well as domestic pressure to ensure millions of Chinese are able to benefit from cheap, reliable energy for their homes, and to enable China's industrial and economic growth to continue (Berrah *et al.* 2007; Klare 2009; Wang 2009; Zhou *et al*. 2011).

From 2007, and in response to these increasing pressures, the Chinese government proposed a "medium- and long-term" nuclear energy expansion plan, with ambitious targets to be reached as early as 2020 (Yan *et al*. 2011; Zhou *et al*. 2011; Wang 2009, 2487). Even though China has its own domestic uranium ore reserves, it has been argued that it does not possess sufficient proven supplies to fuel the proposed 58-70GWe (gigawatts of electricity) output capacity China hopes to achieve by 2020, rising to 150GWe in 2030 from its current 11GWe output (Massot and Chen 2013; Wang 2009; World Nuclear Association 2014a; Yan *et al.* 2011). One source has even stated that China is hoping to achieve as high as 400GWe output from nuclear power by 2050, requiring vast amounts of uranium in order to do so, going from "a demand of 2875 tons in 2010 to…30,000 tons by 2030" (Dittmar 2012, 37).

In order to achieve this, not only would the Chinese government need to initiate a vast nuclear energy infrastructure building programme in order to meet the reactor requirements for these expansion plans, but once built, these additional nuclear power plants will require more fissile material in the form of uranium ore than China has in terms of proven domestic reserves (Dittmar 2012; Wang 2009; Yan *et al*. 2011). In other words, in order to maintain and expand its current nuclear energy sector to meet the needs of its population, China will have no choice but to seek secure and reliable external sources of uranium. In effect, China will be ensuring dependence on external states for continuous supplies of uranium, as it did with oil from 1993onwards (Shaffer 2009; Wang 2009; Yan *et al*. 2011; Zhou et al. 2011; Zweig and Bi 2005).

With regards to securing adequate and reliable supplies of uranium and other fossil fuels such as coal, oil, and LNG, the Chinese government – under the leadership of Jiang Zemin - initiated its "go-out" state-owned resource policy in many parts of the world from 1999 onwards (most notably in Africa) (Holslag 2006, 134). China considers its ‘go out’ policy to be part of a “multi-layered ‘new diplomatic approach’”, as well as a pivotal energy security strategy for securing resources in many parts of the developing world, by providing resource-rich states with vital infrastructure in return (Cáceres and Ear 2013, 39). This policy has led some to view China’s economic and political bent as being mercantilist in origin, or ‘Asian Mercantilism’: an Asia-specific form of what is often referred to as neomercantilism, underpinned by notions of a strong state as the prerequisite for a strong economy (Holslag 2006, 135).

Aim and Scope of the Thesis

This aim and focus of this thesis is to establish whether China’s ambitious nuclear energy expansion plans provide the basis for a Faustian bargain to occur: In an attempt to become a world leader in nuclear energy production and energy self-sufficient, China will inadvertently become more dependent upon external states for uranium to enable this to happen. This increased dependency will occur because China’s domestic uranium reserves will be unable to meet the demands of its nuclear energy expansion plans over the coming decades.

The Faustian bargain, as it pertains to nuclear power, is based on a definition first used by Weinberg (1972), who suggested this bargain existed between the nuclear industry and society more broadly, based upon the principle of utilitarianism; in other words, nuclear power was viewed as a necessary evil that the majority would ultimately benefit from. In the context of this thesis, it is a term taken to mean that in China’s desperation to provide cheap, reliable power to satisfy its energy requirements and become energy self-sufficient, this need may be driving China to become dependent upon uranium-rich states such as Australia and Kazakhstan to enable this to happen. By doing so, China may be placing itself in a position of unnecessary geopolitical risk with other states in attempting to secure greater and greater amounts of reliable and affordable uranium supplies.

This thesis will attempt to fill a lacuna in the current political science literature concerning China’s nuclear energy sector. It examines whether China’s nuclear energy expansion plans are too ambitious to be achieved if they are to rely solely on their own domestic uranium reserves, or whether they are in fact realistic and achievable under these conditions. The central research question will be examined and analysed via exploratory case study analysis using mostly secondary and tertiary sources, and primary where possible, and will be analysed through the lens of neomercantilism or Asian mercantilism.

The significance of this thesis, and more importantly, the implications of China's nuclear energy expansion and resource strategy – often referred to as the "China Model" - has the potential to be far-reaching for developing states in the Asian region and beyond (both in terms of its successes and failures). Developing states in Asia such as Myanmar and Vietnam are increasingly looking to China to establish viable policy blue-prints to emulate in order to obtain reliable sources of energy and develop energy programmes to secure their future economic growth and development, but at what costs - geopolitically, economically, and environmentally (Cáceres and Ear 2013, 20).

Research Question

Why has China chosen to expand its nuclear energy sector considering the geopolitical and economic risks adopting this strategy entails?

Subsidiary Questions

- What are the key factors driving Chinese energy security policy and how has China's energy sector evolved and responded to these factors over recent years?

- Why has nuclear energy been viewed as key towards achieving energy security for China domestically, considering the geopolitical risks inherent in adopting this strategy?

- Could the geopolitical risks of expanding its nuclear energy sector, furthermore, secure sufficient and reliable resources to enable its continuation, possibly lead to a Faustian bargain for Chinese policy-makers?

Literature Review

When examining the literature on energy security, nuclear energy, and China's nuclear expansion plans, the literature appears to be divided between political science (including IPE), and the scientific disciplines. The political science literature concerning nuclear power and resources such as uranium often focuses exclusively on the negative connotations associated with them, such as nuclear weapons and fissile materials proliferation, rather than critically analysing the viability of nuclear power in the twenty-first century and beyond for civilian energy purposes in developing countries (Jones and Steven 2015; Klare 2002, 2009a and 2009b; Lin, Yang and Portner 2013; O'Sullivan 2013; Yudin 2013). Because issues concerning fissile material and weapons' proliferation are often conflated with generating nuclear power for civilian purposes and have been dealt with extensively elsewhere (*inter alia*, Jones and Steven 2015; Klare 2002, 2009a and 2009b; Shaffer 2009; Sovacool 2010, 2011a and 2011b; Sovacool and D'Agostino 2010; Yudin 2013), they are beyond the scope of this thesis and will not, therefore, be included in this review.

The literature in the political science realm focuses on issues of energy security – predominantly towards the geopolitical analysis and implications of the fossil fuel energy sectors, such as oil, LNG, and coal (Economy and Levi 2014; von Hippel *et al*. 2011; Klare 2002; Shaffer 2009 and 2012; Sovacool 2011b; Thomson and Horii 2009). Where China's rise, resource quest, and economic growth is concerned and located within this body of literature, there is no exception: Scholars have tended to focus predominantly on the role and future of fossil fuels in securing China's economic future vis-à-vis energy and resource security (Economy and Levi 2014; Klare 2002, 2009a and 2009b; Xu 2006). Literature explicitly referencing the Chinese nuclear energy sector in terms of its contribution to energy security, largely comes from the scientific, engineering, and energy policy fields, and is predominantly written by Chinese scholars (Massot and Chen 2013; Wang 2009; Yan *et al*. 2011; Zhang 1998; Zhou *et al*. 2011).

The debates in both the political science and scientific literature fall broadly into three categories: 1) Dimensions and strategies of energy and resource security in general, Chinese energy security and energy dependency, and the geopolitics of energy; 2) China's economic rise and the development of nuclear power for civilian purposes, and China's subsequent quest to secure the necessary resources to enable its economic growth trajectory to continue; and 3) the increasing role of nuclear power for providing energy and securing sufficient amounts of uranium ore to fuel its expansion plans, and Chinese energy policy considerations in this regard. It is evident from the literature that IPE and political science scholars tend to focus extensively on the first two points, whereas literature gathered explicitly in regards to the third point, is located solely within the scientific disciplines.

While there are over forty-five definitions of energy security in use in the political science literature, the general consensus is that energy security and independence can be achieved by states as long as supplies are accessible, reliable, and affordable (Sovacool 2011b, 3-6). In addition to these, there are five components considered vital for the success of any energy security strategy: 1) Diversification of energy sources; 2) diversification of suppliers; 3) enable provision for the storage of strategic energy reserves (most notably oil); 4) better utilise redundant energy infrastructure through modernisation processes; and 5) maintain flexibility in regards to shifting fuels - in terms of types and suppliers – if, and when necessary (*inter alia*, Ogle 2010; Shaffer 2009; Sovacool 2011b). Thus, energy security can be said to be a multi-dimensional, though essentially contested concept, underpinned by a multitude of converging political and economic factors (Jones and Steven 2015; Klare 2002, 2009a and 2009b; Shaffer 2009).

Whilst most of the political science literature tends to focus on securing reliable supplies of fossil fuels such as coal, oil and LNG as the mainstays of states' energy security strategies (Jones and Steven 2015; Klare 2002, 2009a and 2009b; Shaffer 2009), some authors suggest that unlike fossil fuels, uranium is *not* a fungible energy commodity (it is not easily exchangeable or substituted for a 'like' good), thereby ensuring uranium producers and consumers are inexorably linked - politically, legally, and economically (Ogle 2010; Shaffer 2009; Sovacool 2010; 2011b).

The political science literature that focuses specifically on China's nuclear energy sector and uranium requirements tends to do so from a US-centric point of view, often equating and conflating it with national security and military issues, along with the potential for conflict to arise between China and other states vis-à-vis energy and resource competition (Economy and Levi 2014; Friedberg 2006; Klare 2002, 2009a, and 2009b; Ogle 2010). This particular viewpoint could be as a result of the literature being used to represent a specific political and/or ideological viewpoint on behalf of the U.S. government; to convey the vested interests of commercial entities in the U.S. energy sector; or, it could simply be a case of "China-bashing", merely rhetorical in nature, and designed specifically to influence the U.S. domestic political audience (The Economist 2012). What this literature does, however, is highlight the growing geopolitical tensions surrounding resource competition - particularly between the larger economies in the developing world - that have been increasing in magnitude over the last few decades.

As large developing countries such as Brazil, China, and India grow their economies in order to meet the expectations and development requirements of their sizeable industrial sectors and burgeoning populations, we see a positive correlation between increased demand, and increased inter-state competition for reliable supplies of resources and sources of energy (Klare 2002, 2009a and 2009b). This competition in turn, is reducing the amount of available resources and energy for all to benefit from, leading to a new "Great Game" being played out on a global scale which is set to remain a central issue for the foreseeable future and re-shape the geopolitical world as it currently exists (Jones and Steven 2015; Klare 2002; 2009a, 87). This situation – if left unchecked - is likely to lead to increased tensions between large consumer-states and for conflicts to ensue; a situation further compounded by the need for states to be increasingly mindful of the need to reduce environmental pollution and the effects of climate change, and where possible, seek alternatives to fossil fuels (Klare 2002; Sovacool 2010, 2011a and 2011b; Sovacool and D'Agostino 2010; Yudin 2013).

Large energy consumer-states such as China are comparatively energy resource-poor relative to the increasing energy consumption and demands of their populations. Consequently, they are being forced into positions of import-dependency in order to secure and meet their resource and energy requirements, as evidenced by neomercantilist economic and energy security policies states such as China are said to operate under (Holslag 2006; Klare 2009a). China's decision to seek out sources of energy to secure its economic growth and development, and how its behaviour is viewed by others in doing so, doesn't necessarily imply that geopolitical instability will automatically occur, as developed countries have been behaving this way since the mercantile era of the seventeenth and eighteenth centuries. Indeed, China is merely "a newcomer to this contest…[and] is not behaving noticeably different[ly] [to other resource-seeking states]" (Cohn 2012; Holslag 2006; Klare 2009b, 189). But, the global resource quest of large developing economies such as China and India to acquire and secure cheap, reliable, and diverse sources of energy, is serving to increase competition between such behemoths, in turn, likely leading to increased geopolitical tensions and risk-taking to occur (Jones and Stevens 2015; Klare 2009b).

China's future economic and political goals and trajectories are inextricably linked to what some consider to be a neomercantilist quest for energy security and self-sufficiency, and its vested interests in the Middle East and in many parts of the African continent, can be viewed as being testament to this policy bent (Garrison 2009, 33; Holslag 2006; Klare 2002, 2009a and 2009b). Neomercantilism or more specifically, Asian mercantilism can be defined as a "blend of mercantilism aim[ed] at developing strategies for national prosperity…[and] a compromise between two extremes of full integration in the globalized capitalist economy and economic autonomy" (Holslag 2006, 136).

China's resource policies and strategies for securing energy commodities in many countries in Africa, for example, rely solely on allowing Chinese SOEs operating in the resource and energy sectors to negotiate directly with foreign state governments, thereby bypassing the international commodity markets associated with energy resources, such as coal, oil, and gas, thus ensuring they are not reliant upon this mechanism alone (Holslag 2006; Wilson 2014). Consequently, "Mercantilist resource strategies are therefore competitive and zero-sum in nature, and act to politicise international resource interdependence" (Wilson 2014, 17). China's nuclear energy sector, and the policies and strategies implemented by the Chinese government to secure uranium, are by no means any different in structure and function to the state-owned and controlled coal and oil industry sectors in this regard (Garrison 2009; Holslag 2006; Massot and Chen 2013; Wang 2009; Zhou *et al*. 2011) .

Most of the literature reviewed agrees that keeping China's economic growth and development goals on an upwards trajectory will require large amounts of resources and energy to do so, and is perhaps the greatest challenge facing Chinese leaders over the coming decades (Economy and Levi 2014; Klare 2002, 2009a and 2009b; Ogle 2010; Shaffer 2009 and 2012). These challenges in turn will ensure China's dependence, not only on reliable and continuous supplies of energy and raw materials, but also on China's continual implementation of a two-pronged energy diversification strategy: 1) diversification of energy *source* – multiple external supplies from multiple states; and 2) diversification of energy *type* to reduce dependence upon hydrocarbon-based fuel sources, such as oil, coal, and LNG, by investing in nuclear power as well as the renewable energy sector (Dittmar 2012; Klare 2009b; Shaffer 2009).

Following a World Bank Country Study focusing on the future of China's energy sector (World Bank 1985), Chinese scholars in the scientific, engineering, and energy policy disciplines soon began to shift their analytical focus from fossil fuels and their associated technologies towards nuclear power, as China's economic trajectory shifted skywards. To this end, they predicted that a significant increase in energy production from nuclear power would take place in the early twenty-first century (Zhang 1998).

What Chinese scholars also asserted from as early as the 1990s, were concerns over China's ability to fuel a commercial nuclear energy sector to meet the increasing demands of its population, given the known uranium reserves at this time: "For such large-scale development, the demand for uranium will be in the order of several million tons…[raising] serious concerns about [the] availability of domestic uranium resources, which…is almost an order-of-magnitude lower than that required" (Zhang 1998, 52). Concerns amongst the Chinese scientific community regarding the potential for China's domestic uranium reserves to be insufficient have only increased following China's expansion plan of 2007, and has led many scholars to examine the economic and policy challenges China is facing regarding these plans (Massot and Chen 2013; Wang 2009; Zhou *et al*. 2011). Chiefly, they focus on the seemingly Herculean task of building the required nuclear power infrastructure, securing sufficient and reliable uranium supplies given China's inadequate proven domestic reserves, and how both these obstacles might be overcome (Massot and Chen 2013; Wang 2009; Yan *et al*. 2011; Zhou *et al*. 2011).

Some authors believe China's plans will be successful, and are "ambitious, yet…feasible" *if* certain challenges are met and overcome (Zhou *et al*. 2011, 778, emphasis in original). These include: Strengthening Chinese nuclear safety and security, and bolstering what are considered to be "weak nuclear regulatory systems"; addressing concerns over an inadequately skilled workforce and flagging public support; promoting a culture of openness and transparency in the nuclear energy policy-making process; and providing an increase in funding in research and development to improve China's capabilities in developing indigenous nuclear technologies (Massot and Chen 2013; Zhou *et al*. 2011, 778-80). Others are less convinced, with some going as far to assert that China's ambitions for its domestic nuclear energy sector as being "more propaganda than reality", and suggest that "development speed should be based on upstream uranium resources and downstream spent fuel management", rather than prestige, which only plays into the hands of politicians for domestic political gains (Wang 2009). The rapid expansion plans as they currently exist, have failed to take into account the lack of domestic known uranium reserves, essentially creating a "bottleneck of natural uranium fuel supply", and are therefore unsustainable over the long-run; rushing head-long into such an ambitious programme without the appropriate supply considerations is viewed by some scholars to be over-ambitious and simply fool-hardy (Wang 2009, 2488; Yan *et al*. 2011; Zhou *et al*. 2011).

Whilst an increase in electricity generation through nuclear power could go a long way towards meeting the energy consumption and demands of the Chinese people and help reduce its overall reliance upon fossil fuels, China's proven uranium reserves are only sufficient to meet half of the expected 40GWe generation capacity by 2020 at the earliest, and thus, are considered only short-term in focus (Wang 2009; Yan *et al*. 2011). Some scholars have demonstrated that China lacks the necessary fissile material required to fuel its nuclear power expansion plans over the medium- and long-term (to 2030 and beyond).

Consequently, they suggest, it is inevitable "that China will purchase a great quantity of natural uranium for its nuclear power plants", thereby becoming increasingly dependent upon uranium-rich supplier states such as Australia and Kazakhstan to ensure China's economic and development successes continue over the medium- and long-term (Massot and Chen 2013; Wang 2009, 2490; Yan *et al*. 2011). Indeed, the difference between what China has in terms of domestic uranium reserves, and what it requires to ensure nuclear power is a viable domestic energy source and an alternative to fossil fuels, could mean that "China's uranium resources could not satisfy…the demand of nuclear power, and the degree of external dependence would reach as high as 90% or more, indicating that in less than 10 years, nuclear energy, instead of oil, would become the energy with the highest dependence on foreign [supplies]" (Yan *et al*., 2011, 742).

The literature in this field provides a thorough analysis of China's current nuclear power capabilities and proven uranium reserves, and according to the data collected, demonstrates that this is at odds with what they intend to achieve in terms of domestic power supply through nuclear energy over the long-term (Wang 2009; Yan *et al*. 2011; Zhou *et al.* 2011). What is ultimately concluded, based on China's known proven uranium reserves and future projected supplies to meet the electricity output projections anticipated by the expansion plans, is that China's uranium-dependency issues could be resolved by implementing new nuclear reactor technologies, such as fast-breeder reactors, and reactors using alternate fissile sources, such as thorium (Yan *et al*. 2011). But, not only would these technologies be costly endeavours to undertake (relative to the large construction and commissioning costs in current scalable PWR-based technologies), the time it will take to enable these new technologies to come on-line will mean the Chinese will be unable to meet their nuclear energy expansion plan targets on time.

Thus, an apparent lacuna exists within the literature, in turn providing an opportunity for these issues to be addressed in this thesis: What are the geopolitical and economic considerations associated with the domestic energy security challenges China is facing vis-à-vis its nuclear energy expansion plans, and how can these be overcome?

Thesis Structure

Chapter 1 provides background history and context to the research problem, and examines the evolution of China's energy sector, the key actors, and the political and economic factors which have influenced it over recent decades. A critical examination of China's energy security and corresponding policies will also be outlined.

Chapter 2 will focus more specifically on examining and outlining China's nuclear energy expansion plans and the reasons why the Chinese have decided to adopt this as a viable strategy for achieving domestic energy security. It will also look at the geopolitical risks associated with adopting nuclear energy in terms of analysing China's strategies and the policies it has implemented for securing, not only uranium, but other energy resources more broadly.

Chapter 3 will examine whether the political and economic policies China has implemented in order for its nuclear energy expansion plans to be fully realised, have placed them in a position of greater dependency upon external states, and the associated geopolitical risks of using neomercantilist policy strategies to ensure accessible, reliable, and affordable supplies of uranium. This will be examined according to the Faustian bargain metaphor. It will be argued that China is not in danger of committing itself to greater dependency on external states for uranium supplies due to a multitude of technological advancements in the uranium mining and nuclear reactor technology industries. Perceptions of China's increased geopolitical risk-taking in pursuit of sustained economic growth and development is often framed according to the China' threat' perspective, and China's quest for energy resources is by no means exempt from this narrow viewpoint.

Finally, the conclusion will provide a brief summary of the main findings and put them into context by outlining any implications for real-world policy considerations. The conclusion will also acknowledge any limitations of the research process and findings, and suggest how any necessary improvements or ideas for further research in this field could be made and conducted.

Chapter 1 – 'The Evolution of China's Energy Policy and Energy Security'

What are the key factors influencing Chinese energy security policy and how has this policy responded and evolved over time to meet China's changing energy security needs and challenges? What are the challenges China is said to be facing, and why are they occurring? Firstly, to help put these questions into context, definitional contestations in the areas of energy security will be highlighted, whilst energy dependence and the geopolitics of energy will be addressed throughout the chapter. The history and evolution of Chinese energy policy will be examined, along with the driving political and economic factors said to be behind this evolution over recent decades since China's rise to great power status began. Finally, the types of energy security challenges – both global and domestic - said to have influenced the changes in China's economic and energy policy responses will be analysed. The impacts these, and other geopolitical influences have made upon China's energy policy decision-making processes, and the energy diversification strategies China is currently employing to overcome these challenges, will be analysed concurrently.

Energy Security

Energy security is considered an essentially contested concept, with no less than forty-five separate definitions having been identified (Sovacool 2011b, 3-6). These definitions range from: "[t]echnical feasibility, affordability, environmental protection, reliability, and security of supply" (Sovacool 2011b, 5); Drezel's alliteration - the "five Ss: *supply*; *sufficiency*; *surety*; *survivability*, and *sustainability*" (Sovacool 2011b, 5, emphasis in original); to those of international organisations (IOs) such as the International Energy Agency (IEA 2014):

> "[t]he uninterrupted availability of energy sources at an affordable price. Energy security has many aspects: long-term energy security mainly deals with timely investments to supply energy in line with economic developments and environmental needs. On the other hand, short-term energy security focuses on the ability of the energy system to react promptly to sudden changes in the supply-demand balance. Lack of energy security is thus linked to the negative economic and social impacts of either physical unavailability of energy, or prices that are not competitive or are overly volatile."

One succinct definition which is not included in Sovacool's extensive nomenclature is provided by Shaffer, who defines energy security as: 1) Reliability; 2) affordability; and 3) environmental friendliness of energy resources (Shaffer 2009, 93, and 2012, 4). Shaffer argues that energy and commodities markets alone cannot ensure all three (reliability of supply and environmental friendliness in particular), therefore, the continuance and centrality of the state is vital in securing them through political policies (Shaffer 2009 and 2012). Accordingly, the state effectively maintains both a vital and inextricable link between energy and politics - an "energy-politics nexus" (Shaffer 2009, 166) - the existence and maintenance of which being especially significant when analysed within the context of the "direct correlation between economic growth rates and energy consumption rates" (Shaffer 2012, 5).

Essentially, the definition of energy security has broadened and evolved over the last decade or so, from narrow definitions surrounding the physical supply of energy resources, to broader interpretations focusing upon affordability, sustainability, "environmental protection, and social acceptance" (Berrah *et al*. 2007, 2). In keeping with the definitions of energy security outlined above, the key objective of energy security, therefore, is to ensure that "adequate, reliable supplies of energy [are obtained by states] at reasonable prices and in ways that do not jeopardize major national values and objectives…supplies, markets and communication, and transportation routes" (Ogle 2010, 188).

Key Drivers of China's Current Energy Policy

China is home to approximately 1.3 billion people, whose net income per capita is rising along with its energy consumption (Cáceres and Ear 2013). Consequently, China is the biggest energy-consuming state globally, the largest total resource importer of commodities such as coal and iron ore, and the second largest oil importer after the US; it overtook Japan as the second-largest economy in 2010, and by many calculations, is set to replace the U.S. as the world's leading economy (Cáceres and Ear 2013). Economic growth and development for such a large industrial sector and population, however, comes at a price, as some believe China's "growth in energy consumption is posing a real threat to China's energy security" (Garrison 2009; Ogle 2010, 207). To put the scale of the problems China is facing into perspective, in the period between 1990 and 1996 as a result of the economic policies initiated by Deng Xiao-ping, China's economy grew by more than 93 per cent, with energy consumption alone rising by almost four times the rate of the anticipated consumption by Europe and the U.S. combined by 2020 (Klare 2002, 16-17). This rise in energy demand and consumption has resulted in "a corresponding increase in the consumption of…coal, oil, natural gas, nuclear energy, and hydropower" (Klare 2009b, 183).

It is within the context of China's increasing energy consumption, subsequent shortages, and the energy security challenges China is facing now and over future decades, that from 2007 onwards, its energy strategy and policy shifted from relying solely upon fossil fuels, to announcing plans to expand its fledgling nuclear industry (Yan et al. 2011; Zhou et al. 2011; Wang 2009). Considering reliable and continuous affordable sources of energy are seen as a pre-requisite to ensure sustained economic growth, it comes as no surprise that China has sought energy policies and strategies to ensure energy self-sufficiency, and to provide cheap, reliable sources of energy to millions of people around mainland China (Chang 2001).

Components for Ensuring an Effective Energy Security Policy

One tool considered necessary for optimising a state's chances of achieving and maintaining energy security and energy self-sufficiency (whether this is considered to be a realistic goal for many states around the globe, not just China), is an effective energy policy (Luft 2012; Ogle 2010). To this end, energy policies can be considered "an integral part of a nation's external trade, foreign relations, and security policy" (Ogle 2010, 183), and designed to ensure dependency upon other states for energy and resources is minimal, where energy dependence is defined as "the ratio of energy imported versus the energy consumed" (Ogle 2010, 194). Where resource and energy-dependency is unavoidable due to an imbalance between the availability of a state's own domestic supplies and the demand and consumption of resources for energy purposes by its population and industry sectors, effective energy policies designed to diversify and secure external resources and energy supplies are essential (Klare 2002, 2009a and 2009b; Shaffer 2009). An energy policy which ensures affordable and reliable energy supplies, whilst also remaining cognizant of geopolitical issues and considerations, should (at least in principle), be of the utmost priority for states when devising such policies (Garrison 2009; Jones and Steven 2015; Klare 2002; Ogle 2010).

As energy demand and consumption increasingly continues to out-weigh availability and supply in large economies in the developing world such as China, India, and Brazil (Klare 2002, 2009a and 2009b), some have argued that geopolitical influences surrounding energy - "the effect of the location of resources on states' politics" - have never been more important (Ogle 2010, 184). Energy and resources are increasingly being viewed as central themes and sources of discord between states, and nowhere is this more evident than in the Asian region as China and India compete for access to scarce overseas resources in order to sustain their large developing economies (Economy and Levi 2014; Jones and Steven 2015, 19; Klare 2002, 2009a and 2009b). The possibility that resource competition may lead to geopolitical rivalry and even conflict, therefore, is a crucial hurdle for China to overcome in terms of being able to negotiate resource extraction agreements with other large economies, and is possibly the key factor underpinning China's "multi-layered 'new diplomatic approach'", or 'go out' strategy (Cáceres and Ear 2013, 29).

Chinese Energy Policy Responses and Evolution: The Initial Catalyst and its Links to Neomercantilism

A critical turning point whereby Chinese domestic oil consumption exceeded domestic production occurred in 1993, bringing about an end to energy self-sufficiency, and forcing China into a position of greater reliance upon imports from outside states (Friedberg 2006; Shaffer 2009). Dependence upon others to secure resources for sustaining economic growth and development tends to be viewed as a "necessary evil", and "part of the price…developing economies must pay to achieve rapid modernization" (Roy 1994, 159). China's energy sector, particularly on the demand-side, is now facing similar dependency challenges if China is to continue on its current economic growth and development trajectory, and meet the energy demands of its manufacturing industries, and domestic population in general (Shaffer 2009).

Ever since Deng Xiaoping's "reform and opening" period from the late 1970's onwards, and in order to shrug off its perceived economic 'backwardness' relative to the highly-developed and industrialised western states, China has increasingly relied upon overseas suppliers for investment and technology transfers, in combination with an economic strategy of exporting "low-to-middle-end" manufactured goods, as its development model to drive its economic growth forward (Cáceres and Ear 2013; Garrison 2009; Roy 1994, 159). Neomercantilism and Asian mercantilism are terms that have been used to explain the underlying factors and drivers of China's overseas resource, or 'go out' policy, particularly in the African region (Holslag 2006, 134). The impetus for this policy within the context of Chinese neomercantilist economic practices can be found in the corresponding power shortages which started to worsen and spread from 2002 onwards, due to an increase in demand both privately and commercially: In a four-year period to 2004 alone, electricity demand rose dramatically from 9 per cent to 16 per cent per annum (Xu 2012, 135-36). The most recent statistics for China's total energy consumption, demonstrate a 36 per cent rise in total energy consumption between 2004 and 2008, with an overall decrease in consumption by 2 per cent (to 34 per cent) between 2008 and 2012, following commencement of China's nuclear expansion plans (EIA 2015).

China's main neomercantilist objectives concerning energy and resource procurement within the context of the 'go out' policy, are to "increase their [domestic] oil and gas reserves…expand production and…diversify their sources of supply" (Jiang and Sinton 2011, 12). The ways in which this could be achieved would to be by investing heavily in mining and resource infrastructure, and other forms of infrastructure, such as roads and rail links in developing countries, so as to secure the extraction and transportation of those supplies (Jiang and Sinton 2011, 12). Indeed, as of 2010, the newly-formed National Energy Commission agreed that "securing energy supply through international co-operation" would be considered one of China's major objectives, and outwardly demonstrated that both Chinese government officials as well as state-owned energy companies shared concerns over China's future energy security (Jiang and Sinton 2011).

Perceptions of Chinese neomercantilist tendencies and policies, however, are also linked to the China's rise and 'threat' perception narrative (Barclay and Smith 2013, 129), with China perceived to be operating a zero-sum game vis-à-vis energy and resource acquisition: "When Chinese resource companies face the choice of national interest or commercial gain, the latter nearly always wins out"

(Barclay and Smith 2013, 129; Friedman 2006). China's neomercantilist practices towards its energy sector are said to be outwardly demonstrated by the 'go out' energy resource security policy, which began in 2002 under the CCP leadership of Hu Jintao in the midst of China's domestic power shortages (Holslag 2006).

SOEs operating in China's energy sector were provided with generous tax incentives and finance and investment opportunities by the CCP in return for Chinese FDI in overseas countries rich in essential energy resources such as coal, oil, and gas, and including uranium for domestic nuclear power production (Holslag 2006; Xu 2012). To date, more than half of all Chinese FDI in Africa, Asia (Central, Eastern, and Southern regions), the Middle East, and South America has been in securing and extracting resources alone (Garrison 2009). This has been made possible through the help of "state diplomacy and financial backing", the majority of which centres upon oil production and exploration for export directly back to China, but also for sale onto global commodities markets (Garrison 2009, 32-33).

China's Quest for Energy Security and the Insecurity Paradox: Chinese Policy Strategies for Overcoming this Dilemma

Since the 'reform and opening' of Deng Xiaoping's economic growth and development policy, and until 1993, China's energy supply, by and large, has "met the needs of the country's rapid economic expansion" due to its vast domestic coal and oil reserves, with imported energy representing less than 6 percent of total domestic energy supply (Berrah et al. 2007, 1). But in spite of China's rapid economic growth and energy self-sufficiency during the 1980s and 1990s, China's policy-makers have become increasingly concerned over future domestic energy demand and supply as a result of China having become heavily dependent on imported oil supplies, which had risen to over 45 per cent of China's total energy consumption in 2005 (Berrah et al. 2007, 2).

Even though China's rise over recent decades has been made all the more possible by a corresponding increase in the production and acquisition of energy, it seems that an unrelenting quest for energy security is also contributing to the insecurity large developing economies such as China appear to be feeling (Klare 2009b). The Chinese government is only too aware of these problems and challenges, having gone from a position of net energy exporter of its domestic oil supplies, to now having to import more than half its annual total to satisfy domestic energy requirements in just a little over two decades (Jones and Steven 2015).

China's energy policy objectives in view of the widening schism between energy production and consumption, has led the CCP – largely acting through SOEs - to seek energy policy and security strategies that encompass the ability to obtain, secure, and transport sufficient supplies at affordable prices. But this strategy alone has been insufficient. China's two-pronged strategy concerning diversification has been key in attempting to close the gap between consumption and production: 1) diversification of energy source – multiple external supplies through its 'go out' policy of non-interference in resource and energy-rich (and quite often politically unstable) states such as Angola, Kazakhstan, Libya, Niger, Venezuela; and 2) diversification of energy type to reduce its dependence upon hydrocarbon-based fuel sources, such as oil, coal, and LNG, by investing in nuclear power and renewable energy sectors (Klare 2009b).

To date, China's energy concerns are said to arise from four factors: 1) a growing population; 2) insufficient domestic energy resources to ensure sustained economic growth over the long-term; 3) poor policy co-ordination; and 4) internal conflicts within the CCP and government ministries outside of those solely responsible for energy policy co-ordination and implementation (Cáceres and Ear 2013, 22; Garrison 2009). China's energy sector is also considered to evolve within a "cocoon of economic protectionism", with some arguing that it lacks a coherent and cohesive strategy due to the multitude of different actors involved (Garrison 2009, 32). To this end, China - in relation to the state's political influence and control over its energy sector policy and strategy – can be described as a "fractured central state" trying desperately to exert control and influence over a multitude of commercial entities and a vast web of decentralised local governments, each with their own competing interests and serving to protect the energy sector (Garrison 2009, 32). In order to try and reduce the burgeoning energy consumption and dependency, and expanding bureaucracy, China established the State Energy Office (SEO) with the purposes of increasing China's diversification of energy sources and types, as well as lowering China's energy dependence upon external states and sources to 5 per cent (Ogle 2010, 194).

China's 'go out' energy security policy, although effective in extracting large amounts of resources, has been viewed as a 'back-door', or *quid pro quo*, type-of-approach by some towards securing the energy resources it requires, by directly investing in infrastructure in politically unstable countries, such as Nigeria, Angola, and Sudan, in return for securing the resources it requires (Holslag 2006). This practice, although potentially both financially and politically costly, however, is a way of ensuring China can bypass international markets in certain resource sectors – an energy wholesale approach if you like – by dealing directly with each state and negotiating contracts accordingly "with major suppliers to gain advantage" (Garrison 2009, 33).

In short, China's future economic certainty is so dependent upon securing and accessing reliable, plentiful, and affordable energy resources, that to not do so would be considered economic suicide (Cáceres and Ear 2013; Garrison 2009; Jones and Steven 2015). The direct central government involvement on behalf of the CCP could turn out to be a risky manoeuvre, however, as the geopolitical risks associated with dealing and investing in countries with less than transparent political regimes are rarely taken into consideration, such is China's overwhelming thirst to secure the resources it requires to ensure its future economic success (Garrison 2009; Holslag 2006). China's 'go out' policy could also lead to greater external dependence on states in Africa and South America who are deemed to be in the geopolitical high-risk category, therefore China's decision to expand its domestic nuclear sector and develop indigenous nuclear technologies could be viewed as a way of countering greater resource dependency and geopolitical risk-taking.

Chapter 2 –'The Expansion of China's Nuclear Energy Programme: Rationale for Adopting Nuclear Power to Ensure Domestic Energy Security'

China is facing serious energy security challenges resulting from increasing demand without a corresponding rise in domestic supplies, leading to greater amounts of energy resources needing to be imported. Why then has it considered expanding nuclear power to provide a possible solution to these problems? Firstly, China's current energy mix will be discussed, followed by an examination of its nuclear energy sector – from its nascent beginnings to the present day – and the political leadership involved at various stages of planning and development. The chapter will focus on structural issues associated with the Chinese government and industry bodies involved in the nuclear power sector and their influences. This will serve to highlight the complexity and poorly co-ordinated nature of the industry and the multitude of actors that play a part in its overall lack of structural cohesiveness, in turn, impacting the energy policy, and decision-making processes. What China hopes to achieve from their nuclear expansion plans, some of the challenges China faces by doing so, and the problems these plans are aiming to resolve will also be discussed.

China's Energy Mix

Today, almost seventy per cent of China's power is generated from coal. Because of environmental sustainability, pollution, and concerns over the impacts of climate change, China has increasingly sought to reduce its dependence upon fossil fuels and diversify its energy sector (Bodansky 2004; Garrison 2009; Klare 2009; Tunsjo 2013). For these reasons, as well as the energy dilemma it is currently facing with regards to domestic supply and demand, China is endeavouring to construct forty nuclear power stations by 2020 at the earliest (in addition to the twenty-one fully-operational commercial plants it currently has), and is aiming to overtake the U.S. as the world's largest nuclear power producer by 2050 (Hubbard 2014; Ogle 2010; Zweig and Bi 2005). These targets are all the more ambitious considering China currently generates approximately 1.4 per cent of all its energy from nuclear power, thus the more it can diversify its energy sources, the greater the chance of reducing its reliance upon fossil fuels (Ogle 2010, 206; Tunsjo 2013). A lack of installed nuclear power capacity in some regions of China (predominantly eastern) is hindering the economic development of these areas, and as a consequence, they have had to heavily rely upon coal as their primary source of energy – a reliance which is also impacting heavily upon the delicate river-system regions of the Yangtze River and Pearl River Deltas (Yan *et al*. 2010, 747).

Oil is the energy-type China currently imports in the largest quantity (and has done so since the nineteen-nineties), as well as LNG for domestic energy purposes, and coal for its industrial and manufacturing sectors (Shaffer 2009; Tunsjo 2013). In order to try and keep up with demand, China has diversified its energy mix to include – amongst nuclear energy – bio-mass fuels, photo-voltaic technology (solar), hydro-electric, and wind power, but it has also aimed to improve and increase energy infrastructure around the country, particularly in rural areas (Garrison 2009; Lin, Yang and Portner 2013; Tunsjo 2013). With regards to reducing reliance upon fossil fuels and their associated environmental impacts, whilst providing cheap effective power generation, the only energy source considered sufficient to be able to provide large-scale power generation over widespread areas with little or no carbon dioxide emissions (with the exception of hydro-electric power), is nuclear power (Carpintero-Santamarsia 2010; Klare 2009; Zhang 1998).

China possesses large domestic coal reserves (the third largest in the world after the U.S. and Russia), and so following on from the point in 1993 at which China found itself having to rely more heavily on oil imports rather than its own domestic oil reserves, coal was viewed by China as the solution to its predicted future energy shortages (Klare 2009; Sovacool and Valentine 2012). China's reliance upon coal and increasing consumption since this time in order to maintain a steady rise in its economic growth, has led to it receiving the unfortunate title of the world's leading emitter of greenhouse gases, which has subsequently led to increasing pressure from the international community for China to reduce its reliance on coal and seek energy alternatives (Klare 2009). It is with the environmental issues and concerns associated with large, sustained coal usage, combined with the domestic energy shortages that the Chinese government faced from the early 1990s onwards, and a spike in global energy prices, which provided the basis for the Chinese government to start to more seriously consider nuclear power as a potential solution from the early 2000s (Klare 2009; Yan *et al.* 2011; Zhou *et al.* 2011).

Following the global oil shock which occurred during the early 1970's, nuclear energy was considered the most efficient form of energy, as well as the cheapest alternative to fossil fuels, and viewed as an energy panacea (primarily by the U.S.), to be used as a political tool in order to reduce the western world's reliance upon the oil-producing states of OPEC (Clark 1990). Great expectations had also been placed upon nuclear energy as a fast and clean - if not altogether cheaper - alternative to replace the global demand, thirst, and reliance upon fossil fuels (Clark 1990). Indeed, as a direct consequence of the inflated oil prices during this time, global power generation and production through nuclear energy grew markedly during the 1970s and the 1980s, before slowing down following the Chernobyl disaster in 1986 (Bodansky 2004).

In the U.S. and Western Europe from the 1970s onwards, the promise of greater reliance on, and abundant enthusiasm towards, nuclear power as a mainstay for large-scale energy generation and production, started to wane. Country after country throughout Western Europe followed in the footsteps of the U.S. and either down-sized their existing capacity for nuclear energy production, or shelved projects for expansion in their nuclear sectors entirely (Clark 1990). Following a drop in oil prices, the rise of environmental and nuclear activists in western states, and its failure to become a cost-effective and competitive energy form relative to oil and coal, nuclear energy ceased to be seen as neither a viable, nor as a safe energy alternative for future generations (Bodansky 2004; Clark 1990).

A Nuclear Renaissance?

Where demand and popularity for nuclear power has diminished in developed countries over recent decades, interest and investment in this energy sector has increased in many parts of the developing world (in countries such as India, Vietnam, Myanmar, and Kazakhstan), due to the prestige often associated with possessing advanced technologies such as nuclear reactors (Garrison 2009; Wang 2009; Yan *et al.* 2011). This demand and interest has occurred most notably in Asia, with China often viewed as taking the lead in this regard with its nuclear energy development and expansion plans from 2007 onwards viewed by some to be “aggressive”, somewhat ambitious and unrealistic, and quite unlike any other state’s energy policies and plans to date (Tiezzi 2014; Wang 2009; Yan *et al.*2011; Zhou *et al.* 2011, 771).

The result of nuclear power’s resurgence in popularity in many parts of the developing world has led many to consider this to be a sign that a “nuclear renaissance” is upon us (Zhou *et al.* 2011, 771). It is a term widely used to describe the growing interest in increasing nuclear power generation and production to meet the world’s – particularly countries in developing regions such as Asia – energy requirements and demands, whilst increasing levels of economic growth and development, and reducing carbon dioxide emissions (Barré 2013; Carpintero-Santamarsia 2010; Zhou *et al.* 2011, 771).

Some are critical of these claims and vehemently opposed to nuclear power being viewed as a safe, clean, and viable alternative to fossil fuels in terms of the economic and political costs often incurred by implementing it, and the potential safety concerns often associated with this form of energy (Sovacool 2010, 2011a and 2011b; Sovacool and D’Agostino 2010; Sovacool and Valentine 2012). With these criticisms in mind, the idea and practicalities associated with a ‘nuclear renaissance’ are viewed by some to be fool-hardy, and deemed an unnecessary development path for any country to even conceive of venturing down considering the continuous improvements in the efficiency and efficacy of renewable energy technologies, furthermore, increasing investment, not only in the developed world, but around the globe (Sovacool and D’Agostino 2010).

From Swords to Plough-Shares

From as early as the mid-nineteen eighties, just as China was beginning to open up to the rest of the world, scholars as well as international organisations such as the World Bank started to predict that nuclear power would play a much greater role in sustaining and securing China’s future economic growth and development. They also asserted that in order to successfully initiate and sustain it, China would require “a major long-run commitment in terms of manpower and infrastructure development” (World Bank 1985, 131; Zhang 1998). The report also accurately predicted China’s future reliance upon coal as a primary resource (both domestic reserves and imported supplies) for domestic power generation and production, as well as acknowledging the associated consequences of such reliance in terms of the environmental impacts (World Bank 1985).

Although the demand and consumption of electricity in China increased in the first few years of the twenty-first century (representing a positive correlation with China's increased economic growth and social development), China's desire to become energy- independent through self-sufficiency can be traced back to the Mao era, particularly following the Sino-Soviet split which occurred in the latter 1950s (Zhou *et al.* 2011). Prior to the split, China had depended on the Soviet Union's technical expertise in this direction, but after this relationship turned sour, Mao argued China should strive to become independent, and considered self-sufficiency key towards achieving this (Falk 1982). The building of nuclear reactors for power generation, however, was deemed by Mao to be largely unnecessary at this time, as China possessed considerable domestic oil and coal reserves for the purposes of generating large amounts of power (Sovacool and Valentine 2012).

The nascent beginnings of China's nuclear power programme instead originated in national security and military applications arising from nuclear weapons' programmes from 1955 onwards, after an initial proposal was considered in the "Five-Year Plan" in 1953 (Sovacool and Valentine 2012, 190). These plans, however, did not move on apace until the subsequent economic reforms and transformations of the post-Mao era under Deng Xiaoping. This period in China's economic and political history is viewed as being central to the shift in the focus of nuclear technology, from national security, to developing and evolving along a path towards becoming an essential energy source for sustained economic growth and social development, aimed meeting the increasing needs and demands of China's population and industrial production and export sectors (Zhou *et al*. 2011). Following Mao's death in 1976, and under the reformative leadership of Deng Xiaoping, Mao's policy of self-sufficiency was replaced by Deng's vision of modernisation, namely in the four areas of "agriculture, industry, science and technology, and national defence" (Falk 1982, 242).

In response to economic reforms outlined by Deng Xiaoping in the late 1970s, China transferred the majority of its financial resources from the military and weapon's production activities in order to focus greater resources on improving China's economy (Zhou *et al*. 2011). But, despite China's plans for nuclear energy expansion in-line with the economic reforms and subsequent growth of the late 1970s onwards, its civilian nuclear power programme remained "modest until 2005" due to a lack of strategic planning, and a reliance on domestic coal and oil supplies to meet its industrial and domestic energy requirements; nuclear energy was not, therefore, "integrated into China's overall strategic energy plan" at this time (Zhou *et al.*2011, 772).

Not only was a lack of strategic planning , institutional governance, and co-ordination lacking at this time to take the industry forward, development in the Chinese nuclear energy sector lacked significant financial investment necessary for nuclear reactor construction to begin in earnest. The necessary economic incentives to expand commercial nuclear power production were in short supply at this time, and a corresponding lack of political will was also an issue (Zhou *et al.* 2011). Greater emphasis upon economic activity and nuclear energy only came to the fore once China's economy (under Deng's reforms) had shifted from a central, to a more market-orientated position, and the security threats and interests of the Cold war era had diminished (Sovacool and Valentine 2012; Zhou *et al.* 2011).

Nuclear Power Development and Long-Term Aspirations

The first Chinese commercial nuclear power plant was built in 1981 at Haiyang in Zhejiang province, eleven years after Premier Zhou Enlai delivered a speech emphasizing the need to explore the peaceful use of nuclear energy, and twenty-six years following the initial proposals put forward during Mao's leadership (Sovacool and Valentine 2012). Shortly afterwards, in 1982, the Ministry of Nuclear Industry (MNI) was created and was subsequently renamed the China National Nuclear Corporation (CNNC) in 1989 (Tunsjo 2013; Zhou *et al.* 2011).

China initially emphasised self-reliance primarily upon domestic production of nuclear power plants and associated technologies, and where this was not possible, assistance with design and technology transfers would be sought from overseas supplier-states such as France, Canada, and Russia, and implemented in order to benefit domestic design and production (Zhou *et al.* 2011). Because China was able to utilise nuclear technology transfers from external states for the benefit of improving and streamlining domestic reactor design and construction, three fully-operational commercial reactors were up and running by 1994, with a further five by 2003, making a total of eight fully-operational commercial plants by 2004 (Bodansky 2004). The Chinese sought nuclear technology transfers from overseas suppliers because they believed this would accelerate the rate at which they could develop their own indigenous nuclear technologies, which it was hoped would eventually lead China towards energy self-sufficiency and towards becoming a world leader in these fields (Zhou *et al.* 2011). Indeed, such is the extent of China's quest for domestic nuclear energy expansion, it has formerly declared it hopes "to be a world leader in nuclear power in 2020" (Chen 2014; Tiezzi 2014).

A white paper released by the CCP – the Information Office of the State Council of the People's Republic - approved a ''Medium- and Long-term Nuclear Power Development Plan'' (2006–2020), which outlined its goal of increasing China's nuclear capacity to about 40GWe by as early as 2020 (Wang 2009). In a second white paper released in 2007 and entitled ''China's Energy Conditions and Policies", nuclear energy was listed as an indispensable energy source and the paper suggested that the Chinese government should transform nuclear energy from a moderate development role (as outlined in the '10th Five-Year Plan') to an active development role as outlined in the '11th Five-Year Plan' (NDRC 2007; Shaffer 2009). Two years later, Chinese nuclear energy development had shifted from a state of ''active'' to ''aggressive'' development (Wang 2009, 772), but was brought to an abrupt halt in 2011 following the Fukushima reactor disaster in Japan (Hubbard 2014).

Prior to Fukushima, China had started to re-examine its nuclear reactor design and technology development from 2008 onwards. This was initiated by the CNNC in order to improve efficiency, both economically and in terms of power production, as well as to develop policies in order to standardize nuclear reactor design and the manufacturing of associated technologies in-line with concerns over safety and inefficiencies (Hubbard 2014; Sovacool and Valentine 2012; Zhou *et al*. 2011). Along with current policies on economically-driven domestic growth and development, changes to China's energy policy with respect to its nuclear sector in these regards are also underpinning and driving China's nuclear energy expansion plans forward, as well as expediting the required reactor construction and infrastructure (Wang 2009, 773). In 2008, following on from these policy changes and initiatives, conservative estimates suggested that China's nuclear power capacity would increase from just over one, to five per cent of all electricity generated domestically in China by as early as 2020 (Wang 2009). This translates into a 60GWe total energy production capacity which provides the basis for China's assertions of not only meeting, but exceeding, previously released targets in 2006 of 40GWe to be achieved in the same time period (Wang 2009, 773; Tunsjo 2013).

China's Key Nuclear Players

The key stakeholders in China's civilian nuclear power sector, and those responsible for setting China's nuclear energy expansion targets, include: 1) Government organisations and SOEs; 2) the nuclear industry itself; and 3) nuclear energy-specific research organisations (Zhou *et al.* 2011, 773). Generally speaking, government organisations and SOEs are largely responsible for the planning and licencing of all new and pre-existing nuclear reactor projects, whereas the nuclear industry and research organisations play more specific roles in the implementation of China's current and future nuclear energy policies and planning, including China's proposed expansion plans according to the CCPs 2007 White Paper (Wang 2009).

Planning, approval, and licencing are often complex and convoluted procedures in China, involving multiple layers of bureaucracy at all levels of government, and only three Chinese SOEs – the so-called "nuclear troika" – are granted licences to own and operate nuclear power plants (Zhou e*t al*. 2011, 774). These SOEs operate at both regional and national levels, and are as follows: The CNNC - by far the largest national body with the broadest remit, responsible for over-seeing "scientific research and development, design and construction, production and operation in various fields such as nuclear military industry, nuclear power, nuclear electricity generation, nuclear fuels and nuclear technology application, as well as international economic cooperation and import and export businesses" (CNNC 2015); CGN (formerly known as the China Guangdong Nuclear Power Group) - the largest "clean energy group" in China (CGN 2015); and CPIC - the largest state-owned electricity producer in China

(Zhou *et al.* 2011). An additional SOE, the State Nuclear Power Technology Company (SNPTC), is solely responsible for overseeing the selection and implementation of overseas technology and facilitating nuclear technology transfers (Wang 2009).

China's Ad Hoc Energy Policy Approach

From 1993 onwards, in the wake China going from a position of net oil exporter to net importer, China (perhaps somewhat surprisingly), has not developed and implemented a national ministerial-level government department specifically responsible for the development and implementation of energy-related policies (Ogle 2010). Some suggest that as a result, national energy policy development, implementation, and co-ordination efforts have been operated on a somewhat *ad hoc* basis and poorly co-ordinated, resulting in uneven nuclear power plant and infrastructure developments around the country, particularly in rural eastern China (Yan *et al.* 2010).

The Chinese government have made repeated attempts to create a central energy policy co-ordinating body, but all have failed due to persistent opposition from the main state-owned energy companies and organisations outlined above, as well as from other ministries within the CCP (Ogle 2010). The State Energy Office (SEO) is one such example of an attempt to create a central policy co-ordination body which reported directly to the CCP leadership, but one which ultimately failed. The SEO was initially set up in 2004 with the chief purpose of co-ordinating and implementing policies specifically targeted towards reducing China's dependency upon imports such as oil and gas, from twelve per cent in 2004, down to five per cent (Zweig and Bi 2005). Due to internal political wrangling and the 2007 White Paper announcing China's intention to expand its nuclear energy sector, however, the SEO lost its stand-alone energy agency status, became the National Energy Administration, and was subsequently absorbed into the much larger umbrella organisation - the National Development and Reform Commission (NDRC) - along with thirty-two other separate government departments (NDRC 2015; Wang 2009; Zhou *et al.* 2011).

Systematic political and industry governance issues that reach well beyond the energy sector and nuclear industry, and poorly co-ordinated, under-staffed, and inconsistent energy policy-making bodies, which are both under central CCP control and regionally de-centralised at the same time, all represent vast hurdles for China to overcome in order for their expansion plans to become fully realised (Ogle 2010). The effective and efficient governance, co-ordination, and implementation of this ambitious, yet potentially feasible energy policy, as well as over-arching governance of the energy sector itself, is being further compounded by logistical issues such as a lack of skilled manpower at all levels of the nuclear industry and its associated bureaucracies, investment, and institutional reform (Zhou *et al*. 2011).

These long-term major issues aside, the immediate challenges China is facing with regards to enabling the future success of these plans, mainly centre around the following critical issues: 1) the need to improve Chinese nuclear safety and security culture, particularly in the wake of the Fukushima disaster, as concerns remain surrounding the speed at which many facilities are constructed and the disposal of radio-active waste, which may not be in accordance with the equivalent U.S. and European standards for reactor construction; 2) corresponding insufficient, and often opaque, legal and regulatory systems due to a lack of co-ordinated responses, implementation, and governance at all stages of the policy-making process; 3) flailing public trust and engagement, made all the more evident in the wake of Fukushima; and, 4) inadequate research and development capabilities and investment from SOEs and research-specific facilities and organisations (Hubbard 2014; Zhou *et al*. 2011, 778-780).

China's nuclear expansion plans were formerly set in motion from 2007 onwards, and as yet, are still in their infancy. It remains to be seen, therefore, whether they will come to be fully realised and succeed over the coming decades. Predicting China's long-term future energy security outcomes with any degree of certainty is all but impossible, even though certain trends may already be established, such as decreased fossil fuel consumption, a corresponding increase in energy type and sector diversification and investment, resulting in improved nuclear and renewable technologies and infrastructure. Some have argued that China's nuclear expansion plans and its nuclear industry in general, combined with its current economic growth and development trends, provide fertile and stable ground for these ambitious expansion plans to come to fruition, but only if the challenges and potential stumbling blocks outlined above are remedied and overcome (Massot and Chen 2013; Yan *et al.* 2011; Wang 2009; Zhou *et al.* 2011).

The domestic energy security challenge China currently faces is rooted in a multitude of inter-linking factors that are not easily discernible from one another, making it difficult to pinpoint one specific cause. The key reasons for China choosing expand its nuclear energy programme are that it faces a durable and intractable domestic energy security problem due to increased demand and consumption on behalf of its industrial sectors and population, and its inability to keep energy supplies in-line with this demand. The result of this energy security quandary has meant that China has had to diversify its energy sector and expand its nuclear sector accordingly to better meet demand, as well as reduce the environmental impacts that have resulted from decades of reliance upon fossil fuels (Tunsjo 2013). But, are government, industry, and institutional structural challenges the greatest of China's concerns in implementing these plans successfully? What of China's domestic uranium reserves? Will these prove sufficient to enable these plans to be fully realised over China's medium- and long-term future, and ensure China avoids dependency on overseas supplier-states for uranium?

Chapter 3 – 'Striking a Faustian Bargain? How China Will Ensure Reliable Uranium Supplies'

Following the analysis of key factors underpinning China's decision to expand nuclear power to overcome the energy challenges it is currently facing, this final chapter will focus on whether China has sufficient domestic uranium reserves in order to do so. It will examine whether China's 'go out' policy is at odds with notions of neomercantilism, and if this variant of 'Asian mercantilism' will pose any problems for China over the long-term. Firstly, current and future Chinese and global uranium reserves will be analysed, how these translate into electricity generation and production, and over what time period. Secondly, the implications for China and other developing countries hoping to emulate China's model of nuclear energy development and expansion will be discussed. Lastly, whether China's quest to secure external uranium supplies could lead to increased geopolitical risk-taking, and how crucial relationships with uranium-supplier states will be towards enabling the success of China's nuclear expansion plans.

The 'Faustian Bargain' as a Metaphor for Resource Dependency

As previously discussed, the association of nuclear energy in relation to the concept of a "Faustian bargain" was first introduced by physicist Alvin Weinberg (Sovacool 2011a, 1-3; Weinberg 1972, 33). Weinberg's argument was essentially underpinned by utilitarian principles, whereby the benefits of nuclear energy for any society requiring cheap, virtually continuous, and non-polluting power, were perceived to out-weigh the associated, yet unavoidable, costs of large amounts of end-cycle spent fuel in the form of radioactive waste, as well as vast amounts of industry, governmental, and institutional regulation and oversights (Clark 1990; Weinberg 1972, 33). From this point of view, argued Weinberg, society is forced to reluctantly accept and "embrace the 'Faustian bargain'" (Clark 1990, 258).

By using this as a metaphor for China's nuclear expansion and whether it will have sufficient domestic uranium reserves to satisfy these plans, is the move towards nuclear power as a replacement for fossil fuels a 'Faustian bargain' for China, or a carefully calculated strategic move? China is only too cognizant of the need to reduce its dependence upon oil and coal (and reliance on imports of both), by heavily investing in alternatives such as renewable and nuclear energy technologies, to aid towards becoming energy self-sufficient (Zweig and Bi 2005). As highlighted in chapter 2, China's net energy imports were approximately twelve per cent of total consumption in 2004, with the CCP aiming to achieve figures as low as five percent from 2007 onwards (Zweig and Bi 2005). Despite China's optimism regarding these aims, the most recent figures outlining China's net energy imports were produced by the World Bank in 2011/2012, and show a reduction of only just over one percent since 2004 (World Bank 2015a). The same figures, however, also show that during a ten-year period between 2000-2010, China's domestic energy production more than doubled following the energy source and type diversification strategies it had sought to implement from 2004 onwards, which were primarily centred around the nuclear and renewable energy sectors (World Bank 2015b).

Nuclear Power and the 'China Model': Costs and Benefits for China and Developing Economies

Nuclear energy for power generation has huge benefits for increasing China's energy security, and for lessening its dependence upon hydrocarbon-based resources, but only if domestic uranium supplies are adequate to sustain it, or if reliable external sources of uranium can be secured indefinitely to supplement domestic supplies. Traditionally, and in accordance with the tenets of mercantilism, China has preferred to rely as much as possible on its own domestic energy sources in order to try and advance rapid economic growth and development; until 1993, this approach was possible because of China's large domestic reserves of coal, oil, and gas (Klare 2009b). But some scholars and analysts are highly critical of China's claims of being able to maintain its self-reliance and become energy self-sufficient regarding domestic uranium reserves, particularly in view of its ambitious expansion plans, and suggest that the deficit between energy production and consumption China is currently experiencing is set to worsen with continued economic growth (Klare 2009b; Massot and Chen 2013; Wang 2009; Yan *et al*. 2011).

China's nuclear energy expansion and resource strategy is considered to be part of the "China Model" of economic growth and development, and regarded by some to be a blue-print for poorer developing countries such as Vietnam and Myanmar to emulate (Cáceres and Ear 2013, 20). Some are sceptical about its chances of success and recommend that other developing states exercise caution, and don't rush in and reproduce it just yet (The Economist 2010). The 'China Model' - considered to be a unique mixture of autocracy and "transformative capitalism" - has been viewed as misguided optimism on behalf of the countries in the Asian region wishing to adopt it when viewed as an ideal-type economic growth and development formula, especially considering the political and structural challenges China faces in successfully implementing its energy components (Cáceres and Ear 2013, 20; The Economist 2010; Zhou *et al.* 2011).

Uranium Reserves and Global Nuclear Power Supply: China's Plans in Context

If China's energy development goals are to be achieved by 2020 at the earliest, uranium supply needs to be approximately sixteen times the current annual yield, based on figures correct as of 2010 (Wang 2009, 2487; Yan *et al*. 2011, 745). This amount could potentially be as much 12,153 tonnes per annum, far out-stripping China's current supply capacity, potentially forcing greater reliance upon external states for reliable supplies instead (Wang 2009). Indeed, such is the scale of the nuclear power developments planned in China, that if most of the power plants (if not all) were to be operational for the next 40-60 years, demand would outstrip China's domestic uranium supplies by a factor of fifteen (Yan *et al*. 2011, 745-46). With these figures and predictions in mind, it comes as no surprise that the Chinese government is seeking to advance nuclear spent-fuel re-processing technologies and facilities, and fast-breeder reactors concurrently, even though an expansion of re-processing technology is considered to be highly controversial due to the nature of the materials involved (plutonium) and their weapons' applications (Yan *et al*. 2011, 747).

In spite of the subsequent wane in nuclear power's popularity during the 1980s, as of 2009, almost 440 nuclear power plants remained in commercial operation around the globe in 30 countries, representing total global power generation of 375GWe (roughly 14 per cent of the world's electricity), and requiring a total of 68,000 tonnes of uranium per annum (Sovacool 2011b; Wang 2009; World Nuclear Association 2014a). An additional 62 nuclear plants were being constructed in 2011 - 26 of which were in China alone (Barré 2013, 83-84; Carpintero-Santamarsia 2010; Klare 2009a; Sovacool and Valentine 2012;

Hubbard 2014) - with PWR technology being the most common type of reactor in use (Barré 2013, 90).

Current global operational nuclear power capacity is approximately 374GWe (World Nuclear Association 2015a), with China's current operational nuclear power capacity (based on 2015 figures) at approximately 23GWe from a total of 26 fully-operational reactors (representing 6.15 per cent of total global nuclear capacity) (World Nuclear Association 2015b). A further 23 reactors were under construction in China as of April 2015 capable of producing an additional 25GWe, with 45 additional reactors planned to commence construction sometime this year aiming to produce a further 52GWe (World Nuclear Association 2015b). Another 127 reactors are proposed for construction by 2030 (representing an additional 150GWe), but are as yet unconfirmed (World Nuclear Association 2015b). Currently, China's uranium requirement for all of its 26 fully-operational reactors stands at 8161 tonnes (World Nuclear Association 2015b).

The total identified uranium ore reserves globally (of all cost brackets combined – from less than US$40/kg of uranium to more than US$260/kg of uranium), is 7.635 million tonnes currently, with Australia holding 29 percent of all total known reserves at costs of <US$130/kg of uranium (the most commonly accessed and used form of uranium because of its greater abundance and geographic variance), followed by Kazakhstan with 12 percent, and the Russian Federation with 9 percent (OECD/NEA/IAEA 2014, 18-19). Australia, Canada, China, Kazakhstan, Namibia, Niger, Russia, the Ukraine, the U.S., and South Africa, together account for approximately 85 percent of the world's known uranium reserves, and approximately 97 percent of the 52000 tonnes of uranium produced globally (Barré 2013; OECD/NEA/IAEA 2014; World Nuclear Association 2014b).

<u>The Global Uranium Market</u>

The uranium market itself no longer has a producer's organisation like OPEC, with certain regions of the world responsible for politically controlling the majority of supplies (Massot and Chen 2013). The 'uranium cartel', as it was colloquially referred, was formed in 1972 by major uranium-producing states in the West (except for the U.S., back then the holder of the largest known uranium reserves) – namely Australia, Canada, and France - in response to the resurgence in popularity of nuclear power, but was subsequently disbanded in 1976 (Taylor and Yokell 1979, xvi). Consequently, the global uranium market today remains highly-politicised, and an example of Shaffer's 'energy-politics nexus' in operation, whereby maintaining cordial relations with uranium supplier-states are vital for China (or any other state) to be able to secure uranium procurements, with market forces less so (Massot and Chen 2013).

The structure of the international uranium market today is poorly co-ordinated, geographically dispersed, and until recently, had been chronically underinvested with a corresponding lack of interest, making it unlike any other resource market, thus enabling China to more effectively engage with it (and with uranium producing states) to China's advantage (Massot and Chen 2013; Wang 2009). Countries with large known reserves of uranium currently exporting to China, include: Australia (the largest total known reserves globally); Canada; Kazakhstan; Namibia; Niger; and Uzbekistan (World Nuclear Association 2014a). Now more than ever it seems, in view of China's nuclear energy expansion plans, China's relationship with key uranium-rich states such as these will be critical for securing the resources it requires, and will be key partners in enabling China's nuclear power development plans to come to fruition (Massot and Chen 2013).

Unlike commodities such as oil and gas, nuclear power tends to be shielded from the extreme (and quite often geo-politically derived), price fluctuations that are often associated with fossil fuels. This is mainly due to the price of its primary raw input – uranium ore (in spite of it not being a fungible commodity like oil and gas) – only accounting for up to five percent of the total cost involved for producing one kilowatt of energy over one hour when compared to oil and gas equivalents (Barré 2013, 84). Because uranium reserves are geographically distributed around the globe, this means they are not specifically concentrated in regions where access to them can be limited and entirely dependent upon relations with specific types of political regimes, such as military dictatorships in parts of Africa, or autocratic and theocratic regimes in parts of the Middle East, such is often the case when obtaining oil supplies (Barré 2013, 84).

Other advantages of nuclear power include: The power plants themselves, which have an average life-span of sixty years; it still remains the cheapest form of energy to mass-produce for consumers (80 per cent of energy produced from fossil fuels and approximately 50 per cent produced from wind power generation), even though the cost of constructing a nuclear power plant is on average twice the cost of coal and gas plants; and the cost of uranium is only five per cent of the cost of the energy produced when compared to coal (fifty per cent) and gas (seventy per cent) (Carpintero-Santamarsia 2010, 70).

<u>Peak Uranium: The Prospects for Global Uranium Reserves and Emerging Nuclear Technologies</u>

While the exact point at which current known uranium reserves will reach their peak is unknown due to continuous improvements in uranium detection, exploration, and extraction technologies and reactor design, estimates as to how long these reserves are likely to last (based on current global uranium consumption and nuclear energy production), range from forty, to one hundred years (Barré 2013, 99; Klare 2009a). Some analysts have argued, however, that if the 'nuclear renaissance' continues to occur in many developing economies around the globe, a considerable increase in the number of operational reactors - from approximately 440 to as many as two thousand or more - will likely occur (Barré 2013; Klare 2009a). Consequently, the length of time these known uranium reserves will be able to supply this increase in demand will likely diminish, leading to the likelihood of more costly nuclear reactor technologies being sought and constructed – a cost that poorer developing economies are unlikely to bear (Barré 2013).

Fast-breeder reactors are the types of costly nuclear technologies being considered for construction in China as an alternative to PWR technology. These reactors are designed to yield more energy from raw nuclear fuels such as uranium and plutonium than they burn in the entire process, but at a larger cost financially in terms of their construction and running costs due to the advanced technologies involved, as well as the highly technically-skilled workforce needed to run them (Barré 2013, 94). Fast-breeder reactors are the preferred forms of nuclear technology for large-scale expansion plans requiring larger amounts of uranium than available reserves due to greater efficiency, by yielding up to 70 per cent of the available energy from uranium, as opposed to PWRs, capable of yielding only 2 per cent of total energy (Zhang 1998). Because of the sheer scale of nuclear energy development, construction, and expansion, the demand for uranium by China alone could turn out to be millions of tonnes per annum, making the move from nuclear power technology based predominantly on PWRs to expensive fast-breeder reactor facilities an essential and inevitable move if China is to become energy self-sufficient (Massot and Chen 2013; Wang 2009; Zhang 1998). But is this the only solution to a potential uranium supply problem for China?

Some scholars have become quite alarmist, even going as far to suggest that this increase in operational nuclear power capacity across the globe will more than likely lead to uranium becoming more scarce, and, therefore, highly sought after; in turn, this may "trigger yet another geopolitical struggle among the great powers", as they vie for survival in an increasingly zero-sum world (Klare 2009a, 254). Competition over finite resources such coal, oil, and gas – all considered vital resources for the continuation of economic growth and development around the world, in both developed and developing states alike - has not led the 'great powers' spiralling into inevitable conflict, so there is no reason to suppose the same will happen with uranium. Uranium may be a finite resource, and nuclear power a non-renewable source of energy, but to suggest that the increasing popularity of this form of energy production will invariably lead to increased competition (and ultimately conflict), is perhaps in the realms of realist fantasy considering the degree of economic inter-connectedness, co-operation, and co-dependency between states in evidence around the world today – China included (Garrison 2009; Ikenberry 2008).

Chinese Uranium Reserves

Uranium exploration in China began in the mid-1950s, and as of 1998, its main uranium reserves were located in the northern and north-western provinces of Shanxi and Xinjiang respectively (Zhang 1998, 51). During the 1990s when China was beginning to explore nuclear power as a viable future energy alternative to oil, immediately economically exploitable uranium reserves were said to be approximately 100,000 tonnes, with "total known reserves in excess of 800,000"; it was concluded, therefore, that "[China's] domestic uranium supply will not be a limiting factor in…short-term nuclear power development" (Zhang 1998, 51). But what of China's medium- and long-term expansion plans? Recent reports released from the CNNC (the only domestic supplier of Chinese domestic uranium for nuclear power generation and production), claim that due to improvements in exploration, detection, and extraction technologies, China now possesses in excess of two million tonnes of uranium (in the <US$130/kg cost bracket) found in multiple geographical locations on the Chinese mainland (World Nuclear Association 2015c).

In spite of these most recent claims by the CNNC (and of those made previously), some are highly sceptical of China's ability to sustain such ambitious expansion plans, and claim that China will be unable to satisfy these demands by itself, and thus, will become dependent upon external actors for ninety percent or more of its total uranium requirements according to its own projected figures by 2020 (Yan *et al.* 2011). But are these criticisms based purely on the hubris associated with China's aims of becoming energy self-sufficient and a world leader in nuclear power generation and production, as well as a leader in nuclear technology advancements by 2030 (Massot and Chen 2013)? Or are they linked to the broader rise of China 'threat' narrative?

According to the World Nuclear Association (2015c), in order to meet the fuel requirements for its nuclear energy expansion plans,

> "[China's] national policy is to obtain…one-third of uranium supply domestically, one-third from Chinese equity in foreign mines [through its 'go out' resource exploration and procurement policies], and one-third on the open market…Uranium demand in 2020 is expected to be about 11000tU [tonnes of uranium] (with 58 reactors operating), in 2025 about 18500tU (for 100 reactors) and in 2030 about 24000tU (for 130 reactors)."

Considering China's policy proposals as outlined above, coupled with the fact its known uranium reserves are said to be in the order of several million tonnes (if taken at face value), with both domestic and transferred exploration, detection, and mining technologies constantly evolving and improving, it doesn't appear that China's nuclear expansion plans will lack the required uranium supplies for the foreseeable future. If this appears to be the case in reality, China will fail to become the geopolitical threat to other states around the globe it is often purported to pose, at least in terms of acquiring uranium resources for nuclear power generation in order to ensure its own domestic energy security.

The 'Energy-Politics-Economics Nexus' of Uranium

The U.S. Energy Information Administration has predicted that both China and India will more than double their energy consumption over the next two decades and beyond. Both states are investing large amounts of capital in domestic oil, gas, and coal exploration, as well as diversifying their energy mixes to include renewable and nuclear technologies in order to reduce their reliance on fossil fuels (Jones and Steven 2015, 21). Because large populous states such as China are increasingly seeking to extend their reach beyond their borders into multiple regions, this is generally considered to mean that "[e]nergy will…remain a central, perhaps defining, geostrategic issue", as they increasingly go in search of reliable sources of energy (predominantly oil and gas supplies) in regions of the world with high levels of risk and political instability, such as countries in Africa and the Middle East (Jones and Steven 2015, 22-23). But are these problems unique to China?

Some argue that China is merely yet another actor in an ever-increasing pool of states attempting to source and secure energy resources beyond their borders in order to secure their long-term economic futures (Garrison 2009 142). From this perspective, economic nationalism - or more specifically in China's case, Asian mercantilism as this type of policy phenomena has come to be known - is neither uniquely Asian, nor Chinese-centric in origin, once you consider how other states are behaving by attempting to secure energy resources (Garrison 2009; Holslag 2006). If heavily resource and energy-dependent states like India, Japan, and the U.S. are not facing (nor have ever faced) the possibility of having to strike a Faustian bargain in the form of becoming more dependent on external states for resources in order to secure their economic futures, why should this only pose a problem for China? The answer is it doesn't.

Expanding nuclear power production is perceived to be a panacea for over-coming China's energy security challenges over the coming decades. To this end, China is investing a lot of time and financial resources into diversifying its energy mix. It is also producing and developing indigenous technologies designed to improve energy efficiency, infrastructure, and improve their ability to explore, detect, and mine new reserves of coal, oil, gas, and uranium, as well as investing heavily in renewable energy technologies and infrastructure. In turn, the Chinese hope this investment will significantly increase the degree to which China is able to work towards becoming energy self-sufficient (if this is truly attainable in reality for any state), and less reliant on other states and external energy supplies over its medium- and long-term future. As uranium detection technologies improve and the costs of advanced reactor technologies such as fast-breeder reactors become more widespread and thus cheaper to construct and maintain, the amount of China's known domestic uranium reserves will expand, and its power plants will hopefully be more efficient at yielding more from less. Should this prove to be the case, China is no more in danger of striking a Faustian bargain with overseas supplier-states for access to reliable, affordable uranium supplies, thus becoming greatly dependent on them, than any other developing state wishing to pursue similar expansion plans with comparable known domestic uranium reserves.

Conclusion

After reviewing the current literature regarding China's proposed nuclear power expansion plans and analysing the information presented in each of the chapters, China is not in danger of striking a Faustian bargain in order to satisfy its domestic energy needs from continuing to implement these plans as a solution to the energy security challenges it is currently facing. This conclusion is contrary to the initial assumptions made that China was at risk of greater dependence on overseas uranium supplier-states, as opposed to striving towards achieving energy self-sufficiency, however unrealistic this goal may be.

In answer to the central research question of why China has chosen to expand its nuclear energy sector considering the implied geopolitical and economic risks of adopting this strategy, China's increased reliance on oil, gas, and coal imports over recent decades have not proven to be stumbling blocks for economic growth, nor have they led China into a position of greater resource-dependency upon overseas supplier-states. There is simply no evidence to support the assumption that China's nuclear energy expansion plans will inevitably cause China to become dependent upon others for uranium supplies leading to greater geopolitical risk-taking, and be forced into striking a Faustian bargain in a desperate bid to secure its economic and energy future.

China aims to become more than ninety per cent energy self-sufficient over the next few decades in order to ensure it maintains its economic and development growth trajectories. It is aiming to achieve this, not by closing itself off from the rest of the world as mercantilist states operating policies and strategies of economic protectionism traditionally would have done, but by 'going out', forming relationships, and engaging with states in countries in South America, Africa, and in its own Asian neighbourhood. These relationships have the potential to not only benefit China, but to benefit other developing nations also seeking to emulate China's impressive rise.

This viewpoint may seem excessively idealistic given the potential political and economic costs associated with dealing directly with less-than transparent political regimes in many parts of Africa, South America, and the Middle East, but it appears that China is not acting any differently to the ways in which many European states operated in the mercantile era of the seventeenth and eighteenth centuries in order to secure their economies and industrial sectors. Indeed, from the strict viewpoint of China's nuclear expansion plans and the ways in which China intends to secure cheap and reliable uranium supplies to fuel it, there is insufficient evidence to demonstrate that China is behaving any differently to other states around the globe in its pursuance of energy resources. China's relationships with other states, therefore, are not at risk as a consequence of its oft-perceived hostile and aggressive energy and resource policies and objectives. Criticisms of China in this area of geopolitics specifically tend to be bound up in the rise of China 'threat' narrative and therefore analysed almost exclusively within this context.

China's nuclear expansion plans will no doubt be a costly endeavour in terms of the considerable financial investment in indigenous nuclear technologies and reactor design, and recruiting and retaining the highly-skilled workforce these plans will require over the long-term. These elements are especially critical to consider if China intends to continue building fast-breeder reactors at the speed of construction and operational power capacity it intends to pursue over the next few decades in order to counter the energy security demand and supply challenges it is currently experiencing. With developing countries in the Asian region now turning to China's nuclear expansion plans for use as an energy blue-print to enable similar economic growth and development successes, it is critical that China overcomes many of the hurdles it is currently facing. By improving the safety and security of all its operational nuclear facilities, as well as those under construction and consideration, co-ordinate more effectively its energy governance and policy-making bodies, and continue to invest significant time and resources in research and development (particularly in the field of uranium detection and exploration), these improvements will help bolster domestic and international support for these plans and change some of the negative opinions surrounding it.

With regards to the 'China' Model' and the impacts of using China's nuclear expansion plans as a blue-print for developing states in the Asian region and others around the world, these aspects have only been dealt with superficially in this thesis. Further research should be conducted in this area to determine the effects of China's nuclear programme on states such as Iran, Vietnam, and

Myanmar in emulating these plans, given the significant costs – politically and economically – of doing so, their own lack of domestic energy resources in general, and similar energy security challenges these states are now facing. The geopolitical tensions said to be evident between China and India resulting from their respective resource quests towards attaining domestic energy security should likewise be pursued further. This is an extensive topic in itself and has therefore only been dealt with fleetingly here.

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