China in the Climate Change Regime Complex

The Efficiency of the Climate Change Regime Complex and the Bottom-up Approach

Jianglin Qin

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Abstract

In recent years, the idea of regime complex for climate change has become popularised. The influential work of Oran Young (2004) has shown how 'mechanism theory' might explain the influence of international regimes on a country's behaviour. The purpose of this study is to test the utility of a "regime complex for climate change" (Keohane & Victor, 2009) for enhancing the capacity of states to embrace the building of renewable energy industries. Nowhere is the need to combat climate change (CC) more evident than in the case of China. The degradation of the environment and more frequent occurrence of natural disasters has significantly influenced the lives of the Chinese people and the security of this country. By focusing on three constituents of the international regime for CC, I seek to show that China's participation in these areas has played a significant role in China's efforts to build renewable energy technology industries.

China, as the largest emitter of CO_2 has been criticized as one of the laggards, which blocked the negotiation process of an international legally binding agreement. Though under huge social pressure, China does not show too much enthusiasm slowing down its economic development for the sake of combating global climate change. In this sense, focusing on energy innovation is a promising way of pursuing the goals of greening the growing (economically) as a ground breaking study by John Mathews and Hao Tan (2015) in Nature journals has recently shown. A research on the climate change regime's influence on China and China's participation in the climate change regime is of strategic importance as well.

The International regime for climate change has shaped the Chinese government's cost-and-benefit calculations in agreeing to emissions targets and peaking year, China's role and identity with regards to the country's views on the environment-economy relationship, and provided opportunities for China to cooperate with others in a constructive manner, which would otherwise not have been available. At the same time, we cannot ignore the specific characteristics of domestic sectors also matter in explaining variations in China's responses. Importantly, at the same time, China's participation in climate clubs only contributes indirectly to China's energy innovation capacity while national initiative and bilateral cooperation between China and other countries contribute directly to enhance it.

The discussion of the bottom-up approach in this thesis indicates that the bottom-up approach is applied in all the three sectors investigated in this thesis. This approach is carried out with strong unitary political system in the national initiative. In the bilateral cooperation, it was adopted with strong governmental guidance. And the bottom-up approach is considered well adopted by the climate clubs. The project networks established by clubs have put many private entities, governments, individuals on the same platform and intend to make a difference at the project level.

The findings make three key contributions. First by demonstrating the influence of international regimes on state behaviour, the study seeks to bring a "system-level" perspective to the studies of China's leading role in the building of renewable energy technology industries, even the most important works of the field such as Mathew's work (2015) focus overwhelmingly on the quality of the country's domestic institutions especially on the role of Chinese state, while

playing down international factors in bringing about China's renewable energy revolution.

Second, China's response to the international CC regime challenges the perspective of so many studies in international system-level analyses. While writers in this field take seriously the role of international regimes on state behaviour, a widely held view amongst such writers is the international factors have little effectiveness on China and other large carbon emitting states. Indeed, by specifying the conditions for varying levels of the international climate change regime's effects on sectors within China, I seek to show why domestic sectoral characteristics matter a great deal in explaining not only weaker effects of international on the domestic (which is the preoccupation of writers in this Field), but why there are some times stronger effects on state behaviour.

Third, by combining the regime theory and polycentric approach this thesis manages to study two variables within the 3 chosen regime constituents: the role in enhancing China's energy innovation capacity and the status of adopting the bottom-up approach.

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Abbreviation	Meaning
ADB	Asian Development Bank
AFD	French Development Agency
AIBO	Academy for International Business Officials in China
AOSIS	Alliance of Small Island States
BFI	Bilateral Financial Institution
CCAC	Climate and Clean Air Coalition
CCAN	China Civil Climate Action Network
CCS	Carbon Capture and Storage
ECP	the U.S.-China Energy Cooperation Program
GEF	Global Environment Facility
GO	Government Organization
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Cooperation Agency
KfW	KfW Development Bank
NDRC	National Development and Reform Commission (Chinese)

NGO	Non-Government Organization
NIS	National Innovation System
NPC	National People's Congress
PIC	Prior Informed Consent
PRE-COP	Preparatory meeting for the Conference of Parties to the United Nations Climate Change Convention
REP	Renewable Energy Partnership
S&ED	The U.S.-China Strategic and Economic Dialogue
SAB	Sustainable Aviation Bio-fuel
SCCF	Special Climate Change Fund
SDC	Swiss Agency for Development and Cooperation
SED	the U.S.-China Strategic Economic Dialogue
SIDS	Small Island Developing States
SOE	State Owned Enterprises
TYF	U.S. China Ten Year Framework on Energy and Environment
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environmental Programme

UNFCCC	United Nations Framework of Climate Change Convention
USAID	United States Agency for International Development
WALCC	World Alliance for Low Carbon Cities
WMO	World Meteorological Organization

Chapter 1： Introduction

Despite the fact that there is now a strong scientific consensus of the causes of climate change, no integrated and comprehensive regime that governs efforts to limit its impact currently exists. In its place there is what has been termed a 'regime complex': a loosely coupled set of specific regimes (Keohane & Victor, 2010). This thesis investigates how the regime complex makes real differences to states' behaviour. Specifically, the thesis looks at how China's behaviour has been influenced by its engagement with the climate change regime complex, which has led to an increase in China's energy innovation capacity. The mechanisms at work in this process are identified and their impacts on China's behaviour explored. This thesis also examines the utilisation of the bottom-up approach in the regime complex for climate change.

As China's economy has developed, its carbon emissions have grown to a large extent. Given the severe consequences of climate change, there are a growing number of states as well as other non-state actors urging China to reduce such emissions. The United States and India are in similar situation. Since the effort to achieve an international legally binding agreement on climate change has failed, the global community lacks confidence on the effectiveness of the current climate regime. However, this thesis provided evidence that the current climate change regime is influencing China's behaviour in a positive manner.

1.1 The puzzle

The puzzle of this thesis is that, concerning climate change and carbon emissions, China always seems to hold conflicting positions. On one hand, China has been deemed as a laggard by international society because it refused to set a carbon emissions reduction target sufficient to prevent irreversible negative impacts of climate change. On the other hand, China is a world leader in promoting green development despite the fact that it has alleged that developed countries are obliged to take more responsibility before developing countries became bound by mandatory reduction targets.

In addition, according to the most recent joint announcement on the issue made by China and the United States (U.S. - China Joint Announcement on Climate Change, 2014), the two countries have both set ambitious targets. The United States plans to reduce its carbon emissions by 26%–28% by 2025 compared to its 2005 emissions. China for the first time pledged that it will have its peak year no later than 2030. China also plans to increase the share of non-fossil fuels in primary energy consumption to around 20% by 2030.

This joint announcement suggests that the world's two most powerful countries are considering legally binding responsibility and will possibly sign a global agreement to consolidate this announcement at the 2015 United Nations (UN) Conference on Climate Change in Paris. They intentionally made their proposal well ahead of this conference so other countries would have time to consider this change and formulate their own strategy.

The social sciences have offered two different models in response to the climate change challenge. The first is to tackle climate change with a few master

plans – the top-down approach. The UN Climate Change Conference in Paris is an example. The other strategy consists of a variety of 'local' activities undertaken by (sub) units of a diverse and complex system (Underdal, 2010) – the bottom-up approach. This thesis intends to assess the effectiveness of climate change regime based on the perspective provided by the second model.

1.2 The research question

This thesis chooses to focus on the behavioural changes of one particular country, China, to study the impact of the climate change regime complex. More specifically, this thesis examines the impact of the climate regime on energy innovation capacity of China. This scoping down of the research question could have negative impacts on the veracity of the conclusion of the thesis but can be justified by the limited scope of a doctoral thesis. The research question of this thesis is:

Is the climate change regime complex effective in improving China's energy innovation capacity and how?

China has a unique political system. The Chinese Central Government and its local representatives in the provinces have vast financial resources, which has enabled them to accomplish grand projects on many levels. However, the concentrated power and resources can have unwanted side effects such as a lack of innovation in the system. The research conducted for this study revealed that the Central Government has identified this side effect and taken action to remove it. The Central Government is now encouraging innovations at local level so new ideas and innovative trials can be brought into the system. Any

climate regime complex that enhances China's innovation capacity will therefore be welcomed by the Central Government.

The political system of China is not monolithic and conflicts exist within the system among leaders, the Central Government and local governments, ministries and provinces, and so on (Congressional Research Service, 2013). Such conflicts have been seen in the case of the Central Government promoting a low-carbon economy. Some local governments do not share the same zeal about reducing their carbon emissions. This is another reason why this study adopts a bottom-up perspective and considers strategies and innovations on multiple levels by multiple actors, not just Central Government.

1.3 Three paradoxes

Not only is the climate change issue complicated, it is also a long-term problem. To achieve an effective solution, many states will have to make substantial adjustments with respect to their industry structure, energy technologies and even their people's lifestyle. In addition, there are still powerful sceptics who continue to question the science of climate change and deny that the climate change we are experiencing is anthropogenic. These people argue climate change is due to natural and cyclical fluctuations in the weather system. The high costs of adapting to climate change and the attendant uncertainty means that simple solutions will not work effectively (Zhang, 2007). The complex nature of the climate change issue has resulted in the duality of China's domestic and international policies with respect to climate change.

Three paradoxes repeatedly emerge in this thesis. They are intertwined with China's cooperation with other entities. The first is the paradox of fragmented interests and the common danger climate change poses to international society. It is already a commonly accepted fact among mainstream scientists and the mass media that climate change is one of the most serious challenges confronting all people. Climate change and poverty were listed by the UN as two of the most serious challenges of the 21st century. In the Fifth Assessment Report of the UN Intergovernmental Panel on Climate Change (IPCC, 2014), human impact was confirmed as having an influence on the surface temperate on earth (Harvey, 2013). However, individual countries lack the incentive to reduce their carbon emissions.

A multitude of reasons have been put forward to explain this phenomenon. First, the cost of reducing carbon emissions is very high. It has not found an economical substitute for petroleum and the world has experienced a protracted financial crisis in recent years, providing more reasons to fall behind on making reductions and investment pledges. Conquering a challenge such as climate change involves great expenditure without benefits that will only be tangible in the long term. Second, the fear of other countries' free riding is another potential reason. Like natural disasters, climate change does not respect national borders. Overall, global carbon emissions are still on the increase and a limited number of countries' reduction efforts will not change the overall trend. Third, despite the recent publication of the IPPC's Fifth Assessment Report, there are still sceptics questioning whether manmade greenhouse gases are causing the pattern of global climate on earth. Some even question whether climate change actually exists by arguing that climate change is within the bounds of natural

variability (Bagley, 2013). If such positions on climate change spread, it will be more difficult for countries and other entities to gain support for taking action to counter climate change.

The second recurring paradox concerns China's heavily criticized reluctance to make any reduction promises and its vigorous investment in areas such as renewable energy and other energy-saving technology. In the past China has been criticized as a country that does not cooperate in the climate negotiations. Partly as a result of this stance, the world seemed to lose faith in reaching an international agreement to reduce their carbon emissions (Lynas, 2009). However, China is now engaging in many collaborative projects related to climate change and is taking a relatively innovative stance with regard to the latest trends. For example, China has invested in world-class wind power grids and is also very active in assisting other developing countries with climate change mitigation and adaptation. Although these efforts do not directly reduce global carbon emissions, they have helped the world move forward incrementally to a considerably more healthy and more sustainable position. This paradox is very interesting and is also seen in relation to the United States, which has also been blamed by international society for taking a half-hearted approach to climate change. On the other hand, the United States is among the biggest investors in new energy technologies.

The third paradox is China's dual identities: while China is the world's largest carbon emitter, it has a comparatively low emission rate per capita. Besides, China is the world's second largest economy and has been very successful in maintaining high growth rates. In the five years from 2008 to 2012, China's economy grew on average by 9.26% and China now ranks sixth in the

world fastest-growing economies (World Bank, 2013). These two figures seem to suggest that China has stepped into the ‘great power’ category. However, China’s GDP per capita ranks only 81st in the world according to the World Bank (2013). The fact is that China emits a disproportionately great amount of carbon dioxide and this amount is growing fast. In 2012, China emitted approximately 1.5 times the amount of the United States’ emissions while its economy is only half the size of the United States’. China has the potential to reduce its carbon dioxide emissions if it adopts more energy-efficient technology. At the same time, China also faces obstacles to achieving carbon reduction as more people become urbanized and thus consume more energy. In addition, China still receives large amounts of financial and technical assistance from developed countries. However, China itself is a generous benefactor to many countries in Africa and Asia. The separate and disparate identities of China are reflected in its diverse actions with regard to its domestic policy and cooperation with other global actors on climate change.

With the absence of affordable and accessible technology, China will be required to pay a high price to achieve any imposed reduction target. However, it is interesting to note that China sometimes shows more than its usual enthusiasm towards its environmental problems. During the 2008 Beijing Olympics, to clear the murky and polluted skies in Beijing and alleviate the energy shortage, the government ordered hundreds of factories to shut down for two months (Chen, Jin, Kumar, & Shi, 2013). This is a sign that China is willing to sacrifice its economic gains temporarily for the sake of air quality as well as its international reputation. Plus, there is more and more evidence that market demand, instead of economic cost, is the main determinant whether investment

in climate change is made or not. However, more incentives need to be discovered before China makes the decision to undertake a costly and long-lasting carbon reduction effort.

In the chapters that follow, these paradoxes which sometimes enable China to make more effort towards climate change and at other times cause it to draw back from international cooperation will be discussed and analysed. In combination they help to explain China's dos and don'ts with regard to its decision making and policy adoption. The three paradoxes also show the strengths of the bottom-up approach, which encourages countries to take more positive measures to address climate change on multiple levels. This is the case in the United States, where some local governments urge the central government to take more stringent measures towards climate change. For example, California is leading the United States in increasing its renewable energy facilities (Gallucci, 2015). Adopting a bottom-up perspective, this study explores these three paradoxes to gain a deeper understanding of the influence of the climate change regime complex on China's innovation capacity.

This thesis argues that the regime complex for climate change plays a positive role in enhancing China's innovation capacity. This is achieved by a number of functioning mechanisms, including Utility Modifier, Enhancers of Cooperation, Bestowers of Authority, Learning Facilitators, Role Definers and Agents of Internal Realignments. These mechanisms influence China by changing its cost-benefit calculation, identity, engaging it into the international society, enhancing its cooperation with other entities and break its internal balance to induce more changes. This thesis also explores how the selected three sectors in the climate change regime complex influence China's energy

innovation capacity and whether the bottom-up approach was adopted in these constituents. These three sectors are China's national initiative, bilateral cooperation and club participation to enhance its energy innovation capacity.

1.4 Analytical framework

This thesis conducted three case studies respectively to study the different parts of climate regime complex's effectiveness on China's energy innovation. The analysis part not only depicts the landscape of China's innovation activity in certain area but also will see how these efforts influenced by or influencing the following aspects of China. These aspects, according to many scholars, are very important in enhancing China's energy innovation capacity.

Government policy and investment

The overall government policy is crucial to the enhancement of China's energy innovation capacity. Except for traditional energy resource such as oil and gas, the development of other new energy resource has not been accepted by market. Government fund and support is extremely important in this case.

Government's investment creates the capacity to absorb technology and create valuable partners for technology cooperation. Without such support for developing country, foreign firms are less likely to effectively bring their technology to it. Most of China's domestic investment was for asset finance, rather than advancing new technology (M.A. Levi, Economy, O'Neil, & Segal, 2010).

Universities, such as Tsinghua in Beijing, have become major centres of clean energy research, benefiting from both investments by the central government and partnerships with multinationals such as BP and government entities such as the EU.

Demand for low-carbon technology

People's habit and living style do not change easily. The new living style comes hand in hand with wide scale basic facility construction. For example, although China has very advanced solar energy but it mainly export to foreign market. The domestic market for solar technology is quite small. The central government has been trying for years to lower the energy intensity in local provinces and cities in China and some effects have already been observed (M.A. Levi et al., 2010). Beijing has pledged to cut carbon intensity by 40 to 45 percent from 2005 levels by 2020 and increase non-fossil energy to 15 percent of total primary energy by 2020. Most provinces and cities now in China has its own reduction target and will face unpleasant outcome if they do not meet the target by the end of the time scale. Creating market for low-carbon technology can indirectly promote innovation and technology transfer as firms seek to meet new demand (M.A. Levi et al., 2010).

Intellectual property protection

Intellectual property protection protects patents and trade secrete which allow diffusion of technology. IPR was included in many of research centre to help accelerate innovation. China has long been the focus of United States

concerns about IPR. Although the IPR law exists in China but it was barely implemented in most joint research centre.

International trade and investment

Barriers to trade in low-carbon technologies can both promote and reduce technology transfer. It was used by government to control the free flow of technology transference to domestic or protect domestic companies. China is very willing to sacrifice the economic efficiencies and environmental benefits gained from adopting foreign technologies for what it sees as the longer-term economic benefits or having its own clean energy industries. This means that China has laid a serial of barriers to international trade and investment in low-carbon technology. China provides subsidies to domestic producers as well. Especially after 2006, China has been pursuing a strategy to develop its own energy innovation capacity. China not only aimed to reserve its own market but also actively seeking for external market to consume its energy product.

1.5 Significance of this study

China is no longer a laggard on climate change mitigation. Many people and organizations have recognized the challenge brought by climate change. Alongside the Central Government, these people and organizations have realized that climate change could impact China more seriously than other countries. China could well experience more droughts, storms, lower crop yields, and health problems. The Central Government has chosen the transformation of the country's energy sources as a key strategy. Research on

how the climate change regime complex functions and how to improve its performance is in high demand at this time. This thesis provides additional evidences to answer the questions of whether and how the regime influence states' behaviour. It also contributes to the theoretical framework by building on the mechanisms explaining climate the change regime complex's short-term and long-term impact on states.

Second, this study offers an additional perspective, beyond the conventional wisdom of the 'global deal' approach, to consider China's approach to tackling the challenges posed by climate change.

Third, this study contributes to the academic debate on China's role in the climate change issue by bridging international expectations and China's efforts regarding this issue. Specifically, this thesis attempts to offer a way forward on global climate change mitigation by redefining the core challenge brought by climate change. The goal is to reduce states' carbon emissions but an essential step is to tackle the problem of energy technology. Innovation is central to tackling climate change effectively (Grubb, 2004). And this innovation could be achieved through adopting a portfolio of options that suit different situations in different countries.

Theoretically, this study seeks to develop the theory concerning how the climate change regime complex exerts influence on states' behaviour through applying mechanisms. Practically, it sheds light on China's policy making on improving its energy innovation capacity through engaging in the climate change regime complex and reconsidering its innovation capacity. Methodologically, this study employs an intervening factor – a mechanism – to measure and explain

how the climate change regime complex influences states' behaviour and uses case studies to conduct a behavioural study of China's energy innovation performance.

1.6 Organization of the thesis

After this Introduction, Chapter 2 reviews the existing literature on the global climate change regime complex and China's energy innovation capacity. It aims to demonstrate the significance of China's energy innovation capacity as well as identify a research gap and possible contributions that can be made in this area. The chapter also establishes the theoretical framework for this project based on the regime theory.

Chapter 3 discusses the methodologies applied in this thesis. This chapter provides a summary of the methods used in this thesis and explains how the cases in each case study were selected.

Chapter 4 presents the first case study of China's engagement in the global climate change regime complex. This chapter examines China's national and sub-national initiatives to enhance its energy innovation capacity by first briefly reviewing the efforts made by officials at the national, provincial and municipal levels. It also takes into consideration firms, ordinary citizens, and non-governmental organizations. The chapter respectively examines the initiatives at the Central Government, Beijing municipality, Haidian district, private firm, and Beijing citizen levels to ascertain the consistency and divergence among them.

Chapter 5 explores China's bilateral cooperation initiatives with countries of varying economic status, including the United States, India and a group of developing countries. This chapter demonstrates how bilateral cooperation between China and other countries contributes to its energy innovation capacity. This chapter discovered that the international networks of the innovation were fragmented among these countries. Furthermore, China's image as a recipient of technological and financial assistance is in transition. Its assistance from other countries is decreasing and its aid to other countries is increasing.

Chapter 6 discusses China's initiatives to mitigate climate change via club cooperation. This chapter discusses several advantages of clubs in dealing with climate change before providing a description of two current clubs which address the climate change issue, the G20 and the GMI. Based on the discussion, the chapter evaluates the performance of the innovation mechanisms and studies how the climate change regime complex influences China's energy innovation behaviour.

Chapter 7 concludes the thesis by first summarizing the conclusions of the foregoing chapters. The chapter then answers the research question and provides policy suggestions based on the findings, as well as a discussion of the study's limitations and suggestions for areas for future research.

Chapter 2 Energy Innovation in the Regime Complex and the Bottom-up Approach

2.1 Introduction

This chapter first outlines the bottom-up approach to tackling the problem of climate change before reviewing the existing literature in relation to the main concepts brought up in the research questions. It then clarifies how this thesis understands and applies each concept. The review focuses on the role of environmental regimes and the specific ways they influence states' behaviour and the cooperation among states, before turning to examination action of the climate change regime in relation to China's innovation capacity.

Many environmental problems such as ozone depletion have been quite successfully addressed by the top-down or 'global deal' approach. The depletion of the stratospheric ozone became an international political concern in the mid-1970s (Morrisette, 1989). Efforts to negotiate an international agreement limiting chlorofluorocarbon (CFC) emission began in the 1980s and led to the ratifying of the Montreal Protocol in 1987 by 169 countries, which is considered an important milestone in environmental agreement history. Since the protocol took effect, CFCs, the reducers of ozone, have been gradually phased out (Velders et al., 2012).

The similarity between ozone depletion and the climate change issue has led many people to believe that a similar kind of resolution could be applied to

climate change. However, one of the reasons that the global deal approach was able to positively resolve the ozone problem was that a substitute for CFCs had been discovered which did not cost manufacturers much more. In addition, the number of emitters of CFCs is limited and they could easily be traced by to the large producers of household appliances. The failure to apply the same approach to climate change has led many scholars to question that whether climate change regimes are working effectively.

The reality is that the climate change issue is much more complicated than the ozone depletion issue. There is a much closer relationship between humans and the carbon emission resource. Humans first started to use coal when they were still cavemen. Then in the 1700s, fuel was discovered as a cleaner and more efficient energy resource. The Industrial revolution played a major role in expanding the use of coal ("A Brief Hustory of Coal Use,"). A significant amount of CO_2 has been released into the atmosphere by almost every industry. Many more actors are involved. It is therefore going to take a much longer time for people, groups and countries to change their ways of thinking and ways of living and functioning. According to recent studies, the high cost of new, more environmentally sustainable technology does not deter investments from government and private corporations. Private industries invest in new technology based on the demand of the end market. The whole of society has to experience a significant change before it can comfortably transition to the so-called sustainable development mode.

From the traditional perspective, the most straightforward way to observe the effectiveness of a climate change regime is to determine how much reduction of carbon emissions states are willing to commit to and then assess

their reductions. Countries with large carbon emissions are expected to make substantial adjustments related to their economic structure. However, many such countries refuse to adopt legally binding reduction targets. The world's top two carbon emitters, China and the United States, have both refused to adopt legally binding targets. Other big developing countries such as India and Brazil have also refused to adopt such targets. Up until now the traditional global deal approach to the climate change issue has not worked effectively.

2.2 Concepts and definitions

Change of perspective

The global deal approach has greatly shaped the way scholars and laypeople understand climate change and its solution. However, the integrated legally binding agreement approach is now widely considered to have failed or at the very least to be ineffective. From the traditional theoretical perspective, China and the United States could be perceived as laggards since they refuse to adopt carbon emission reductions for one reason or another. In fact, these two states have both invested hugely in developing a greener economy. The United States was at the forefront of calls for a 'process-oriented approach' to the problem with flexible non-compliance procedures and ambitious implementation mechanisms, as well as detailed provisions on scientific research and information exchange (Andresen & Agrawala, 2002). As a result of adopting this approach, the scale of local mitigation action in the United States

could stabilize US emissions at 2010 levels by the year 2020 (Lutsey & Sperling, 2008).

China meanwhile has achieved significant success in improving its energy efficiency as well. China's wind and small hydroelectric power station technologies, for example, are considered to be world-class. This is a clear evidence that the traditional framework is not sensitive to the new approaches of international actors like China and the United States. What we need is a new theoretical framework that incorporates all of the small improvements various actors institute in order to guide future efforts in the right direction.

Global climate governance, global climate regime and climate regime complex

Global climate governance is the diplomacy, mechanisms and response measures aimed at steering social systems towards preventing, mitigating or adapting to the risks posed by climate change. This definition does not specify what kind of diplomacy, mechanisms or response measures that need to be taken.

Global climate regime is a global framework that aims at regulating the interaction of human activity with the climate change system and to mitigate global climate change. This framework is constituted by legal clauses and the global society is trying to enforce a global climate regime to prevent and mitigate the dangers brought about by climate change. Global climate regime is one mechanism to address climate change and is one kind of climate governance.

Global climate regime is not formed in one day. Especially, climate change is a very complicated issue. A global regime on this issue may require many agreements on different issues such as forestry, emission of greenhouse gases carbon technology and so on. Global society might have come to an agreement within one or several specific areas. Climate regime complex is featured with several governing networks loosely connected together. Global climate regime could be considered as an underdeveloped form of global climate regime.

A change of approach: Focus on what we have now

The failures of global climate conferences and summits demonstrate that an international climate regime will not be created in the near future. There is a need to focus more on ‘what we have now’ than ‘what we will have’ in the future (Bulkeley & Moser, 2007). Commensurate with this, scholars need to shift their attention from the creation of an international legal system to other ways of dealing with climate change.

This thesis analyses the international climate regime’s impact on China by using a bottom-up approach. If we imagine all the options available to fight against climate change on a spectrum, ‘bottom-up’ and ‘top-down’ would be at respective ends of this spectrum (Hare, Stockwell, Flachsland, & Oberthür, 2010). The classic top-down approach is to create a global climate regime regulated by a single legally binding agreement. Supervision and a tribunal system are put in place in case violations or conflicts occur. This is also referred to as the traditional global deal strategy to address climate change. At the other extreme of the spectrum the bottom-up approach envisions international efforts

as an aggregation of local projects put forward by all kinds of international actors on a strictly voluntary basis. In many cases, it signifies the approach in which countries voluntarily take initiatives to address the climate change issue (D Bodansky & Diringer, 2007). Scholars are unable to agree on which approach is more effective in the case of climate change.

The approach put forward in mid-2009 by the US Obama administration is considered a typical bottom-up approach. In the US approach, countries pledged to undertake certain actions and reduction targets according to their own will. However, this approach is in the mid-range of the bottom-up side of the spectrum. State-level actors are the main actors in this approach but recent domestic and international policies on climate change suggest countries are trying to involve actors at a lower level to contribute to climate change. The US approach nevertheless represents a more progressive approach, with major initiatives taken by both civil society and private corporations. These sub-national and ground-level actors form new partnerships and networks to address climate change. It is evident that the role played by the 'bottom players' such as local governments and private corporations is increasing. The following literature review mainly focuses on the methods espoused by bottom-up approaches. As noted above, it is end market demand market instead of cost that is the diving factor determining whether investment in new energy technology will be made.

Different opinions

Although the bottom-up approach is now recognized by international society, it is a relatively recent development and there are many sceptics questioning whether this approach could change the current situation, especially those who support a strong centralized international governance structure. They believe the global top-down approach is the best and most effective solution to climate change. For them it is the only approach that can provide the confidence the countries need to commit to making deep emission reductions and other efforts (Hare et al., 2010).

Fragmentation is another characteristic of the bottom-up approach that has drawn criticisms. The initiatives put in place by bottom-up approaches are often of limited size and the activity landscape of such approaches is greatly fragmented. Proponents of unified international agreements believe this is a sign of inefficiency (Hof, Elzen, & Vuuren, 2009). There are also concerns that the bottom-up approach could not bring commitments strong enough to remove the dangers of climate change (D Bodansky & Diringer, 2010). For these scholars a binding commitment under a single comprehensive agreement is required to ultimately solve the climate change problem (Hare et al., 2010). However, they conceded that initiatives undertaken by multiple groups of actors at various levels could increase global confidence in a climate change regime. A high level of mutual confidence is crucial to produce an international legal agreement.

The supporters of the global deal strategy insist that bottom-up approaches are designed to avoid legal commitments. There are also dissidents who claim that much of the transnational cooperation encouraged by the bottom-up

approach such as partnerships networks are only possible in the area of ‘low politics’. There are still other scholars who argue that connections among various actors impinge on national power and impede political accountability. These connections are described as ‘club-like’ and some scholars fear this phenomenon will only flourish in certain economies and reinforce the dominance of the major economic powers, increasing the inequality between the Global North and the South (Raustiala, 2002). In addition to that, without a proper supervision system, there is no guarantee that countries will comply with what they pledged. In such a scenario, the regime established on bottom-up approaches will be meaningless.

The bottom-up approach and its application in an authoritarion society

2.2.1.1 Multiple actors at multiple levels

The main focus of the original global deal approach was on state agencies. However, many scholars have realized that state agencies might not be enough to address a complex global problem like climate change. Ostrom (2009) argues that it is unlikely that a single governmental unit will be able to take action and resolve problems that require global collective action aimed at climate change because of the free-rider problem (Ostrom, 2009). Knieling and Filho (2013) also see a need to engage different sectors of society in the mitigation and adaptation of climate change. Climate governance is closely related to many actors such as state and public administrative systems and is influenced by the behaviour of private sectors (Knieling & Leal Filho, 2013). The merit of the

bottom-up approach is that it seeks to explore the strength of the private sector and the concerned general public which is where the carbon emissions mainly come from. This has been recognized by international society as well; the most recent climate conference held in Warsaw in 2013 saw the participation of big automobile and oil companies (Goodman, 2013). Therefore any efforts made by actors relating to their economic interest, reputation, or environmental concerns are all welcomed in the bottom-up approach. This is the reason why the bottom-up approach has received more attention than the global deal approach in recent years. This thesis attemps to trace the influence of how multiple actors other than central government on environmental issues in the case of climate change. In an authoritarian state such as China, the concent of the “multiple actors” might be slightly different than in democratic states. This thesis will study the government at different levels, priviate entities such as private enterprises and NGOs to examine their respective impact on the final decision made by the Central Government in China.

2.2.1.2 Innovation

Many scholars emphasize the concept of innovation as it relates to the global governance of climate change. Innovation associated with energy technology can greatly reduce the cost of clean energy and can make a huge difference to technology and policy systems. For example, Ostrom (2009) points out that the main advantage of the polycentric approach she proposes is that it encourages experiments at multiple levels. Various methods could thus be tested and assessed and the more effective ones could be adopted by multiple actors and applied in other areas. The bottom-up approach is a system that

encourages innovation and learning from smaller groups. The world has witnessed how difficult it is to adopt a new agreement to mitigate climate change. Innovative trials are easier to conduct when small groups are used. Ostrom suggests that attention should be paid to small- and medium-scale governance bodies as the lead in tackling climate change issue will come from trials conducted by these actors. The bottom-up approach embraces innovation from the level of the private sector, and from the level of city and county governance.

Innovation in energy technology has caught many scholars' eyes in developed countries. Although in these countries, energy sector only accounts for a small share of GDP, but the pervasive use of energy throughout all economy sectors has made energy innovation an issue could not be ignore ("Innovation in Energy Technology Comparing National Innovation System at the Sectoral Level," 2006). This report, for example, compares energy innovation systems in nine developed countries. Another distinct characteristic of this report is that it achieves this comparison in different industry sectors with a focus on hydrogen fuel cell technology. This report has identified several factors which drives innovation. Of course, the willingness to fight against climate change and the economic opportunity presented by advanced energy technology is the common driving factor among nations. There are some other drivers as well: the first is government and industry's contribution to R&D funding. There is always a long term investment concern for commercialization regarding to private investment in energy innovation. The private sector and venture capital often played a limited role in this area. The second factor is national innovation systems. Universities and government laboratories play an

important role in this section. Some large national and multinational enterprises, as well as small and medium-sized enterprises are quite active in this area as well. The balance between the public and private sectors varies a lot from one country to another. Public/private partnership is another organization active in energy innovation. The third one is fuel cell innovation policy beyond R&D. National policy on forming a market is extremely important as the market drives the investment interest of government and especially of private sectors. At the initial state for the development and deployment of new energy technology, government's subsidies are quite important. The creation of regional, national and international programs for the development of energy technology can play a catalytic role to bring changes to innovation system. The efforts to create international codes and standards for energy are all important step to develop energy innovation system. There are also scholars that would like to measure energy innovation by spending and learning on energy R&D (Holdren, 2003).

2.2.1.3 Possibility of immediate action

An international agreement, once it takes effect, requires countries to make carbon reductions immediately. Without proper technological support, carbon emission reduction can be very costly. Countries might need to sacrifice economic growth and experience shifts in the cultural values and identities of its people (Wittneben, Okereke, Banerjee, & Levy, 2012). Such transformations take time. Technology upgrades and educating people regarding the seriousness of climate change and the importance of environmental sustainability cannot be achieved overnight.

A process-oriented bottom-up approach avoids this process. It promotes and advocates any improvement of small-scale entities via cooperation that increases their ability to function in a greener way. Governments, private corporations and individuals would not be overwhelmed by the sudden change required by the global deal approach – they can adapt at their own pace. Any small group of international actors, even individuals, can undertake to fight against climate change. And if their efforts turn out to be successful, their model can be applied by other such groups and spill over to a broader region and to the world. A key advantage of the bottom-up approach is that it allows action to be taken immediately, and this is why it has been called the most politically promising way to address climate change (Bodansky & Diringer, 2010). As the climate regime complex is fragmented, progress may be easier to achieve initially through a more fragmented approach. Countries could then pursue specific initiatives in accordance with their own perception of the issue without being turned off by reduction targets (Bodansky & Diringer, 2010).

2.2.1.4 Process-oriented/Bottom-up approach

Unlike the original approach which emphasizes meeting reduction targets, the new bottom-up approach recognizes any incremental improvement regardless of whether these improvements will directly reduce global carbon emissions. In other words, the bottom-up approach does not impose a one-size-fits-all solution and supports efforts as long as they are in the ‘right travel direction’ (Rayner, 2010). Conditions in every country and region are different, but the top-down approach does not take this into consideration. Even some

proponents of the top-down approach suggest a synchronization of the original top-down rules in conjunction with bottom-up initiatives (Verbruggen, 2009).

The process-oriented bottom-up approach focuses on step-by-step progress and sets short-term goals within the framework of the long-term goal (Aldy, Barrett, & Stavins, 2003; Verbruggen, 2009). With this approach, countries could establish their voluntary goals based on their national circumstances (Reinstein, 2004). This approach has potential to win over some of the countries not interested in signing an environmental binding agreement such as the United States, China and India.

2.2.1.5 An approach with benefits

Promoting economic development is in every country's interest (Reinstein, 2004), as is enhancing security. An approach focused only on environmental outcomes will not provide enough incentive for most states and smaller actors to participate. Many developing countries are pursuing policies aimed at increasing energy efficiency because of recent oil price shocks (Bosetti, Carraro, & Tavoni, 2009). International organizations' experience shows that with regard to climate change it is easier to leverage private financial resources and involve the private sector in this area than in others such as biodiversity. Clean energy and energy preservation are seen as having more economic potential (Clemencon, 2006).

China's recent resolution to starting cleaning its air because of nationwide pollution hazards has great potential to contribute to climate change mitigation. A solution that promotes both economic and social development along with actions to mitigate or adapt to climate change can have multiple benefits for all

countries (Reinstein, 2004). An approach to climate change that could spur the economy and create jobs would be welcomed by any country and any region. This is another reason why this thesis focuses on energy technology innovation. Such innovation will not only increase the chance of solving the climate change issue but also bring economic and social development to states.An example from the United States demonstrates how such a bottom-up approach works. Some states are concerned about the inaction of the federal government on climate change but states such as California have stringent policies with regard to its energy sector which are not focused solely on climate change mitigation. Such states are doing this for a variety of reasons such as cost savings and creating jobs (Thomson & Arroyo, 2011). Taking into consideration the overall climate regime complex, cooperation mainly occurs in the sector where there is the most promising economic return. According to a study on the Cities for Climate Protection (CCP) programme, local governments that are most effectively engaged within the network are mobilized more by the financial and political resources the programme offers and the legitimacy conferred on particular norms than by access to information about climate change (Betsill & Bulkeley, 2004). China has been more and more active in Energy research & development investment recently. According to the statistics in 2001, China already has a share of 8% in total world R&D investment (Source: OECD, Main Science and Technology Indicators, 2003).

Regime

The word ‘regime’ originates from French and means ‘a system of rules or regulations’ (Stokke & Vidas, 1996, p. 13). Regime refers to the how

governance is achieved in a certain issue area and how power is distributed. Regime also includes the rules and regulations that have been instituted in an area. In the international relations arena, the world embraces a slightly broader meaning: 'implicit or explicit principles, norms, rules, and decision-making procedures around which actions' expectations converge in a given area of international relations' (Krasner, 1982). Traditionally, the majority of the principles, norms, and rules concerning governance come from multilateral agreements.

Today governance mechanisms take variety of forms and authority is diffused across levels of social organizations (Andonova, Betsill, & Bulkeley, 2009). This may provide an explanation for why a legally binding agreement is so difficult to achieve with climate change. National governments do not have the sole authority to enforce carbon emission reduction targets on civilians and industries. Doing so will greatly influence the quality of civilians' life, industries' economic interests, and the government's legitimacy. On the other hand, subnational actors are gaining more power in this area. Both non-governmental organizations (NGOs) and private corporations have taken measures to constrain climate change globally. The achievements and activities of these actors have also contributed to change the state behaviour.

Recently, the increasing cooperation in the area of climate change which is not controlled by central governments has attracted more and more attention from scholars. Private actors and even individuals have been proved to have the capacity to contribute to a global climate change regime. Scholars are finding more and more acceptable the idea that such a regime should include rules and initiatives suggested by private and public-private networks (Pattberg & Stripple,

2008). Research and development (R&D) is not only being carried out by governments but also by many private companies as well. In conclusion, climate regime is defined by ‘rules’ but is featured by dispersive power which means the both the government and private sector possess balanced power to deal with climate issue.

2.2.1.6 The climate change regime

The climate change regime relates to the global governance on the specific issue of climate change. Global governance is a counterpart to national governments although it is ‘softer’ (Knieling & Leal Filho, 2013). International society is not hierarchical and is unlikely to carry out governance in the same way as a government does within a country. The climate change regime cannot demand that countries and states strictly obey certain laws since it includes the involvement of many private actors. Global governance is seen as coordination of social actions instead of hierarchical regulation of control (Knieling & Leal Filho, 2013). As mid-level governance, the climate change regime seeks to coordinate efforts to address climate change by applying regulatory and non-regulatory instruments. These instruments include 1) negotiating an international agreement that stipulates rules for states to follow; 2) moral power to restrain countries from doing something; 3) provide economic incentive to encourage participators to do something (e.g. an economic model).

2.2.1.7 The evolution of the climate change regime

Regimes are dynamic and change continuously after their formation. If they successfully solve problems, they keep growing; otherwise, they wane over time. The effectiveness of a specific regime is different at different stages of its life cycle (Young, 1999, p. 1). This factor makes comparing two international regimes difficult. In the case of the climate change regime, this issue was introduced to the international arena in the 1980s (Daniel Bodansky, 2001). In its history, it has chosen different forms of incentives and activities to reduce carbon emissions, which represent different features of the climate change regime at different stages of its life cycle.

There are basically two predictions about where the climate change regime is heading. Either we will see the establishment of targets and timetables for countries to reduce their aggregate greenhouse gas emissions or the regime will continue to involve a variety of loosely coordinated smaller-scale agreements (Barrett & Toman, 2010). The first option is more costly to achieve; the second is more flexible and more able to be achieved.

2.2.1.8 Fragmentation of the climate change regime complex

As mentioned earlier, the climate change regime is not a set of solid or closely related legal institutions. Instead, it is a loosely connected network of many governing systems. Keohane and Victor (2011) list eight elements in which substantial rule making of climate governance takes place. These eight elements are the United Nations (UN) legal regime, expert assessments, the Montreal Protocol, bilateral initiatives, specialized UN agencies (e.g. World

Meteorological Organization, United Nations Country Programme), unilateral actions, multilateral development banks (e.g. World Bank, Asian Development Bank) and clubs (e.g. G20, G8). This makes a valuable contribution by clearly describing the landscape of climate governance. However, some critics point out that this perspective only considers efforts made by national is interstate in nature (Abbott, 2012).

Non-state actors such as private corporations and universities are becoming more and more active in the arena of climate change. At the encouragement of governments and intergovernmental organizations, many connections have been established between private actors and their counterparts in other countries. These developments have made the content of unilateral action more diverse.

The components of climate change regime complex are now cooperating on a number of different levels. There is also communication and interaction among all elements in this complex. Each actor is set within the context of the continual interaction of science, government, corporate, and citizen forces (Dana, 2003). As the entire regime complex is evolving over time, the changes and communication taking place are shaping the direction the regime complex is headed in.

The following section provides a brief review of the constituents involved in the climate change regime complex, which will be discussed in more detail later. This thesis conducts three case studies on three components of the climate change regime complex based on the theoretical review of which components may of spectacular potential in solving climate change issue.

2.2.1.9 Unilateral actions

Unilateral actions include 1) actions taken by the national government and local governments; and 2) actions taken in the private sector such as by universities, business corporations and organizations. Recent years have witnessed actors from civil society working together to address global issues. These actors have formed partnerships and these networks have been branded as a new form of global governance which bridges multilateral norms and local action (Morsink, Hofman, & Lovett, 2011). These kinds of partnerships also strengthen the implementation of climate policies and regulations and can be defined as 'collaborations between investors, state actors and citizens where different actors share in defining or carrying out the purposes of investment' (Morsink et al., 2011).

These collaborations sometimes transcend state borders and become transnational partnerships. Some scholars believe that transgovernmental networks are the most effective form of organization for the Information Age (Raustiala, 2002). It is argued that research related to transnational cooperation between subnational actors such as subnational governments, regions, NGOs and corporations has not received enough attention. Yet there are a number of studies devoted to the climate change cooperation network related to cities and climate-related partnerships (Hallegatte & Corfee-Morlot, 2011; Rosenzweig, 2011) .Governments at the provincial, municipal and country levels have been studied because they are in a better placed than central governments to address climate change by being able to tailor policies to suit their own situations. However, more incentives have to be created for these local

governments other than just the environmental benefits. Studies have shown that local governments get involved for a number of different reasons, not solely to address climate change. This thesis also examines how local governments in China are trying to address climate change. A lot of attention has been paid to the municipal level by researchers. This thesis argues that although climate change is a global issue which affects everyone on Earth, middle- or small-sized governance will be required to address it (Betsill & Bulkeley, 2006). Governance and projects at the municipal level could tailor policy and projects according to the different local situations. Cities are sites of high energy consumption and waste production and big populations. As cities are developed in economic terms the people who reside in them become more aware of the dangers brought by climate change. Cities also have great capacity to address the climate change challenges. Alliances of global cities such as the C40 have garnered much attention, and in Europe alone there are 28 networks of local governments (Betsill & Bulkeley, 2006).

2.2.1.10 Bilateral cooperation

One of the reasons international society has not reached an agreement on climate change is that some countries lack confidence in other members that are party to international agreements. However, this problem could be avoided via increased bilateral communication. China and the United States both devote much more money to bilateral cooperation than to multilateral development banks and other financial institutions (Nelson, 2012). Bilateral cooperation might also be the engine which provides the required intelligent action and articulation necessary to address climate change.

The issue linkage concept provided by game theory offers another reason why bilateral cooperation might work to address climate change. Game theorists argue that there is a way to induce cooperation in the Prisoners' Dilemma, in which the self-interested behaviour of separate actors (individuals or states) leads to outcomes that are unnecessarily detrimental to each of them. The Prisoners' Dilemma becomes a 'supergame' if it is repeated over time indefinitely. Scholars have found that under some circumstances cooperation is rational as well. These scholars argue that individual states are always contending over several issues simultaneously. The existence of other issues provides opportunity for linkage-based cooperation. One country sacrifices on one issue in return for the other country's sacrifice on another issue. In the end, both issues are solved. States with intertwined relations are more likely to cooperate (McGinnis, 1986). There are already scholars who confirm that issue linkage may increase the incentive for countries to cooperate (Kemfert, 2004). Kemfert points out that issue linkage between climate control coalition and technological innovation might induce more cooperation in both areas since the benefits of improvement in each area are universal.

Scholars have begun to apply issue linkage theory to major countries such as the United States to see if there are any other means by which the United States could be more cooperative (Hovi, 2008). The theory suggests that although China and the United States hold different opinions over the climate change issue, the complex nature of the relationship between the countries could bring about compromise. The United States deems China to be a large developing country with growing carbon emissions which should take more responsibility regarding climate change. However, with its low carbon emission

rate per capita, China refuses to take up a legally binding reduction target. Even so, issue linkage theory suggests that because there are many issues the United States and China agree on, the two states could trade-off their interests in other issues to balance any compromise related to climate change. However, Hovi (2008) does not believe the United States puts enough faith in issue linkage for such a compromise to occur.

Scholars consider issue linkage theory to have huge potential when combined with a bottom-up approach to climate change. When many entities form small groups and cooperate with other groups, actors are more likely to develop strategies which are long-term and multiple-issue-based. Issue linkage could be adopted by the members to increase incentives for other actors to take action to address climate change, especially in the form of bilateral cooperation among states.

2.2.1.11 Clubs

Scholars believe that the G8 and G20 should serve primarily as forums for political discussion and agreements on climate change. A number of existing forums have begun to take the climate change issue into consideration as well (D Bodansky & Diringer, 2010). The World Trade Organization hosted a joint conference on fossil fuel subsidies to attempt to clear ways for the development of clean energy resources. It is argued by some scholars that non-universal negotiating forums might be better for implementing climate change strategy (Dirix, Peeters, Eyckmans, Jones, & Sterckx, 2013).

Smaller groups also have the advantage of numbers. Studies have shown that 12 might be the best number of countries who sit around the negotiating table to negotiate an agreement on climate change (Victor, 2006). Smaller groups of countries are more able to organize initiatives to address particular issues. A joint Norwegian-French initiative to establish a partnership on reducing emissions from deforestation and forest degradation (REDD+) has resulted in the Agreement on Financing and Quick-Start Measures to Protect Rainforests. This non-binding agreement has been adopted by 50 states. The cooperation of clubs might be another source of new ways to address climate change.

2.2.1.12 Uncertainty over the effectiveness of regimes

As mentioned in the Introduction, there are conflicting voices concerning whether regimes function as expected. Some scholars see international regimes as mere epiphenomena (Mearsheimer, 1995; Strange, 1999; Waltz, 1979). They argue that international institutions do not reflect the real world and that their policies are therefore bound to fail. Even among scholars who agree that regimes do work, different opinions exist regarding to what extent they are able to find solutions to problems. Young (2011) believes that international environmental regimes can and do make a difference. But their success depends on other determinants and the strategy being used (Young, 2011). Stokke and Vidas (1996, p. 19) argue that in some cases inappropriate regime setting might have a negative impact on a state's behaviour, leading it to do something that is contrary to its original intention. Supporters of regimes believe that regimes do work when they met certain standards. Guided by this thought,

scholars who focus on regimes have been exploring the necessary characteristics for regimes to work, which are summarized below.

2.2.1.13 Regime design

Regime design has been proposed by Young (2011) as a significant determinant of effectiveness. Well-designed regimes can be effective even with malign problems. However, in the case of climate change, the design factor is especially significant. The climate change regime is very fragmented and there is no overall design for this governance system. However, the naturally developed structure of climate regime may have some impact on its effectiveness.

2.2.1.14 Knowledge

Young (2011) also points out that too much attention is given to the regulatory terms of a regime. Often overlooked is the function of regimes in generating knowledge about the problems to be solved and contributing to a shared understanding of the issues at stake among participating actors(Young, 2011). By generating knowledge, regimes can change nations' and people's behaviour as they change how they perceive their interests. Nations and people are both rational actors. Theoretically they make their decisions based on their calculations of how to achieve their best interest. A host of specific variants have been invoked of the general mechanism by which regimes may affect problem-related behaviour by altering the incentive structure of states (Underdal, 2004, p. 91). The knowledge generated may also contain new technology which could

bring solutions to the problem in question. In the case of climate change, the technological upgrade of automobiles, power stations and other facilities could make a huge difference.

2.2.1.15 Fairness

Multiple pathways can lead to success in efforts to solve many environmental problems. Regimes should always provide opportunities for individuals, agencies and companies to get access to new resources, enhance their own status, or strengthen their competitive edge. The climate change regime includes power distribution among all involved states and members but could guarantee a higher level of fairness among members by making sure they are on the same page. Countries should be updated with what is happening in other countries and could devise their own strategy accordingly. The current attention given to the Alliance of Small Island States is not enough. There are many less developed countries which require more attention and investment in order to face the climate change challenge with more confidence.

2.2.1.16 Regime complexes and the climate regime complex

Regimes fall into different categories according to their features. A regime complex is one kind of international regime with no integral legal system but several governing networks loosely connected together. The climate change regime is a typical regime complex and it is very difficult to study how such a complex setting influences the overall direction of the regime. No regime functions in a vacuum and most are embedded in other larger regimes. A

regime's effectiveness therefore is always the co-production of the regime and other regimes.

The regime complex, under certain conditions, is capable of delivering impressive progress towards the desired end, as in the case of climate change. Previous studies have shown that regimes without a legal institution can also help to make advances or continuous progress. These process-generated effects may well be as significant as international conventions or protocols in the end (Haas, Hveem, Keohane, & Underdal, 1994). Regime complexes offer a way forward for institutions that do not lend themselves to the creation of a single integrated governance system. Following this line of thought, this thesis tries not to confine the solution of climate change to a single integrated agreement or a single governance system and pays more attention to the small changes which may bring about success in the future.

The climate regime complex – the broader set of agreements and institutions addressing the climate change issue area – also evolves over time (D Bodansky & Diringer, 2010). Today, the world trade system is an example of a well-developed regime complex with a clear legal basis and even a dispute settlement system. There is no evidence that all regime complexes will eventually evolve to be as well-developed as the world trade regime complex is. Sometimes they can even more in a backwards direction. There are many criteria to evaluate the status of the evolution of a regime complex. These criteria measure the depth and breadth of the climate regime complex such as the institutions in the area, the legal agreements, the compliance system, the extent of integration and so forth. Based on these criteria, the climate regime

complex is still in the initial phase. The following section is a summary of the features of climate regime complex.

The involvement of multilevel actors

The impact of climate change has no boundaries. Climate change creates many problems for society and people, industries, governments and organizations are all victims of climate change. As a result, to address climate change it is possible to get support and devotion from multiple sectors at different levels. It is due to the variety of actors that climate change impacts and the variety of actors that contribute to climate change that it is so difficult to come to an international agreement on how to solve the problem (Knieling & Leal Filho, 2013). The involvement of multilevel actors must be a feature of a successful regime to address the climate change issue. Many scholars believe that international society has ignored this aspect of climate governance and found itself confused when it was exposed to the many affected groups and their intricate interests. The situation got worse when international society found that the state governments that they have been relying on to solve the global issue were playing only a blurred role (Dirix et al., 2013).

The involvement of multilevel actors generates new forms of cooperation to address climate change (Morsink et al., 2011). Partnership networks gather actors to work together on one specific issue no matter which level the actors come from or whether they are in or outside government. Globalization and the rise of non-state actors are challenging state power (Raustiala, 2002), and

thesis not only examines state-level actors but also actors at lower levels and industries, including individuals.

2.2.1.17 A combination of many components

The functioning of climate change governance relies on the cooperation of actors at different levels and in different areas. Although an overarching international legal agreement related to climate change governance does not exist, a couple of initiatives and a regional governance system loosely linked together do serve to address climate change issues. As many scholars have illustrated, the climate change regime complex is fragmented (Hof et al., 2009; Keohane & Victor, 2011). These institutions sometimes cooperate and sometimes conflict with each other. The functioning of climate governance requires the coordination and cooperation of stakeholders at multiple levels. The mitigation and adaptation efforts made at the local and regional levels are very important since they can boost the commitment and participation of stakeholders (Onysko, 2011). Climate change governance can therefore be described as a broad range of forms of coordination concerning climate change adaptation and mitigation (Knieling & Leal Filho, 2013).

The United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol function as a semi-international agreement. The commitments written in the framework are not sufficient to control the global temperature rise within the expected range because the two biggest carbon emitters are omitted. Countries, local government and corporations respectively are taking actions to mitigate climate change. Parts of the United States, for

example, are taking vigorous action, with California establishing translevel official ties with the Natural Resources Defense Council and promising more cooperation on climate change mitigation (Chen, 2013).

Soft in nature

No international legally binding regulation on carbon emission reduction has been reached at the time of writing. There are only voluntary, non-binding reduction targets that have been announced by many governments. The United States and China most other big developing countries are trying their best to avoid legally binding promises regarding carbon emissions. For instance, before Copenhagen Conference, the United States has promised to reduce emissions by 17 per cent below 2005 levels by 2020, 42 per cent below 2005 levels by 2030, and 83 per cent below 2005 levels by 2050 (Broder, 2009). China meanwhile has promised to reduce its CO2 emissions per unit of GDP (carbon intensity) by 40 to 45 per cent from 2005 levels and use non-fossil fuel for about 15 per cent of its energy. India has also made a commitment to reduce its emissions per unit of GDP 20 to 25 per cent below 2005 levels by 2020. These commitments were affirmed at the 2010 Cancun Conference, however, even if the countries did manage to achieve these reductions, these efforts would only keep the global temperature rise within 3.5˚C by the year 2050 (Dirix et al., 2013).

In areas other than the reduction commitments, the power at play is always soft power as well. Persuasion and attraction are more likely to occur than coercion and compulsion (Raustiala, 2002). There are also successful

resolutions related to a number of global issues that have been achieved by non-binding instruments (Victor, Raustiala, & Skolnikoff, 1998). These attempts were successful because of the support from entrepreneurial NGOs, developing countries and some European countries which proactively supported tougher export controls. The key to success is the implementation area. Studies show that ambitious norms are more easily achieved in soft law institutions than in legally binding ones since the former offer greater flexibility (Skjærseth, Stokke, & Wettestad, 2006). Abbott and Snidal (2000) confirmed the value of soft law which fosters shared opinions among international actors and generates contracts that lead to legally binding agreements(W. Abbott & Snidal, 2000).

The softness of the current climate regime complex is another reason why the bottom-up approach might succeed. 'Governance from below' is the essence of the bottom-up approach and this could effectively strengthen the implementation of global environmental policies (Morsink et al., 2011), which represent the weak point of current climate governance.

The innovation capacity of a state

Innovation capacity is the ability of an actor to transition itself into a better state in terms of technology and system structure. A state with good innovation capacity is capable of generating new knowledge and technology at a speedy pace. In addition, the state is also capable of adjusting its political structure to provide a friendly environment for such advancement to take place. The relatively recent recognition of innovation as being at the core of a knowledge-based economy has resulted in an array of studies and reports about states'

innovation capacity. Capacity reflects the ability to produce or perform innovation (Hall, 2007). In the context of this thesis, this concept should be understood as a collection of resources that might result in innovation.

Energy technology innovation can be defined as materials and knowledge combined in some novel application involving energy conversion and the provision of a useful energy service (Grübler & Wilson, 2013, p. 9). Innovation is most simply conceived of as novelty. Unlike oil and forests, innovation is a purely human-made resource. Energy technology innovation relates to the capacity of human knowledge to overcome the limits of our current energy supply and ultimately satisfy humanity's need for energy. Energy technology innovation ranges from radical new inventions to marginal performance improvements, and encompasses social and behavioural changes alongside more visible material changes in technological hardware (Grübler & Wilson, 2013, p. 2). This thesis will not elaborate on the importance of technology innovation to a state since it is not only important to climate change but also to a country's economy and social change (Smil, 1994).

2.2.1.18 How innovation capacity can be improved

This thesis argues that the innovation capacity of China could be improved through certain kinds of mechanisms, and that the international climate change regime plays an important part. The concept of 'mechanism' will be elaborated in the following sections. Scholars such as Young (2011) have explored many mechanisms that influence global governance and this thesis adopts the same methodology to study the effectiveness of the climate change regime. Instead of

studying many mechanisms which are interacting with each other, this thesis focuses solely on the impact of innovation mechanism on the climate change regime.

2.2.1.19 The definition of regime (complex) effectiveness

The measurement of a regime's effectiveness is widely debated and there is no agreed standard. Stokke and Vidas (1995) define it as 'the impact it has on certain basic problems which it addresses – whether these problems are conceived of in economic, environmental or any other terms' (Stokke & Vidas, 1996, p. 15). The impact of a regime is often understood as the impact it has on states' behaviour. The assessment of regime effectiveness needs to address the key question of whether the behavioural adaptation caused by the regime has contributed significantly to solving major problems. This thesis focuses on the energy innovation capacity of a state to study the effectiveness of the climate change regime (complex) and aims to measure the effectiveness of the climate change regime by studying its impact on China's innovation capacity.

2.2.1.20 Consequences (effectiveness) of a regime (complex)

The consequences of a regime is a broader concept than its effectiveness (Underdal, 2004, p. 27). Any change brought by the climate change regime, for example, could be a consequence but only the changes that lead to the solving of the problem relate to its effectiveness. Scholars have been more interested in the consequences that are related to the purpose of the regime. The side-

effects of a regime are only of interest insofar as they have a direct or indirect influence on desired outcome of the regime.

Most regimes produce a chain of consequences, and effectiveness can be measured at different points in this chain (Underdal, 2004, p. 34). For example, the climate change regime does not directly result in cooperation from countries. Instead, it creates a chain of consequences. This thesis not only studies the influence the climate change regime has on China's innovation mechanism but also is interested in climate regime's impact on the political environment in which China's innovation mechanism is functioning.

2.2.1.21 Assessing effectiveness

Three questions need to be considered when trying to assess a regime's effectiveness: 1) What precisely is the object to be assessed? 2) Against which standard is this object to be evaluated? And 3) How do we in operational terms go about comparing that object to the standard we have defined? (Underdal, 2004, p. 31).

The effectiveness of the climate change regime in motivating the innovation mechanism is related to the contribution the regime makes to motivate actors to spend money and energy to solve the problem. According to the various definitions of effectiveness, the effectiveness of the climate change regime can be evaluated in different ways. This thesis focuses on the 'problem-solving effectiveness' of the climate change regime. For example, the standard for assessing the innovation mechanism in China is whether the mechanism has developed innovative measures to solve climate change in both the

environmental and technological contexts. While such assessment provides a clear idea of the effectiveness of a certain regime, it is difficult to apply it meaningfully in the real world.

This thesis has therefore chosen an indirect means to evaluate the consequences of the climate change regime in China. Effective regimes cause changes in interests or the perception of interests for actors, leading a state actor to change its policies and performance of institutions both domestically and internationally (Young, 1999, p. 5). Such changes may contribute to positive changes in the system. The accumulation of such positive changes may eventually result in solving the problem. However, it is quite difficult to change the interests and perception of interests of a state actor and usually takes a long time to achieve. This situation describes the current development of the international climate change regime. After many years of negotiations without significant progress on an international legally binding agreement, states are making bigger promises every year. It is highly possible that such an agreement will be achieved in Paris in 2016. Incremental progress eventually brings significant progress.

Adopting such a perspective means that a regime does not need to solve the problem to be deemed effective. A regime is effective as long as it is capable of bringing positive changes continuously. In the case studies in Chapters Three to Chapter Five, this thesis seeks to demonstrate the climate change regime's impact on China's energy innovation behaviour and how China's adaptations contribute to solving the problem at the international level.

2.2.1.22 Direct and indirect impacts

Regimes have both direct and indirect impacts, depending of the length of the causal chain (Young, 1999, p. 12). In most cases, direct effects centre on behaviour involving compliance with regime rules and participation in programmatic activities. Indirect effects of a regime are responses that are causally connected to a regime's rules or activities, but which involve considerably more intervening factors between regime features and reductions in environmental stress. This thesis focuses on both the direct and indirect impacts of climate regime complex on China's innovation mechanism.

2.2.1.23 Natural or quasi-experiments

This method involves examining situations that are broadly comparable except for the presence or absence of a regime or alternatively situations that remain largely unchanged over time except for alternations in the character of the prevailing regime (Young, 1999, p. 17). This is a conventional way to study regime effectiveness but there are many other ways, apart from regime impact, to explain differences in outcome and there are few comparable units of analysis.

2.2.1.24 Thought experiments

These involve a counterfactual analysis of the scenario: If the regime were not there, what would happen? This method emphasizes analysis of the decision-making process of the member states of a regime.

2.2.1.25 Behavioural pathways

This method focuses on process rather than ultimate outcomes, and is often used in single-case studies (Stokke & Vidas, 1996, p. 18). Young (2011) argues that since all regimes aim to bring changes to its member states' behaviour, if we want to measure the effectiveness of a regime, it is useful to study the behaviour path or mechanisms through which institutions produce effects. First, such an approach should define a point or trajectory against which actual performance can (easily) be compared. Second, it should provide a common metric of measurement that can be applied across a wide range of cases (Underdal, 2004, p. 15). This thesis conducts a behavioural pathways study of China's innovation behaviour using the innovation mechanism.

2.2.1.26 Why focus on energy?

The energy sector is the core area for overcoming the climate change issue according to many scholars (Rayner, 2010). Non-sustainable energy production and consumption are the main sources of greenhouse gas emissions. Many scholars have focused their studies on the area of energy or renewable energy (Verbruggen, 2009). To eradicate the climate change problem, we urgently need technologies and energy resources that do not emit greenhouse gases and are less costly than the existing alternatives. Renewable energy resources such as solar, water, geothermal, biomass, and wind energy offer many opportunities to mitigate global warming. The cost to produce alternative energy sources has reduced in recent years and also provides lucrative business opportunities (Verweij, 2003). Some states are extremely

successful in utilizing renewable energy; for example, all of Norway's electricity needs are provided by hydro energy.

An energy-focused approach is commonly accepted by national governments as well as international organizations. In the World Bank's (2012) distribution of carbon finance projects, renewable energy accounted for 31 per cent while energy efficiency accounted for 22 per cent. In his proposal, Verweij (Verweij, 2003) discusses many possible renewable energy options and believes that countries should choose their own energy mix according to their own conditions, locations. All countries, he maintains, can satisfy their needs for energy and transportation with renewable energy. Verweij argues that the timing is right for the world to embrace renewable energy and governments only need to persuade financial institutions to invest in renewable energy and the rest will progress on its own accord. The development of renewable energy technology not only mitigates climate change but also provides wider benefits. It contributes to social and economic development, energy access, a secure energy supply, and reducing negative impacts on the environment and health ("Summary for Policymakers. In: IPCC Special Report on Renewable Energy Sources and Climate Chagne Mitigation," 2011).

Mechanism

Young (2011) defines mechanism as a piece of reasoning or social factors which is capable of bringing about a certain series of other things. States change their behaviour because of the functioning of such mechanisms. Mechanisms describe the causal relationship between factors. The study of a

certain mechanism involves the study of which factors under what circumstances bring a certain consequence. In most of the cases, we have the influencing factors and the consequence. We know that under some conditions, these factors could bring certain consequences. But we are not sure under what conditions the mechanism is sure to work. And defining these conditions is often the goal of such studies.

However, not all the scholars agree that studying mechanisms can help researchers to better understand our society. Little (1996) argues that 'there is no such thing as autonomous social causation; there are no social causal mechanisms that do not supervene upon the structured choices and behaviour of individuals' (Little, 1996). He does not believe that certain social causal mechanisms can direct the choices and behaviour of a group of individuals.

The word 'mechanism' has recently been introduced into international regime literature (Underdal, 2004, p. 74) and is used by scholars in a variety of ways to mean:

• *a set of rules, an institutional body, or an institutional procedure ('Clean Development Mechanism' of the Kyoto Protocol)*

• *a behavioural pathway, which Young (1999) defines as 'the generative source of behaviour on the part of the states and other actors-intergovernmental organizations, nongovernmental organizations, corporations, and even individuals – whose behaviour contributes to outcomes in the issue area under consideration' .*

• *the intermediate processes between an international institution and regime effectiveness (Stokke & Vidas, 1996).*

• an independently verifiable, pragmatically simplified model of micro phenomena designed to improve a theory at a macro level by enhancing its suppleness or elegance or by generating new and testable implications. A piece of scientific reasoning which is independently verifiable and independently gives rise to theoretical reasoning, which gives knowledge about a component process (generally one with units at a 'lower level') of another theory (ordinarily a theory with units at a different higher level) (Stinchcombe, 1991)

• a continuous and contiguous chain of international or causal links (Elster, 1983, p. 29)

• a series of events governed by law-like regularities that lead from the explanans to the explanandum (Little, 1991)

• a plausible hypothesis, or set of hypotheses, that could be the explanation of some social phenomenon, the explanation being in terms of interactions between individuals and other individuals, or between individuals and some social aggregate (Schelling, 1998).

Stinchcombe (1991) strongly emphasizes that theorizing about mechanisms could strengthen the higher-level theory by adding 'suppleness, precision, complexity, elegance, or believability' (p. 367). Young (1999, p. 20) points out that international environmental regimes virtually always constitute elements of multifaceted and dynamic behavioural complexes with a variety of political, economic, technological, and social changes taking place around them. It is inappropriate to assume that one simple mechanism is enough to solve the whole problem. The solving of the problem may depend on the aggregate effect of multiple mechanisms functioning for a long period of time (Stokke & Vidas, 1996, p. 19). In the line with this understanding, this thesis assumes that many mechanisms are at work in the climate change regime but focuses only on the

innovation mechanism. Gradual improvements made by this single mechanism are capable of bringing larger changes to the climate change landscape.

In this thesis, mechanisms are intervening processes between the climate change regime and the outcome of the regime in one area (the first and third definitions above). In a given area, a regime might activate several mechanisms to inject new energy into the currently operating mechanisms. The outcome of the regime is determined by the aggregate effects of these mechanisms. However, any forwarding force created by the climate change regime or in any single mechanism may bring positive achievement and thus is meaningful.

Table 1*:* Mechanisms that affect a state's behaviour in a regime

Name of the mechanism	Focus of impact of regime
Utility modifier	How specific rules and regime activities will influence the interest calculus of its member states.
Enhancers of cooperation	Joint gains brought by collective action in the long run.
Bestowers of authority	The internationalization, routinization and socialization process influence the state's behaviour.
Learning facilitators	The initiating processes that give ruse social learning.
Role definers	The shaping the identities of actors.
Agents of internal realignments	Create new constituencies or shifting the balance among faction or subgroups vying for influence within individual states or other action.

Source: (Young & Levy, 2011)

2.2.1.27 Innovation mechanism and spill-over mechanism

There are two mechanisms which are very important to the success of the bottom-up approach. The first is the innovation mechanism. Technological innovation may effectively mitigate the threat of climate change (Mikler & Harrison, 2012) and is essential to successful climate policy. Innovations in other areas may also assist the mitigation and adaptation of climate change. Such innovative efforts include business organization methods, urban land use planning, public transport, architectural standards, and the creation of specialized financial products to increase investment in the green sector. Such experiments are an important step for the evolution of the climate regime complex (Bodansky & Diringer, 2010). Having multiple actors in climate governance produces more experiments as well as a higher chance of innovation. Actors functioning at the ground level can tailor standard policies or technology to adapt to the local situation. Actors at multiple levels are more likely to mix and cooperate. The recent deal made by the NDRC and the California state government is a perfect example of this cross-level cooperation (Chen, 2013). By studying state-level initiatives and activities to address climate change, scholars have found that the advantages of state-level strategies include stimulating technological innovation, the spill-over of technology innovation, and learning by experimentation process (Wiener, 2007). To boost technology innovation, financial support has to be in place (Isabel & Christopher, 2009). However, promoting technological change is so far an unrecognized rationale for state action on climate change (Adelman & Engel, 2008). China is becoming a powerhouse for technological and scientific

innovation in the 21st century and it is therefore useful to study China's innovation system and the impact of the climate change regime at each level.

The other important mechanism is the spill-over mechanism. Scientists argue that fostering a technology revolution – not setting emissions targets – is the key to stabilizing the climate (Isabel & Christopher, 2009). In recent years, researchers have begun to investigate the role of international technology diffusion (Mikler & Harrison, 2012). This relates to the existing learning system network which can collect successful experience and spread that experience elsewhere. In case studies of the decreased used of hazardous pesticide and poisonous chemicals, international training provided to developing countries helped them to implement the PIC and decrease the importation of poisonous chemicals (Victor, 1998). This mechanism could be applied to spread technology innovation as well as knowledge. In a regime complex without the binding of international law, the state of knowledge and technology plays an essential role in influencing the behaviour of international actors (Skjærseth et al., 2006). The UNFCCC notes that the technology that could stabilize and even reduce greenhouse gas levels within a few decades already exits. The problem is getting such technology in place (Mikler & Harrison, 2012). It is very important to trace the flow of knowledge and technology in the climate change regime complex. The efficient functioning of both the innovation mechanism and the spill-over mechanism determines the effectiveness of the bottom-up approach in a given area.

2.2.1.28 China's energy innovation capacity

So far in this chapter, many concepts related to the research questions have been reviewed: regime, regime complex, effectiveness, behavioural pathway, and mechanism. This section looks at the last major concept in the research questions: China's energy innovation capacity. Unlike other studies that explore the overall effectiveness of a certain regime, this thesis only focuses on one aspect, in one country: the energy technology innovation capacity of China.

Until recently, the market for high-tech goods and services was dominated by the United States, Japan and other Western countries. In addition to the rise of Taiwan and South Korea in this sector, many developing countries such as China and India are entering the market in big ways. Currently, China is seeking an 'objective symbiosis' between international investment and indigenous innovation. China is also trying to strengthen its dialogue power in 'international standards setting' (Merrill et al., 2010). This attempt has been considered mostly unsuccessful in first-tier markets. What is more, the current innovation system is relative autonomous, and highly productive industrial R&D enterprises are far from complete (Karplus, 2007). But there is nevertheless clear evidence of China's ambition in high-tech goods.

The author believes that energy technology innovation capacity and spill-over mechanism are two very important aspects to improve a state's performance regarding climate change. Many countries are pinning their hopes

to reduce carbon emissions on the invention of a low-cost new energy or cheap carbon restoration. Studies have shown that an advanced technology will not incur higher costs than business-as-usual in the next 50 years (E. D. Li, Wu, Pat, Chen, & Gao, 2003). This means that states have strong incentive to develop such technologies and strengthen their R&D initiatives.

This thesis argues that innovation capacity is reflected in the aspects of technology innovation and policy innovation which spur technology innovation. There are two sources of China's technology innovation. The first is indigenous innovation and the second is innovation brought about by foreign investment or foreign technology transference. China has been the largest recipient of foreign direct investment (FDI) in the developing world since 1990 (Woo & Song, 2008, p. 243). Many developing countries see the advanced technology embedded in FDI as driving their technological upgrading. As development continues, they focus on promoting indigenous innovation, which is the core of a country's technological capacity. FDI only has limited influence according to many scholars' research (X. Fu & Gong, 2011; X. Fu, Pietrobelli, & Soete, 2011; X. L. Fu & Mu, 2014). China has adopted this approach and has developed a complicated pattern of learning and innovation methods in Chinese industries and sectors (X. Li, 2011). Li reached this conclusion from his study of China's state-owned enterprises. But one thing seems to be certain: without solid knowledge building, it is difficult to absorb the advanced technology purchased from developed countries. Based on this finding, China has adopted a more balanced method to rely on both FDI and indigenous innovation development.

Policy innovation refers to a government's adoption of new policy to encourage indigenous innovation or foreign transference of innovation. The

policy setting is key part for energy technology innovation (Grübler & Wilson, 2013, p. 5). Although more and more studies indicate that the end market demand determines the innovation capacity rather than the cost of investment and public policy, such demand always lags behind the needs of development. Market demand could also be guided by public education. China has therefore made large efforts to protect intellectual property rights and build up its legal system.

The innovation capacity of China has not gained scholars' attention until recently. One important standard to assess innovation capacity is patent numbers and quality. Most of the studies on innovation performance uses this standard (Huang, 2010; Li, 2011). Between 1986 and 2006, patents across all patent classes and assignee sectors increased over 13% per year on average in China (Huang, 2010). Private firms are the dominating force in this trend. This fact shows a strong rise in domestic innovation capacity. Huang also found that the distribution of the innovation capacity is more equal among China's provinces in 2006 than it was in 1986. These figures suggest that, at the general level, China's innovation capacity has developed in a fast and balanced way.

Many scholars have argued that the signing of climate conventions is an important milestone based on their expectation that conventions will accelerate a learning process that enhances the willingness of members to agree to more substantial restraints on emissions of greenhouse gases over time (Young, 1999, p. 25). For example, China and many countries have signed conventions to carry out joint research on different areas related to climate change. It is possible that during the increased communication between China and other

countries that China has learnt what other countries are doing to develop their clean technology, leading to further increases in indigenous innovation.

2.2.1.29 China's energy technology innovation capacity and climate change regime

China's economy has grown hugely in recent years and the country is now the world's manufacturing powerhouse. But does this mean that China has become an innovation-oriented country? Scholars have different opinions, however if thing is certain it is that, in general, innovation capacity is crucial in the case of climate change mitigation. To achieve sustainable development in the next decades, China has to be innovative on both the political front and the technology front. The central government of China has already included this aim in its wider plan to become an innovation-oriented country (Wei & Richard, 2009). The following section discusses the innovation concept before focusing on factors that influence China's innovation capacity based on previous literature.

2.2.1.30 China's energy technology innovation capacity

In recent decades China has encouraged FDI in the hope that the entrance of foreign investment would bring advanced technology. This hope was not completely fulfilled however. Although China's technology strategy of obtaining technology by sacrificing its own market partly failed, Chinese enterprises are now less reliant on foreign technology (Wei & Richard, 2009). China has incentive to develop its energy technology given the fact that energy demand in

the country will increase rapidly in the coming decades (E. D. Li et al., 2003). Scholars have proposed different factors they think will improve China's innovation performance other than FDI.

Escalating R&D spending is one such proposal to improve China's innovation performance (Wei & Richard, 2009). Studies have shown that without considerable R&D spending in addition to FDI, energy innovation capacity cannot be improved. As noted above, demand from the end market is more important in determining the willingness for enterprises to invest in advanced technology than the cost of the technology. Wei and Richard (2009) also propose that global linkages are another driver for technology upgrading.

2.2.1.31 Previous case studies

Previous studies offer a range of case studies on environmental regime effectiveness. The Antarctic Treaty System (ATS) and its components (such as Convention on the Regulation of Antarctic Mineral Resource Activities) is a well-studied case. The ATS is considered a successful attempt to regulate states' behaviour in Antarctic to preserve the environment of Antarctic. Studies on this regime have shed some light on the research conducted by this thesis. To study the effectiveness of the ATS, scholars chose four problems of the governance of Antarctic and studied how the regime tries to solve these problems. These four problems are external acceptance, accommodation of the sovereignty issue, protection of science, and striking a balance between economic use and environmental protection (Stokke & Vidas, 1996, p. 113). These problems are the key issues which determine whether the regime could achieve its goals and whether this regime could be accepted by the involved states. In other words,

how the ATS dealt with these four major problems was considered as the standard of whether it was operating effectively.

2.2.1.32 Horizontal comparison

In their research, Young and Levy (1999) compared three different international environmental regimes: the ATS, the ozone regime and the international fisheries regime. The effectiveness of these regimes was rated from strong to weak. The ATS was found to be remarkably effective in managing the affairs in the region. The ozone regime was also very successful at the initial stage, phasing out CFCs and a number of other chemicals which compromise the ozone molecules. However, in the later stages, many problems have impaired its effectiveness. The international fisheries regime was considered a failed regime. The failure resulted in the depletion of many important fishery stocks (Haas, Keohane, & Levy, 1993). In researching the three regimes the authors were trying to establish what has contributed to their effectiveness or ineffectiveness.

Young (1996, p. 110) has brought scholars' attention to behavioural consequences as a measure of the effectiveness of regimes. The issue of effectiveness became the question of whether regime plays a role in shaping or guiding the behaviour of all the actors involved – governments as well as private corporations and individuals.

2.3 Gaps in the research

The source of effectiveness

Despite the controversy over whether environmental regimes and in particular the climate change regime are effective or not, there is not much study being done in this area. This is partially due to the fact that there is no universally accepted standard to decide whether a regime is effective or not. The effectiveness of environmental regimes varies. More in-depth case studies need to be done to help scholars gain a better understanding of the source of effectiveness.

2.3.1.1 Multilevel analysis

Young (2011)proposes that mechanisms might be the key to explaining how environmental regimes function. Scholars have mainly studied mechanisms at regime level, and little research has been done at state level, industry level or local level. Conducting case studies of these levels would be very useful for explaining the effectiveness of environmental regimes. These case studies would also deliver clearer practical implications to policy makers.

2.3.1.2 China's energy innovation capacity and the climate change regime

China's innovation capacity has caught the attention of many scholars recently. However, most studies revolve around national policy about foreign investment and internal R&D investment. Little work has been done on the relationship between China's innovation capacity and the climate change regime on a larger level.

2.3.1.3 A focus on what is happening now

Most previous studies were carried out against an 'imaginary background' which believed that an international climate change regime would be achieved soon after international society negotiations. However, subsequent developments have taught us that commitments from state members do not come easily. A lot of work still has to be done before countries will willingly accept reduction targets and the costs associated with it. An international legal agreement looks to be still in the distant future. It is imperative that internaitonal society finds a solution based upon the current situation and the achievements that are plausible now. A fragmented regime is what we currently have but this non-perfect regime complex is an important starting point.

More research needs to be conducted to systematically study the participation of a particular country or region in the climate change regime complex in order to ascertain which initiatives are working. Case studies on the bottom-up approach are limited and focus on only a few developed countries. It is necessary to shed some light and apply theories to a number of other countries and regions. Such case studies will generate more information about the way the bottom-up approach is working to shape the regime complex.

2.3.1.4 The need for a theoretical framework

International Society urgently needs a theoretical framework related to the regime complex that combines the various theories about the way regime complexes work (Alter & Meunier, 2009). A framework which explains why different regimes have different effectiveness is more likely to persuade sceptics

of regimes. Such a theoretical framework would also have practical implications for policy makers.

2.4 Conclusion

The first section of this literature review has outlined the bottom-up approach to tackling the problem of climate change before reviewing the existing literature in relation to the main concepts brought up in the research questions. This chapter then clarifies how this thesis understands and applies each concept. Table 3 lists the concepts and definitions used in this research.

Table 2 Concepts used in this thesis and their definitions

Concept	Definition
Regime	Regime refers to the way governance is achieved in a certain issue area.
Climate change regime	The climate change regime is the global governance on the specific issue of climate change. Governance is seen as coordination of social actions instead of hierarchical regulation of control.
Regime complex	Not all regimes involve legally binding agreements. A regime complex is a group of loosely related governing bodies. Climate change is an example of such a loose network of governing bodies.
Innovation capacity of a state	This concept is understood as a collection of resources that might result in innovation.
Effectiveness of a regime	Capability of a regime to change the behaviour of the actors involved.
Mechanism	The intervening processes between the climate change regime and the outcome of the regime in one area.

Many scholars have confirmed that international environmental regimes do have an impact on states' behaviour. Prominent scholars such as Young (1999; 2011) have called for more research on how international environmental regimes have influenced states' behaviour in order to fully determine how effective different international environmental regimes are. This thesis answers

that call by conducting case studies on the effectiveness of the climate change regime in relation to China's innovation capacity.

Chapter 3 Multi-level Case Studies

In order to examine the effectiveness of the regime complex for climate change on China's energy innovation capacity, this thesis adopts the climate change regime model developed by Keohane (2009) which defines the climate change regime as a 'regime complex'. In order to understand the conditions under which the international climate change regime have the greatest influence on shaping China's actions over the promotion of renewable energy technology initiatives, we must first understand the relationship between the international system and state behaviour. To keep the thesis within a manageable scope and this project focuses on China's involvement in 3 constituents, the national initiative, bilateral cooperation and club participation. This shall be achieved by demonstrating the impact of several behaviour changing mechanisms on China's energy innovation behaviour and investigating whether their efforts have employed the bottom-up approach.

The previous chapter examines the literature on regime complex and effectiveness (Biersteker, 1995; Stokke, 1996; Gehring, 2004; Strokke, 2004; Underdal, 2004; Young 2004; Honneland, 2007; Hof, 2009; Young 2011). Multiple methodologies have been adopted to study the consequence of regimes: qualitative case studies, quantitative case studies and quantitative analyses (O. R. Young, 2011). This study adopts a 'multi-level perspective' and behavioural mechanisms to case study the several constituents of the climate change regime complex's impact on China's energy innovation capacity. That is to say, the argument of the thesis will be tested in 3 chosen constituents in the

regime complex and to be studied at multi-level. This section introduces the methodologies adopted in this study in order to answer the research question.

3.1 Materials and sources

This thesis conducts an in-depth analysis of China's behavioural change with regard to its engaging or not engaging with the climate change regime complex. In order to conduct such an analysis, this thesis mainly uses a qualitative research methodology. It uses Chinese domestic sources, such as its official publications, political leaders' public statements, and policy documents to examine and summarize China's energy innovation behaviour. This study also collects data from websites sponsored by the Chinese government such as China Climate Change Info-Net (http://en.ccchina.gov.cn/). This thesis also relies on press articles published on the official websites of other states such as the United States and a number of international organizations including the World Trade Organization, the UN, and the International Energy Agency, etc. News publications, opinions from mass media, and other scholars' work (both Chinese scholars and international scholars) are utilized to provide evidence and support to the arguments made. The official documents concerning China's policy towards climate change are mainly sourced from the state or state-sponsored websites. The thesis also absorbs information from Chinese newspapers, magazines, television programs, film and other mass media. To enhance the originality of this thesis, the researcher accessed video speeches from state level officials of China and collected information from it.

Content analysis will be applied to study the above materials. It is important to note that the author(s) of a mass media article can sometimes be uncertain, impacting on its reliability. It is unclear to see whether the author is in a proper position to provide accurate discount of the issue discussed in the articles. Accordingly, this thesis will try to avoid such sources and not cite articles without clear knowledge of who the authors are.

3.2 Purposive sampling

It is beyond the scope of this thesis to study every facet of China's participation in the climate change regime complex. Instead, this research focuses on three components of the climate change regime complex: sub national initiatives, multilateral cooperation, and club cooperation. Purposive sampling is a theoretical sampling technique (Bryman, 2012, p. 420) and was applied in this study on the basis of the theory proposed by Keohane and Victor (2011). The three components were chosen because the author believes they have significant potential to make a difference to the current climate dilemma. In addition, purposive sampling will also generate a more theoretical understanding of how the number of participants in international organizations influences the outcome of the effectiveness of such an entity.

3.3 Discourse analysis

Language, both descriptive and performative, is a powerful tool (Zehfuss, 2002, pp. 203-204). Innocent people use language to defend themselves. Culprits also use language to avoid blame and punishment. Similarly, states,

people, and any entity can use language to legalize and justify its behaviour. According to many scholars, the data used for discourse analysis should be collected from spontaneous material such as oral material recorded in natural context (Georgakopoulou, 2004, pp. 22-23). In this sense, the ideal data for discourse studies should be collected from interviews and the like. However, due to the nature of the research question it would be impractical, if not impossible, to gather interview data from the highest-ranking government officials and heads of institutions. The main analysis approach for the textual materials (newspaper articles and other documents published by governments, organizations and other entities will be discourse analysis) with be discourse analysis. This thesis attempts to identify the policy frameworks constructed by the persons or institutions through the publications of these entities (Bryman, 2012, p. 528). This approach is a supplementary approach in this thesis since the primary aim is to study the change in China's behaviour instead of its rhetoric or perception.

3.4 Mechanism: An intervening factor

The use of mechanisms has been recommended by scholars to accumulate knowledge between regimes and their effectiveness (Strokke, 2004; O. Young, 2004, p. 87). Young (2004) advises researchers to 'frame a set of models that appear important on theoretic grounds and then turn to the case studies to assess the relevance and relative importance of the behavioural mechanism associated with each of the models under real-world conditions' (p. 87). Keohane and colleagues also organize their causal analysis around 'concrete mechanisms around which institutions can alter the behaviour of state

actions'. The aim of using mechanisms to assess the effectiveness of a regime is to understand how a regime influences states' behaviour in different ways (Strokke, 2004, p. 89).

There are always different ways of thinking about effectiveness. The application of the mechanism method to access the effectiveness of climate change regime complex shows that this study conceptualise effectiveness in the less ambitious way. Success in new regulations or infrastructure or even behavioural changes of the actors is deemed as part of regime effectiveness in this study. Studies also show that regime complex offers a way forward in situations that do not lend themselves into creating an integrated legal system to solve the issues in discussion (Young, 2011). Climate change issue is one of such issues.

The goal of applying the mechanism method is to acknowledge the impact of regime complex and collect the evidence to improve that such impact exists. To decide whether the mechanisms are functioning, this study observes the behaviours of the different actors in China at different levels and reviews the strategy of different actors about how they plan to solve climate change issue and whether these plans are created in accordance with the mechanism or provide friendly environment to the mechanisms operating in this area.

These mechanisms recognize that institutions can influence state behaviour via pathways involving power, interests, norms, knowledge, and habit and so on. These causal links were discovered in many cases and will be retest in the climate change regime complex case again in this thesis.

This study chose to apply this institutionalism's perspective over sociological and constructivism approach for many reasons. Sociological perspective highlights the organizational characteristics and the environmental embeddedness of the regime (Martin, 2016). The in-depth analysis of the sociological significance and the nature of climate change issue are extremely meaningful and useful in the system setting to solve climate change issue. However, while acknowledging the importance of such analysis, this study focuses on evaluating the effectiveness of climate change regime through measuring whether a specific number of behaviour changing mechanisms are functioning. The specific nature of climate change issue does not fundamentally change whether or not these mechanisms are working.

Constructivism approach focuses on the social construction of identities and interests of actor and ideational factors; thus is more concern with how norm influences identity. While also acknowledging the significance of knowledge and interests, this study attempts to find out how does the climate change regime complex impact the behaviour of China in a specific period of time. Sociological and constructivism perspective have lots to contribute to climate change regime issue. Institutionalism is mostly likely to provide a clear answer to the research question in this case.

3.5 E-research

The number of Internet users worldwide has increased from nil to more than 3 billion in less than 20 years ("Internet Live Stats"). China has the biggest population in the world and also has the biggest number of Internet users. The

penetration rate in China (46.03%) is not as high as some developed countries such Japan, the United Kingdom and the United States, but given the huge population of China, this percentage means China has 21.97% of the world's Internet users ("Internet Live Stats").

The influence of the Internet in China is tremendous and in response to this phenomenon, governments, organizations and individuals are all seeking to enhance their impact through providing information on Internet. A large number of studies have been based on data collected from Internet (Sillince & Brown, 2009). The research carried out for this thesis was also influenced by this development.

This thesis will also attain many of the material through internet searching. At the same time, the author will remain cautious about in using materials attained from internet. The author is aware of the fact that the Internet contains abundant of data and advice, it also contains a lot of misleading and incorrect information (Bryman, 2012, p. 654).

To minimize the effect of misleading information, this research adopted the following strategies. First, the author relied on a number of search engines: Baidu, Sogou, Youdao and Soso are all widely used search engines in China, and this research also included Google and other large search engines such as DuckDuckGo and Yahoo. Second, the author used many search key words to find related information. Third, this research mainly relied on documents and information obtained from official websites or websites sponsored by governments or certified organizations.

Table 3 A Summary of the Methods applied in the Thesis

Methodology	The purpose of utilizing this method in this thesis
Purposive sampling	Narrow down the scope of this thesis to a manageable scope. This thesis chose three constituents in the eight constituents of regime complex for climate change based on the author's understanding of the regime complex for climate change and theoretical implication these three constituents can provide.
Discourse analysis	To analyze the framework constituted by different entities in China about how to solve climate change issue, how to enhance China's energy innovation and how to participate in the regime complex for climate change.
Mechanism analysis	This analysis method was applied to explain why regime complex for climate change has different impact on different states. The adoption of the intervening factor "mechanism" also simplifies the complicated consequence of regime complex for climate change on different states.
Case study	This thesis adopts the case study method to have an in-depth look at
E-research	This E research method reduces the chance of this thesis adopt inaccurate information.

Various methodologies have been applied in this thesis and these methodologies have determined the logical process of this thesis to come to the conclusion and the instrument sued to collect data. In summary, this thesis intends to study the behaviour change brought by the regime complex of climate change on China's energy innovation capacity. If there is discernible change on China's energy innovation behaviour brought by the regime complex, it is confirmed that the regime complex of climate change is being efficient in the case of improving China's energy innovation capacity. It is noted that a counterfactual analysis is also applied in this process to exclude possibility that

this is change is brought by other causes. To keep the scope of this research at a manageable level and guarantee this research in considerably in depth, this thesis adopts the case study method and purposive chose a number of constituents in the regime complex for climate change as its research targets. In order to explain how regime complex works to enhance China's energy innovation capacity, the author chose to use mechanism as an intervening factor.

3.6 The case studies

This research employs the case study approach as a way of discovering causal relationships between independent variables and the effectiveness of the climate change regime. This study assumes that the climate change regime complex has an impact on states' behaviour and is thus explanatory in nature. As such, the research question lends itself to the adoption of case studies, histories and experiments as the preferred research methods. This thesis applies case studies as a valid method to examine in depth how certain mechanisms work to influence China's innovation behaviour. Case studies are often a preferred strategy when 'the investigator has little control over events' and when 'the focus is on a contemporary phenomenon within some real-life context' (Yin, 1994, p. 13). Empirical studies of regime effectiveness so far have focused on one or a few case studies of individual regimes at work. This is largely due to the fact that the theoretical framework concerning regime effectiveness has not been fully constructed. This research is based on the analysis of three components of the climate change regime complex and

investigates how these components change China's energy innovation behaviour.

This section intends to provide a detailed explanation on how the three case study chapters select cases and conduct its analysis. This thesis examines how the behavioural mechanism work based on the analysis. In this process, selection of cases took place several times and the selection is not random. This section of the method explains the criteria of this thesis of choosing cases. First of all, the case selected has to be a representative sample of the entire group. Second, the case provides useful variation on the dimensions of theoretical interest (Seawright & John, 2008).

This thesis chooses 3 parts from the 8 constituents in the regime complex for climate change to study the effectiveness of the regime on changing China's energy innovation behaviour. The criteria for selection are as follows. First, this thesis is features with the bottom-up approach and the rest parts in the regime complex is highly relevant with the UN and are symbols of the top-down approach. Second, the selection of China's national initiative, bilateral cooperation and club participation is of theoretical interest as well and allow the researcher to assess how the size of cooperation influences the regime's effectiveness.

The national initiative

Chapter 4 conducts an analysis on how China enhances its energy innovation through taking national initiatives and the influence of the regime complex in this process. This chapter selects various entities at different levels

in the sub-national field in China in order to study their activities to enhance energy innovation capacity. The levels selected are national level, provincial level, city level, district level and company level. This chapter looks closely at the Central Governmental level, the Beijing municipal level, the Beijing Haidian District level and Goldwind Global at the company level to discover their respective action plans in relation to the energy area. The analytical part of this chapter examines the innovation mechanism embodied in the general review of the activities conducted by actors at each level. This part also conducts a counterfactual analysis that attempts to determine the role played by the climate change regime complex in the whole process.

The bilateral cooperation

Chapter 5 intends to gain a broad view of China's bilateral cooperation with other countries by studying Sino-American and Sino-Indian bilateral relations, as well as relationships between China and other developing countries on energy innovation cooperation. The selection of these states reflects the intention to have a general idea of China's energy innovation cooperation with different types of countries. The United States is the largest economy in the world, while India is a significant developing country. China, the United States and India all have substantial economies and are thus major emitters. Taking a closer look at bilateral relations among them facilitates our understanding of the potentials and difficulties of bilateral cooperation. Sino-American and Sino-Indian cooperation is very important to the global climate effort. It is necessary to study relations between China and other developing countries as a preliminary study of South-South cooperation on climate change. This thesis does not look at the

relationship between China and less developed countries: data is insufficient, due to unbalanced coverage of those countries in current literature and news reports.

This chapter first draws a general landscape of China's bilateral cooperation with other countries on energy innovation; it then summarizes the efforts the regime complex for climate change has made to enhance bilateral cooperation on the issue. The indicators include willingness to cooperate, existing communication channels, financial resources, joint projects and joint research. The next section applies the counterfactual analysis of what would happen without the regime complex for climate change and discusses its role in bilateral cooperation between China and other countries in improving its energy innovation capacity.

Club participation

Energy clubs are numerous. However, there are few clubs for energy innovation. The relevant areas of energy innovation are information sharing, technology assistance and technology sharing. Some clubs have strong financial resources, such as CAREC, but they do not directly finance energy innovation projects, being focused on projects assisting the application of known technologies, and so spreading energy technology. This chapter chooses one dialogue forum and one implementation group, G20 and GMI respectively, representing political dialogue forum at the national level and technical dialogue at the project level.

To limit the number of clubs and make this study possible, this article only considers mitigation clubs. Clubs focusing on the strengthening of states' ability to adapt to climate change are not included in this study. Although these adaptation clubs are all useful and necessary, they do not share the same presumption and understanding of climate change as mitigation clubs and do not encounter the same problems, such as free-riding. The clubs selected all have potentials to act as climate clubs because they are already quite prominent and influential.

In the analysis in the following chapters, the author will give a brief introduction to each club and then discuss its members, its shared vision and its function, followed by China's participation in these clubs and how they strengthen China's energy innovation capacity.

Chapter 4 China's National and Sub-national Initiatives in Enhancing its Energy Innovation Capacity

4.1 Introduction

This chapter examines China's national and sub-national initiatives to enhance its energy innovation capacity as part of its climate change regime. The first section generalizes China's national energy innovation strategy and the manner in which China's domestic actors at different levels try to address climate change through adopting innovative energy solutions. The second section discusses how China's innovation capacity building seeks to enhance itself through participation in the climate change regime. The last section discusses the counterfactual of what would happen to China's energy innovation capacity if the climate change regime were not there.

China is experiencing worsening weather conditions. According to the National Strategy of Climate Change Adaptation, a report China released for the UN climate change negotiations in 2013, extreme weather conditions in China have caused an average of more than 2,000 deaths and up to £34 billion in economic losses each year since the 1990s ("How China's action on air pollution is slowing its carbon emissions," 2013). China is now well-known for its less than stellar environmental quality. Air pollution levels in many of China's cities far exceed health-based standards. Recently, many cities in China are

suffering haze weather (MaiTian Qi), which caused widespread complaints from citizens in eastern cities, where the air is unsafe (Larson, 2013). The Chinese government is under pressure and is taking serious measures to act on pollution that also slow carbon emission growth ("How China's action on air pollution is slowing its carbon emissions," 2013). These measures to address the smog also give some hope of tackling climate change (Burck, Marten, and Bals, 2014).

For a long time China had not been concerned with environmental issues. As China developed, the Central Government realized that the environmental problem is not only the concern of developed countries. China started to pay greater attention to environmental issues since the 1970s. China has accomplished development efforts that are legendary for keeping high-speed economic growth for a long period of time and has emerged as a global titan in terms of energy usage and greenhouse gas emissions. China overtook the United States and became the largest emitter of greenhouse gases in the world in 2007. Even so, the Chinese Central Government's policies toward climate change and climate mitigation were 'minimal' from 1988 to 2007 (Stensdal, 2012). In the 11th Five Year Plan (FYP), China's energy efficiency target was still very 'small or non-existent' (Boyd, 2012). However, changes are already underway as the Central Government's attitude has shifted to the more positive side toward climate change mitigation.

Many scholars believe 2007 is the year the shift actually took place. After 2007, many changes occurred and the climate change policy subsystem has included other issues as well which made it more 'multifaceted and unruly' (Stensdal, 2012). The Central Government started to consider climate change

as an issue that greatly affects the national economy as well as people's livelihoods. The Chinese government has experienced a policy shift by embarking upon ambitious energy reform and climate mitigation programs. For the first time in its history, China included specifically targeted carbon emissions reduction into the 12th Five Year Plan (12th FYP). To guarantee the local government's dedication to the 12th FYP, the Central Government included work in this area as important criteria for promoting government officials (Liang, 2013; Sheng, 2013). It seems that the Central Government has recognized that it is in China's interest to work at developing its low-carbon economy and contribute to climate mitigation if the reform and development is at an acceptable pace. Domestically, the Central government replies to Chinese citizens' complaints about the haze and the environmental concern. At the international level, this effort demonstrates that China is a responsible power and can peacefully rise without causing chaos. The economic transition to a greener economy will also be beneficial to China in the long run if decisions are not made in a rushed fashion.

Investing in low-carbon industries and renewable could also reduce China's heavy reliance on coal and other fossil fuels. In 2009, China's investment in clean energy technology was nearly twice than that of the United States (Remais, 2011). China recognises the many benefits of sustained investment in clean energy, including reduction in emissions of greenhouse gases, enhancing China's energy security, and improving the quality of China's environment. At the same time, the development of new industries such as wind and solar power may provide new opportunities for China's development. The

Chinese government is more and more willing to take action towards climate change both through national initiatives and international cooperation.

To tackle climate change, the Chinese government has set up targets. Some are ambitious, such as to raise non-fossil fuel resources to 11.4 percent of primary energy consumption; to lower energy consumption per unit of GDP by 16 percent and CO2 emissions per unit of GDP by 17 percent (China's 12th Five Year Plan, 2011). The government assigned targets to provinces; provincial governments assigned targets to lower levels and industries. China did not intend to slow its economic development for the sake of meeting environmental targets. Instead, China plans to rely on science and on technology innovation and transfer (Chumutina, Zhu, and Riffat, 2012) by encouraging public participation and international cooperation. The Chinese government realized that climate change would require a large investment and a huge amount of professional knowledge and expertise. It was aware that the problem could not be dealt with single-handedly by the Chinese government. It is reported that China has doubled the financial resources (221 billion USD) to make its economy greener. Most of these investments are focused in rail and grid infrastructures (Bosetti, Carraro, and Tavoni, 2009). Even so, according to a Chinese climate financial report, each year a gap still remains of 20 trillion RMB on investment of renewable energy sector ("the Report: China's fund address climate change is in short of 20 trillion RMB (Bao Gao Cheng Zhong Guo Ying Dui Qi Hou Bian Hua Nian Zi Jin Que Kou Chao Guo Liang Wan Yi," 2014). Another challenge for the Central Government to address climate change is how to attract public investment for the green economy.

China has been quite successful in term of reducing its carbon intensity. Although, the average annual growth rate of China's GDP was 10.45%, from 1990 to 2010, the annual growth rate of energy consumption was only 6.14%. During the last two decades, China's CO2 intensity of GDP declined by 57%, compared with the average decreasing rate of 30% for developed countries and the global average at 15% (Jiankun, Zhiwei, and Da, 2012). China has also made great improvement in its clean energy sector. China's wind energy capacity and solar energy capacity rank among the top ten in the world. Some products and services provided by Chinese wind energy corporations and solar energy corporation entered the global market.

National government level

The Central Chinese government has been eager to contribute to the mitigation of climate change. It has been actively engaging in the formulation of international agreements on climate change. Domestically, the Central Government has embedded the carbon emissions reduction goal into its grand economy structure and energy transformation plans.

The Government issued the National Climate Change Programme in 2007. This programme outlined China's strategy and work addressing climate change. Though the programme received criticism for its lack of new and genuine initiatives to combat climate change (Stensdal, 2012), it shows the Chinese government has started to pay special attention to climate change. In the same year of 2007, China also issued its first ever white paper on Energy Conditions and Policies (China's Energy Conditions and Policies, 2007). In this thesis,

China has clarified that it looks to develop an energy industry of thrift, cleanness and safety. Since 2011, the National Development and Reform Commission of China published a summary of China's policies and actions on climate change annually. The Chinese government pays particular attention to energy technology innovation as well. In August 2014, the National Development and Reform Commission issued the Catalogue on the Promotion of National Key Low-carbon Technologies to accelerate the promotion and application of low-carbon technology. The Ministry of Science and Technology, the China Meteorological Administration and other relevant departments compiled the Third National Assessment Report on Climate Change, to systematically summarize China's scientific achievements on climate change. These documents keep a clear track record of current technology progress.

China has a very large state apparatus along with a complex division of labour and responsibilities. Scholars have outlined the policy makers with respect to China's climate change policy: the National Coordination Committee on Climate Change (NCCC), the NDRC, the Ministry of Foreign Affairs, the Ministry of Environment Protection, the CMA and the Ministry of Science and Technology (Chumutina et al., 2012). There are also many scientists and scholars who have been involved in the decision-making of China's climate policies and strategy. However, their influence is difficult to assess, due to a lack of access to documents related to their proposals and opinions they presented to the Central Government. But it is clear that the Central Government regularly summons related scholars in their discussion and workshops to see their analysis and opinions. It is the NDRC that organizes the work and allocates the projects to different ministers and agencies; the responsibility of administrative

agencies and local government is to implement the policies, with the involvement of the entire society (Zhong Guo Ying Dui Qi Hou Bian Hua De Zheng Ce Yu Xing Dong China's Policies and Actions for Addressing Climate Change, 2013). In the 2011 report, the Central Government specified eleven areas of work to address climate change (please see the table below for details). The 12th FYP not only included carbon reduction targets but also planned how to achieve them. A full proposal for the 12th five year plan was approved by the National People's Congress (NPC) on March 14, 2011. The NPC is the highest echelon of state power according to the constitution of the People's Republic of China. It has the power to legislate, the power to oversee the operations of the government and the power to elect the major officers of state. Many laws and regulations have been passed by the NPC related to climate change.

To achieve the overall reduction target, the Central Government assigns tasks to provincial governments and they assign quotas to lower-level governments. This is the typical way a unitary government functions (Qi, Ma, Zhang, and Li, 2008). To achieve the target, the Central Government also provides financial assistance as well as favourable policies to encourage industries to commit carbon reduction.

However, local governments in China might have different views with respect to the carbon intensity reduction target. Developing the economy at the regional level has been dominating the working agenda of local governments for a long time. History shows they were not serious about carbon intensity reduction target, since many required measures might slow local economic growth. At the end of the 11th Five Year Plan period, many provinces shut down

factories to meet targets. In the 12th Five Year Plan, to guarantee the proposed plan is effective, the Central Government evaluates provinces annually (Feng, 2011). These tasks are also assigned to different state agencies. For example, the NDRC, State Environment Protection Administration, the Ministry of Finance and the Central Government passed many regulations to guide various local carbon intensity reduction efforts. The management of climate change related issues is led directly by the National Leading Group for Climate Change. The NDRC categorized the work and assigned the official plan or programme of action projects to different ministers and agencies; these administrative agencies and local government implement the policies; the entire society will be involved (Zhong Guo Ying Dui Qi Hou Bian Hua De Zheng Ce Yu Xing Dong China's Policies and Actions for Addressing Climate Change, 2013).

In 2009, the National People's Congress NPC of China Standing Committee adopted the Resolution on Actively Responding to Climate Change and included climate change legalization in the agenda. The NPC also requested the University of Political Science and Law in China to propose draft regulations on climate change.

To raise the awareness of Chinese people, the State Council introduced June National Low-carbon Day ("China to introduce National Low-carbon Day," 2012). The Central Government also encourages local initiatives that educate the public on the impact of climate change and what the public can do to reduce their energy consumption.

In the area of energy innovation, the Central government has launched many programs to boost energy research. Energy area is one of the focuses of

China's National Basic Research Programme, also known as 973 Programme. This programme directly funded research carried out at Universities, state-owned companies, private companies and elsewhere.

Local engagement

Lower-level engagement is an important key to making long term and continuous progress on climate change (Lutsey and Sperling, 2008). To make a real change to the current situation of climate change mitigation, there must be a commitment that includes local governments, private corporations and individuals (Cynthia, William, Stephen, and Shagun, 2010). Regional and local initiatives are very important since they can boost the commitment and participation of private stakeholders (Knieling and Filho, 2013). Local initiatives can work as a test bed for assessing the feasibility of climate-related measures and can also offer new approaches for setting and implementing climate goals (Knieling and Filho, 2013). Local trial and practice is an effective way to test the innovative technology. The GHG emissions originate from processes that are embedded in specific places, and it is argued that the local level is the most appropriate political jurisdiction for bringing out necessary reductions (Betsill and Bulkeley, 2006). The state of California has provided a good example as a local state pushing the federal governments to take more powerful policies towards climate change by voluntary reduction targets ("A road map for U.S.-China cooperation on Energy and Climate Change," 2009). The state of California in the United States has set a mandatory goal of reducing emissions to 1990 levels by 2020, and has joined six other states in the Western Climate Initiative to establish a regional cap-and-trade system with the same goal. Scholars are

very confident about the initiatives in the United States and believe they will eventually facilitate a new international climate change regime.

Sub-national contribution to climate change has attracted scholars and field workers' attention in recent years. Scholars recognized that the role of cities in combating climate change had been ignored for a long time (Cynthia et al., 2010). As China's political structure is unitary, local governments are supposed to implement decisions made by the Central Government. However, the extent to which local governments respond depends on their motivations, capacity and constraints (Qi et al., 2008). International experience has suggested that some top leaders in local government are very concerned about their careers and will do whatever they can to promote the local economy and fulfil the target established by the Central Government. The local governments are endowed with the legal right to do so by the Constitution of the People's Republic of China. According to the Constitution, the people's congresses of provinces and municipalities directly under the Central Government and their standing committees may adopt local regulations that do not contravene the Constitution. These regulations must be reported to the Standing Committee of the NPC for the record. These clauses give a mandate to provincial governments and municipal governments directly under the control of the Central Government so they have the necessary basic legal right to adopt local regulations to assist their work to mitigate climate change.

One of the obstacles that local initiatives might face is the idea that climate change has so frequently been framed as a global issue that local politicians and citizens did not believe that they can change (Ostrom, 2009). The local government, industries and citizens must realize that they are adopting low-

carbon technology, standards and investments not so much to achieve the assigned quotas from the Central Government but to improve their own environmental standards, to keep themselves from further harm by not creating more polluted air, and to create more opportunities for local companies and people. Provinces and cities can also take this as a chance to develop its own profile and economy.

Provincial level

Recent years have witnessed a dramatic rise in the activity level of lower-level governments in low-carbon projects (Stensdal, 2012). Prior to mid-2007, no local government from the provincial level to the most local level expressed serious interest in working on climate change (Qi et al., 2008). After 2007, most provinces have set up special task forces to lead efforts on climate change and some have made specific plans for research, mitigation, and adaptation measures. At the provincial level, Guangdong released an assessment of climate change's effect on Guangdong Province. It documented the changes in climate patterns in the province, provided explanations for the changes, and projected future scenarios. In November 2007, Qinghai Province and Sichuan Province released similar assessments. Qinghai Province was also the first province to establish a regulation on climate change which took effect on Oct. 1st 2010. This regulation requires local governments official and state-owned companies in Qinghai Province to undergo evaluation on climate change related criteria (Lan, 2010). Some provinces work together to conduct research projects. Five provinces in West China launched a joint research project in January 2007. Gansu Province invited Canadian scientists to conduct research on the impact

of climate change on the ecosystem in the region in September 2007 ("China Climate Change Info-Net,"). The shift in attitude of the Central Chinese Government has resulted in regional governments starting to seriously consider the impact of climate change on their region.

Between June 2007 and March 2008, eight provinces and autonomous regions created leading groups related to climate change, following the model of the Central Government (Qi et al., 2008). Provincial government links performance evaluation systems to the promotion of local government officials and leaders of state-owned enterprises (SOEs). Failure to achieve the reduction target may influence the promotion chances of these local officials and SOE leaders. Some provincial government use a veto system. Failure to achieve the reduction target will prevent promotion of the officials concerned, regardless of their performance in other areas. Some provinces adopted punishment and reward mechanisms for SOEs. Shandong Province government signed contracts with 103 local major enterprises. Failure to achieve annual targets will signify that these SOEs will not receive any award or honour. Anhui Provinces has similar contracts with 153 local enterprises and requires municipal government to sign responsibility contracts.

Three factors are shaping local governments' policy on climate change: the mandate from the Central Government, internal needs, and the international market. There are some other factors also contributing to how local governments manage climate change: the local impact of climate change, capacity and awareness, and leadership and vision (Qi, Ma, Zhang, and Li, 2008). These factors determine a local government's zeal or reluctance to

internalize climate policy as a local priority. In China, the Central Government is more aggressive in pursuing climate change policy than local government.

As the Central Government strengthens its regulation of local officials and the benefits of new energy technology began to appear in the 12th FYP period, local provinces are more serious about energy innovation and carbon emissions reduction.

Municipal level

The centrality of cities in dealing with global governance has attracted scholarly attention (Knieling and Filho, 2013). The International Energy Agency (IEA) estimated in its survey that urban areas are responsible for 71 percent of global energy-related carbon emissions. Some cities are extremely proactive, such as New York, which voluntarily aims to reduce its greenhouse-gas emissions by 30 percent from 2005 levels over the next 20 years.

In China, there are also cities quite concerned about climate change, especially after the breakout of haze weather. Wuhan, the capital city of Hubei Province, published a working plan to improve its air quality from 2013 to 2017. This five-year-plan requires an investment of ¥28’000’000’000. The municipal government and district governments in Wuhan will cover a portion of the investment ("Wu Han Da Xiang 280 Yi “Zhi Mai Da Hui Zhan” Mei Tan Xiao Fei Suo Ding Ling Zeng Zhang," 2014). Shenzhen City is the first to propose an emissions peak between 2017 and 2020 (China's Policies and Actions on Climate Change 2014). Some cities include energy innovation into their development strategies. Baoding, a city in Hebei province, decided to develop

solar power and is determined to become China's "City of solar energy." Zhang Jiakou City, another city in Hebei province, has been chosen by NDRC and the National Energy Administration of China to be the city that provides clean energy to the Jing Jin Tang Region (Liu, 2015).

At the global level, some cities joined the global municipal effort to address climate change. Beijing, Shanghai and Hong Kong all joined the C40 Cities Climate Leadership Group, an association that brought together forty cities and aims to lower emissions levels in order to help those cities adapt to future climate change (Dirix, Peeters, Eyckmans, Jones, and Sterckx, 2013). Not only super cities have joined such alliances: in collaboration with the Swiss Agency for Development and Cooperation (SDC), small and medium cities such as Enshi and Fuzhou have joined the World Alliance for Low Carbon Cities (WALCC). Many cities are also collaborating with other entities such as universities and foreign ENGOs. Multilateral banks have conducted many projects at city level to assist cities to build more environment-friendly urban systems. The WB and the ADB both have projects at the municipal level in China. However, most of these projects are via cooperation between multilateral banks and local government. These international organizations have not reached out to the private sector and individual people in China.

County levels and firms

From a global perspective, many international organizations, including some large global multilateral development banks have started to pay more attention and effort to the projects at the most local levels. Among the 81

projects the ADB is currently running in China on climate change, only ten involve cooperation with the Central Government, whereas 61 are operated at the provincial, autonomous regional and municipal levels (although municipalities are directly under the auspices and guidance of the Central Government). There are also nine projects functioning at county levels and in sub-districts of cities. For example, the ADB has direct cooperation relations with a sub-district of Baise and several counties in Qinghai province. Sub-district governments are also playing their part to address climate change. One of the responsibilities of Beijing's Haidian district's Development and Reform Environmental Resource Section is to stipulate plans and policies to address climate in Haidian District, by organizing saving energy and reducing emissions demonstration projects, and by promoting new products, new technology and equipment related to reducing energy intensity. Some corporations also joined the WALCC such as Huizhou Jiecheng Engineering Art Development Co. Ltd., and Xiang Ming Photoelectricity Science and Technology (HK) Co. Ltd. In term of energy innovation, State owned companies are leading the way with strong financial support from government. There is a strong government-oriented fashion in the core innovation area. For example, after 11 years and more than 10'000'000 tests and spending 100'000'000 RMB, Zhongche Group (Zhu Zhou Branch) has successfully developed the technology of a permanent magnet synchronous motor traction system.

Citizens and NGOs

Citizens in China show willingness to contribute to the mitigation of climate change and other environmental issues. For example, a telephone interview

study of 1108 Beijing citizens on their awareness to save energy shows that more than 70 percent of people interviewed agreed with the notion that resources are limited and we should save energy. More than 90 percent of people would like to pay a higher bill for a more energy efficient product. There is a strong willingness to use solar energy in citizens' daily lives ("Study shows that Beijing citizens would like to save energy and lower their carbon emission," 2010).

In China, there have been individuals and organizations involved with climate change for more than 20 years (Stensdal, 2012).The first Chinese ENGOs were set up in the 1990s, often by educated individuals, many of whom had seen the work of ENGOs abroad. Except for local ENGOs, many international organizations are working in China. Greenpeace, the Climate Group, the Nature Conservancy, World Research Institute (WRI) and the Natural Resources Defence Council (NRDC) have all set up offices in China. In 2009, seven NGOs in China published "2009 Chinese Citizens' Position to Address Climate Change" (China News, 2009). These ENGOs in China are playing an increasing role in raising the awareness of the public and pushing the government and industries to adopt greener policies. One example is China Civil Climate Action Network (CCAN). The China Youth Climate Action Network, formed in Beijing in August 2007, began as a group of seven organizations sharing the desire to tackle global warming. Its main project is to encourage energy efficiency at 52 Chinese universities through holding expositions and interviews of low-carbon heroes. However, the activities conducted by the ENGOs are strictly supervised and restricted by the government as their communication and financial transactions with entities abroad are frequently

monitored (Bao, 2009; "Budding greens; Environmental groups in China," 2010). International observers are quite concerned about the future of domestic NGOs in China.

These NGOs not only try to raise the public's awareness regarding climate change and encourage the government to take more consideration on environmental impact of their policies, they also assist the government by writing reports and negotiating with the polluting corporations. A number of organizations including the Environmental Protection Federation, China Environmental Protection Foundation, and China Environmental Culture Promotion Association all assist the government with their environmental governance (Bao, 2009). A few ENGOs are working with local governments on local energy projects, providing examples of the way energy consumption patterns could be altered. Two environmental newspapers, China Environmental news and China Green Times support the ENGOs' work by reporting on their activities and disseminating information.

Chinese governments are now very concerned about raising individual awareness of saving energy and reducing carbon emissions. Guangdong is one of the most developed provinces in China and it is testing a new carbon reduction scheme that awards citizens for reducing their carbon emissions. Citizens could win "carbon currency" in this way and use this currency in their daily lives. As the concept of "crowd funding" is rising up, scholars are looking forward to witnessing more schemes and projects funded by the public.

The central governmental level

In the 12th FYP, the planning and directing power of the Central Government has been enhanced and the Central Government's system to address climate change has been formed. First, the target is outlined in the 12th FYP. The ministries and committee in Central Government are assigned different specific tasks in their related area. These ministries and committees publish plans and regulations in their respective areas. Provincial governments are also assigned targets. Provincial governments are responsible to ensure local enterprises complete their targets. Failure to achieve the reduction targets may directly influence the related officials' promotion. The Central Government paid special attention to directly seeing big industries achieve their targets and expands the original Top 1,000 Energy-Consuming Enterprises Programme adopted in the 11th FYP to the Top 10,000 Energy-Consuming Enterprises Programme (Top-10'000 Energy-Consuming Enterprises Programme, 2011). In this programme, 17,000 enterprises, each with a total annual consumption of standard coal that exceeds 10,000 tons, are included. In the period of the 12th FYP, the 10,000 industries aim to save 250 million tons of standard coal. The 12th FYP has achieved much better results than the 11th FYP, as local officials are more serious about energy intensity.

As mentioned, to boost energy innovation, the national government has created many programs to fund basic research in the area of energy, such as the 973 Programme. The national government of China also assigned local governments to select and fund local energy innovation programs conducted by universities and corporations.

Beijing city level

Beijing, as the capital city of China, chose to take the lead as its region's principal city to build its system and provide financial support to industries to make structural adjustment. In the 11th FYP, Beijing was one of the eleven provinces, autonomous regions and municipalities directly under the control of the Central Government that overfilled the reduction targets. To achieve the targets assigned in the 12th FYP, Beijing published Beijing's 12th Five Year Energy-saving and Carbon Emission Reduction Plan for all the People in Beijing in which it sketches out the themes and focused areas where Beijing can save energy and reduce emissions ("Beijing "12th Five Year" Action Plan For Energy Saving and Emissions Reduction," 2012).

Beijing municipal government adopts a series of policies to reduce carbon emissions. Beijing launched carbon emissions trading in 2013 and became China's third market for compulsory carbon trading. Under this scheme, an initial 490 companies, whose carbon emissions account for forty percent of the city's total emissions, need to buy unused quotas on the carbon market if their emissions exceed their fair shares (Chen and Reklev, 2013).

Beijing targets the creation or build-up of a standard system in different areas. For example, Beijing stipulated standards for building construction. Residential buildings that are less than twelve levels are required to have solar panels installed (Design Standard for Energy Efficiency of Residential Buildings, 2012).

Beijing also tried to encourage the participation of citizens. Beijing municipal government strengthened its advocating power and organised

expositions, workshops, themed activities and media coverage to raise social awareness of energy-saving and low-carbon living. The Beijing municipal government also encourages its citizens to take public transportation to reduce emissions and alleviate the capital's traffic.

Beijing Municipal Commission of Development and Reform and Beijing Education Committee established Beijing Climate Change Response Research and Education Centre (BCCRC) in 2012. This research aims to provide experts for Beijing's action addressing climate change. To boost energy innovation, Beijing Municipal Commission of Development and Reform has selected and funded programs related to energy innovation every year, according to a standard set by national government.

Beijing has also tried to encourage the participation of citizens and adopts innovative policies through consulting with its citizens. Beijing Municipal Commission of Development and Reform collects policy suggestions to save energy and carbon reduction research from the public (Wang, 2013). Any person who has a thought about energy saving (such as how to control the total amount of energy consumption, how to develop energy-saving and environmental-friendly industries, community construction of low-carbon parks) could send it through email or mail to the Commission.

Beijing joined the global effort to build low-carbon cities. Beijing is a member of C40 and takes various measures to achieve its goals. (1) The current chairman of C40 placed a focus on research and measurement. C40 has a partnership with Carbon Disclosure project and introduced many benchmarking tools that enable a city to report progress and measure risk in

consideration of the changing climate (Marinello, 2013). (2) C40 introduced the experience of some cities trying to mitigate climate change. C40 report the current policies adopted by these cities and how these policies work. In its recently released report, C40 introduced the current situation of Tokyo's cap-and-trade programme ("Update on Tokyo: Year two results from the world's first urban cap-and-trade programme," 2013). Its members (or anyone who is interested) could get a general idea how some cities are trying to fix climate change. Its main goal is to develop a kind of collective learning and provide experience along with suggestions to cities that would like to adopt green policy to manage their carbon emission.

Beijing Haidian district level

Haidian district is the sixth most outstanding district for saving energy and reducing emissions. Haidian district is also one of the most active areas of national research and innovation. Haidian District DRC published its Energy-Saving and Addressing Climate Change Work Plan. This plan specifies the target of the district in 2013 is to cap energy consumption within 850,000 tons of standard coal. Beijing Haidian District Government has taken many measures to improve local energy efficiency. A notice attempts to promote energy-saving projects by providing financial award of no more than RMB 2,000,000 (The Notice that Beijing Haidian District People's Government published Haidian District Energy-saving and Carbon Emission Reduction Supporting Measures, 2012).

Haidian District People's Congress, Peking University, Haidian District DRC jointly sponsored activity to advocate a low-carbon life style. The aim of these activities is to spread the idea of low-carbon into government departments, universities and communities. In 2015, the local district government sponsored an activity to raise the local citizens' awareness of energy saving. This event took place in a local shopping mall ("Hai Dian Qu Ju Ban Jie Neng Xuan Chuan Zhou Zhu Ti Xuan Chuan Huo Dong," 2015).

Goldwind Global

Goldwind Global has recently emerged as the leading Chinese wind turbine manufacturer. The company currently holds 2.8 percent of market share in global wind turbine sales, reaching the global top ten for the first time in 2006. In 2006, Goldwind installed 442 MW – by far its largest annual installation to date. Up until 2006, Goldwind had only supplied the Chinese market. Goldwind, an entirely Chinese-owned company, is 55 percent state-owned and receives research and development funds from the Xinjiang Science and Technology Commission. It first obtained its wind turbine technology through purchasing a license from Jacobs, a small German wind turbine manufacturer (since been purchased by Repower), to manufacture 600 kW wind turbines. The license commands a €5,000 royalty per machine produced. Subsequently, Goldwind purchased a license from Repower for its 750 kW turbine, and a license from another German company, Vensys Energie, for a 1.2 MW turbine. The terms of the Repower license prohibits Goldwind from exporting its turbines. In 1998, XWEC's turbines contained 33 percent local content, and by the next year, the share of locally manufactured materials had increased to 72 percent. This figure

is still increasing. However, the quality and reliability among Chinese suppliers are a problem, particularly for key components such as rotor blades, gearboxes, generators, yaw systems, and electric control systems (Lewis, 2007). Since 1996, Goldwind has pursued a business model that allows it to implement modern foreign technologies while promoting its own technological advancement. As it is not satisfied with importing foreign technology it also has a target to make its own innovation by conducting research and development. Goldwind works to improve its technical capacity by sending its employees abroad to obtain advanced training. The company reports that two-thirds of their staff have already attended events for technical exchange or further training by foreign companies or institutions.

Technology transfer does not come easy. Top companies with the most advanced technology would not want to risk transferring their technology to developing countries such as India and China as they could produce the same products at a lower cost. So China chose to cooperate with second tier companies. These companies have less to lose and they can also benefit from the license fee.

It is noted that at this level, there is still strong dominance of State Owned Enterprises (SOEs). Many local governments have established the Energy Investment (Group) Ltd. that invests in local energy programs and is the main investing body in energy innovation.

4.2 National innovation system (NIS)

The national government of China has a policy system to spur innovation nationwide. A growing phenomenon of transnational firms working outside national innovation systems may eventually "render them (national innovation systems) obsolete" (Lewis, 2007). It is important to study the new innovation system with the rise of multinational corporations. Research on China's National Innovation System (NIS) also illustrates that China's NIS is changing to a more firms-led structure from a funding structure in which the government spurs innovation through its funding system (Sun and Liu, 2010). A number of authors argued that sub-national entities, such as provinces, industrial districts, cities and Silicon Valley are becoming more important than the government. There is also a trend that universities are playing a more active role in this process.

Apart from these, one has to admit that there is still strong tendency for the Central Government to dominate the NIS. This is quite different in other developed countries. Private sectors in Western countries are already very active in leading the innovation process. In Denmark, a network among turbine producers, turbine owners and researchers promotes the transfer of knowledge within the wind energy area (Lewis, 2007). In contrast, the United States wind industry has been characterized by a lack of collaboration and actions taken by firms to impede information flow. In fact, many foreign-owned companies opted not to partner with Chinese-owned companies except for some smaller components, and have not transferred know-how and intellectual property rights as a license (Lewis, 2007). Faced with this situation, the Chinese government has invested heavily in domestic innovation.

In the area of climate change, there has been funding to support climate change related research in each year's government's progress report. Many universities have established climate change research centres. Fudan University's Tyndall Centre was established in 2000. Peking University also established its own climate change research centre in 2009. There are also plenty of training programs that international society provides to China officially or unofficially. Germany and the U.S. both provide such programs. As discussed in Chapter One, although there is an observable rise of academic research and a growing number of academic institutions, up until now China has not established its own top-class academic institutions on climate change policy and science. However, research has always been the focus of the Central Government. Even though learning from international experience and technology is a good way to follow up with developed countries' scientific knowledge and policy system it will not make China the leading force in the green industry. How to handover the innovation responsibility to private corporations and create a healthier environment for the National Innovation System become an issue for Chinese companies.

Innovation system

It is encouraging to see that a network has already been established among governments at different levels, industries, research centres and individual experts. The current government-oriented innovation system has achieved a significant result. This has benefited mainly from a strong national funding support. But only large SOEs have the resources to invest in long term and large scale R&D programs (Karplus, 2007). The strong government support

feature also gives rise to the over reliance on universities and research centre for energy innovation in China (Karplus, 2007). In spite of these, the R&D to GDP ratio rose from 0.6 to 1.3 percent between 1996 to 2003 and the enterprise share of R&D spending has grown from less than 30 percent to almost 60 percent (Gao and Jefferson, 2007).

The Central Government also attempts to learn from the experience of other successful regions in addressing climate change. California is well-known for successfully promoting its energy efficiency which benefits all of the entire State residents. The NDRC not only studied California's success story (NDRC, 2013) it also signed an agreement with the State Governor of California to strengthen cooperation on climate change.

The national innovation system is operated by government at different levels. The Central Government directly funds and liaises with a number of research institutes and industries to boost energy. The Central Government also assigns funds and tasks to local government to select and fund programs at local level. In recent years, it has been witnessed that there is increasing fund coming from industries and there is more involvement of private corporations. The distribution of power to local authorities helps spur energy innovation based on local conditions. But it is hard to predict what is going to happen without government's powerful support. Whether this energy innovation system could support itself in the future is yet to be seen.

To guarantee the result of the innovation system, the Central Government requires reports from local governments on their work in climate change area. Early last year (2014), the NDRC published a notice on temporary measures to

promote energy-saving and low-carbon technology (The notice of NDRC's publication of energy-saving and low-carbon technology promotion, 2014). This notice is to encourage the provinces, autonomous regions, municipalities directly under control of the Central Government and so forth to apply for a priority energy-saving and low-carbon technology programme. The Central Government then evaluates the proposals and decides which technology should be promoted at the national level based on reliability, efficiency and economic return. As this measure was only taken in January this year, the efficiencies that will be gained still depend on the outcome of these measures.

The Central government also assists with many demonstration projects and targets to attract more investment from private sectors to fund similar programs. For example, the “Feng Guang Chu Shu” demonstration project was established by the end of 2011. It has successfully built up a combination of wind, solar and storage projects.

At the company level, in the case study, as the national policy is very supportive, the Goldwind Limited managed to apply a creative, blended way to enter the global top ten in the wind power field in less than a decade. They adopted a combination of licensing intellectual property, creating strategic technology partnerships, accessing regional and global learning networks, and taking advantage of regional resource such as lower labour costs. They successfully set the example of how a new company successfully enters the global arena. Studies show that sustained national support for clean-tech industries play an important part in this process ("Waiting for a green light; Clean technology after Copenhagen," 2010). The success of the Chinese wind industry is a cheering example. With the strong investment support, Chinese

wind industry emerged quickly and recently. However, this development mainly came from the purchasing of licenses from the second tier of wind industries. Such industry lacks the ability to innovate. The purchase may help Chinese wind industries to grow quickly. However, purchasing licenses alone could not put the Chinese wind industry on the very top of the list. Only innovation on technology could take the Chinese wind industry to the summit.

4.3 Analysis

In the process of studying the initiatives to enhance China's energy innovation capacities, this chapter has summarized several features of China's innovation system: government oriented, anarchic and over reliant on research centres and overseas technology transference. Generally speaking, these features were attained by strategy, the global response and China's counter-moves. Strong government support allowed China to purchase the most advanced energy technology. But the reluctance to share top class technology by the international community has forced China to focus on its own energy technology innovation. The dominance of national governments is both a blessing and a curse for China's innovation system. Strict government mandatory targets have made local government more serious about energy innovation than ever before. But fewer actions from the private sector are still limiting innovation.

In the whole process, there is only limited involvement of the climate change regime complex. To better build the blueprint of China's climate strategy, the Central Government tried to learn from other countries or local

states. Many of China's main cities have joined the C40 alliance to share successful experience fighting climate change. Many universities such as Fudan University have joined hands with overseas research centres to conduct joint research. Joint research centres are more common these days with investments from both sides. At different levels, government officials and local officials and technicians got the opportunity to be trained by international organizations or by developed countries. International organizations also helped local projects apply new technology to reduce their carbon emissions and build a more sustainable urban area. But these efforts can do little to change China's national innovation system of energy.

4.4 Conclusion

Unlike the United States where individual states are leading the way to act on climate change, the Central Government in China is dominating sub-national actors' efforts to address the issue. Drawing experience from previous efforts in addressing climate change, the Central Government has developed a highly controlled system to encourage and evaluate local initiatives to address climate change. At the general level, the Central Government stipulates an overall target for the entire country and assigns the targets to provincial level governments. Provincial government assigns the targets to lower levels. To make sure the target will be achieved, the complete level of the target is included in the promotion assessments of the officials. To provide a positive legal environment, the Central Government published many regulations in various areas such as standards for green building and so forth. To ensure success, the Central Government sets targets for the top 10,000 enterprises.

This is a highly unitary system to address climate change and the advantage is that it is very effective. The local governments will do its best to achieve the assigned targets.

In the area of energy innovation, the same method was applied. First, the Central Government directly funded a number of programs. The Central Government has been investing heavily in establishing academic institutions on climate change and has funded a great amount of research. China is also very keen on participating in training programs provided by developed countries such as Germany and the United States. However, such efforts are not as fruitful as hoped. Second, it assigned local governments to fund local promising programs. The spread of authority has made up for the deficiency of Central Government dominated innovation system of China.

China has spent much money and effort on climate change research and raising public awareness of energy-saving initiatives. However, there is no sign that China is catching up with other developed countries on climate related science research, or with private sector participation in the national effort to address climate change.

It is quite difficult to determine the role played by the regime complex for climate change on China's energy innovation capacity. China relies on technology imports from second tier energy companies worldwide for its initial development. But this strategy will not make Chinese energy companies top class. So the Chinese government has turned to innovation. Many government officials and company technicians gained the opportunity to study abroad as short term training in developed countries, such as Germany and the United

States. But this seems not to be the focus of China's national innovation scheme. The Chinese government is fully aware that it has to rely on international innovation to help domestic industry become strongest.

To achieve this goal, the Chinese government has established alliances with many developing countries by providing them with energy training and cheap facility construction. This has provided a huge market for consumption of China's energy products, which is also an important factor for the emergence of the Chinese energy industry.

In sum, the innovation mechanisms are flawed in the sub-national area of China, because of its unitary political structure. Further research is required to understand the reason why the innovation system in China is not functioning optimally and to offer recommendations for improvement, because it is evident that China is not so adept in the area of innovation. Although the Central Chinese Government has established a system to spur energy innovation and has achieved results, it is hard to imagine whether the energy industry can retain this developing speed when strong government support ends.

The counterfactual analysis in this chapter shows that China's involvement in the regime complex for climate change has limited influence on China's national initiative to enhance energy innovation capacity. In recent years, the Chinese government has already shifted its strategy to develop energy innovation capacity from through the open market by allowing foreign corporations to invest in its own national innovation centres and enterprises. With more incentives to improve the local environment, local governments are more active than before in contacting international counterparts and learning

from their experience so as to develop a sustainable environment while developing the economy.

Chapter 5 China's Bilateral Cooperation with Other Countries on Energy Innovation

5.1 Introduction

This chapter sets out to explore the impact of the regime complex for climate change on China's enhancement of energy innovation capacity in terms of bilateral cooperation. It focuses on the energy sector and evaluates bilateral efforts from a bottom-up perspective. It studies several cases to gain a picture of China's bilateral cooperation with different countries on this issue.

This chapter first reviews China's bilateral cooperation with other countries in the area of energy innovation capacity for climate change. The second section discusses the case study method. The third section applies counterfactual analysis to study what happens when the regime complex is not in place, as in these cases. The conclusion asks whether the climate change regime has a solid impact on China's bilateral cooperation on energy innovation with other countries.

The UNFCCC article 11.5 states that "developed countries…may provide financial resources related to the implementation of the convention through bilateral, regional, and other multilateral channels" (UNFCCC, 2009). However, some scholars believe most recent attention has been focused on multilateral institutions, while bilateral institutions have been overlooked (Atteridge, Siebert,

Klein, Butler, & Tella, 2009). Atteridge and his colleagues acknowledge that the role of bilateral mechanisms remains ambiguous.

However, this thesis holds a slightly positive opinion about bilateral cooperation and argues bilateral cooperation can to some extent solve the current climate dilemma. The US State Department envoy, Todd Stern, believes separate bilateral agreements between countries such as the United States, China, India, Russia and Brazil and other big countries could facilitate a global agreement on climate change (Goldenberg & Watts, 2009). Issue linkage theory supports this argument: the comprehensive relationships of these principal countries make it easier for them to compromise to reach one agreement, as they can balance their interests in other areas (Kemfert, 2004). Progress made by many states in the form of bilateral cooperation has brought on good changes to global climate effort. Bilateral cooperation avoids a situation where many participants cannot come to a single agreement.

Bilateral cooperation is a very important part of the climate change regime. A set of in-depth bilateral cooperation among major countries can change the landscape of the global climate change regime. Bilateral cooperation can take many forms. For countries with similar economic status, bilateral cooperation on climate change takes place as joint agreements, MoUs, joint projects and forums. For countries with very different economic statuses, the more developed country usually takes more responsibility by providing finance, technology and materials to the less developed countries.

Bilateral cooperation encounters fewer challenges than multilateral negotiation. It is much easier for two countries to arrive at an agreement related

to a certain area of climate change mitigation, despite their differences on other issues. Some countries, including China, prefer to contribute to global climate change mitigation and adaptation through bilateral assistance, rather than by multilateral assistance through international financial institutions, such as The World Bank and regional development banks. At a global level the amount of financial assistance derived from bilateral assistance outweighs that of the multilateral aid programs.

Bilateral Finance institutions (BFIs) for decades have played a key role in providing aid and investments to developing countries (Atteridge et al., 2009). Many developed countries – including Australia, the United Kingdom and Germany – have established special agencies to conduct bilateral cooperation on climate change. The financial support provided by bilateral finance institutions has greatly encouraged North-South bilateral cooperation. The amount of assistance is outstanding. Developed countries contribute much more through bilateral grants to other countries than by financial assistance to multilateral financial institutions. Since 1990, the money contributed to bilateral grants has been more than twice that spent on multilateral grants (Addison, McGillivray, & Odedokun, 2004). These financial supports to less-developed countries have provided more opportunity for these nations to enhance their capacity to deal with climate change.

BFIs have shortcomings. Their efficiency is comprised by the lack of support and capacity in recipient countries. The recipient country must have both the willingness and the ability to pay the difference of the incremental costs associated with the low-carbon option over traditional carbon-intensive options, as well as domestic policy measures that make low-carbon approaches more

cost competitive (Atteridge et al., 2009). Other problems, such as time-consuming government procedures, mean the recipient government is often very slow to assess and approve projects, which present constraints to the project pipeline.

Bilateral cooperation can be vulnerable (Fingar & Garrett, 2013). A change of economic conditions could have huge impacts on bilateral relations, for better or worse. An unhappy incident may bring disaster to a thriving relationship. For example, the 9/11 incident changed relations between the United States and the rest of the world (Jia, 2003). China and the United States have become closer since 9/11 and their bilateral relations have been relatively stable since then. However, there are still many potential deal breakers that could cause sudden deterioration of Sino-American relations. Although both the United States and China tried hard to improve their bilateral cooperation on climate change as well as in other areas (Economy & Segal, 2009), many issues threaten the deepening of ties. The United States is concerned as to whether China could enforce the required regulations related to climate change, given local reluctance (Economy & Segal, 2009). Unavoidably, the two states distrust each other. Many issues, including Taiwan and the territory dispute in the South China Sea, have the potential to harm the Sino-American relationship. Sustaining a stable and friendly bilateral relationship is one important factor to guarantee bilateral cooperation works.

This thesis specifically focuses on bilateral cooperation to enhance China's energy innovation capacity. The energy sector is already a focus of China's bilateral cooperation. Statistics have shown that 47 percent of bilateral finance has gone to the energy sector whilst 34 percent has gone to transport. Both are

highly relevant to a country's economy security. Although agriculture and forestry are directly related to climate change, they receive little mitigation finance from the BFIs (Atteridge et al., 2009). Countries are more enthusiastic about energy innovation than other aspects of climate change: enhancing energy innovation capacity provides additional power for economic and social development.

5.2 General review of China's bilateral cooperation with other states on energy innovation

Up to 2011, China signed 103 scientific cooperation agreements with 97 countries. Climate change is one of the top priorities of bilateral cooperation between China and other countries ("China's foreign aid," 2011; "China proposes to build int'l mechanism on technology transfer to address climate change," 2008). China has a set of broad cooperation relations with many countries about climate change. China now is both a big recipient and generous donor of assistance in the area of climate change. As a developing country, China has received financial and technical support from Japan and many European countries. The Associated Press has reported that China receives $2,500,000,000 per year as foreign aid in the form of bilateral and multilateral official assistance. However, as the growth rate of the global economy decreases, many states are withdrawing this assistance. Criticism has begun to arise, questioning the wisdom of an emerging giant power receiving international aid (Bennett, 2013). More criticism came after China had sent its

space probe to the moon, making it highly possible that China will be the second country to put a man on the surface of the moon.

Japan, once the largest aid provider to China, has stopped granting China new low-interest loans. China, with sixteen other countries, will stop receiving the United Kingdom's aid by 2016 (Bennett, 2013). China has received a large amount of assistance from developed countries and has started to return this favour by helping other developing countries. According to China's first White Paper on China's Foreign Aid ("China's foreign aid," 2011), China has a balanced expenditure on countries of different economic situations. China's traditional focus of foreign aid is agriculture, rural development and poverty, but China recognizes climate change as a new area ("China's foreign aid," 2011). The Ministry of Commerce of the PRC is in charge of foreign assistance aid and has initiated numerous projects aimed at helping other developing countries to better manage climate change.

Most existing bilateral studies focus on Sino-American and Sino-European cooperation on climate change and clean energy (Dreyer, 2007; Zhang, 2007, 2009). There is much literature studying the strong relations between China and Japan on energy cooperation (J. Wu & Xiao, 2012; Zhang, 2009). Some papers have been published about China's cooperation on climate change and energy with other giant developing countries (Lijun & Maoxia, 2010; Qiao, 2014; Siddiqi, 2011; F. Wu, 2012). Most of these case studies are delivered at country level. A small number focus on the level of enterprises. International cooperation has involved many private enterprises in China, particularly in wind and solar energy (Zhao, Zuo, Feng, & Zillante, 2011). There are already some projects focusing on how private companies apply technology

to reduce their environmental footprints, but these are limited to a few firms in developed countries. In other words, there is a gap for studies that focus on private sector levels and project levels, a need to explore bilateral cooperation from angles other than policy analysis. It is equally important to research how the actors in the global arena receive and respond to policy incentives.

Bilateral cooperation between China and other developing countries in the area of energy is broadening but still quite weak. China has started to cooperate with Russia, India and Brazil (Yue, 2014). However, most developing countries face the same problem of the lack of financial investment and technology. Especially in the area of energy innovation, developing countries are competing with others that are unwilling to share information and technology. To enhance bilateral cooperation between China and these countries, many obstacles have to be removed.

Table 4: Some Statistics about China, US and India

	China	US	India
Economy Ranking (based on 2012 data) (US dollars)	2nd (more than 8 trillion)	1st (more than 16 trillion)	10th (nearly 2 trillion)
Carbon emission (kt based on 2010 data)	1st (over 8 million)	2nd (over 5 million)	3rd (over 2 million)
Energy Consumption (2011 data kt)	1st (nearly 3 million)	2nd (over 2 million)	3rd (749 thousand)
Carbon emission per capita	57th (6.2)	10th 17.6	118th (1.7)

According to Hucheng Gao – China's international trading negotiation representative on the fourth China (Taiyuan) international energy industry exhibition Summit in 2012 – China has established bilateral relations with thirty

countries and has taken part in more than twenty international energy cooperation organizations and conferences (Xinhua News, 2012). In 2012, national investment on R&D met the same percentage of GDP as the EU. In 2013, this investment reached 2.08%, equivalent to US$ 192,000,000,000. This number will exceed the United States in 2019, according to the OECD (Chen, Pan, & Zhang, 2015).

With so much input, this chapter expects to see active bilateral cooperation between China and several countries. Cooperating with China becomes part of these countries' strategies. Most are aware that China's energy consumption will grow in the next decades, driven by urbanization. China needs to increase energy efficiency in traditional energy and develop new energy solutions to meet such need (Levi, Economy, O'Neil, & Segal, 2010).

Sino-Brazilian cooperation on energy innovation is impressive. China and Brazil each has its own technological edge. Both are emerging countries and are willing to cooperate with each other. Sino-Indian cooperation, on the other hand, lacks such a good base. India faces energy scarcity with the growing demand caused by rapid urbanization. Sino-Indian relations have been dominated by an atmosphere of competition, not cooperation, in this area. The IEA report states that in two decades before 2012, the number of renewable energy technology patents by seven key IEA partner countries (mainly BRICS countries) rose from 3.5 percent to 17.5 percent of the total patents submitted by the 28 IEA member countries combined (Mitchell, 2013). China has paid particular attention to cooperation with African countries and ASEAN. China has promised to develop one thousand clean technology projects throughout Africa and is engaging in many dam-building projects there.

Table 5: Sino-American Joint Statement Related to Climate Change

Title of the Agreement[1]	Level	Main Contents Concerning Climate Change
US-China Clean Energy Announcements 2009	The head of state level	● the two presidents announced the establishment of the US-China Clean Energy Research Centre (CERC) ● the two governments announced the US-China Vehicles Initiatives ● the US-China Energy Efficiency Action Plan (US-China Energy Efficiency Forum) ● US-China Renewable Energy Partnership (Advanced Grid Working Group and US-China Renewable Energy Forum) ● 21st Century Coal. The two Presidents pledged to promote cooperation on cleaner uses of coal, including large-scale carbon capture and storage (CCS) ● Shale Gas Initiative. ● the US-China Energy Cooperation Program (ECP).
Memorandum of Cooperation to build Capacity to Address Climate change[2] 2009	Ministerial Level: EPA and NDRC	● initial cooperation on providing technical support for the development of robust greenhouse gas inventories ● planned the area and the form in which the two countries could work together ● designated a Senior Coordinator on each side: Director General of the Department of Climate Change or his assignee; EPA (Assistant Administrator for International Affairs or her assignee).
Memorandum of Understanding to Enhance Cooperation on Climate Change, Energy and the Environment[3] (2009)	Ministerial level	● plans to promote bilateral cooperation by setting up a series of mechanisms including Ten Year Cooperation Framework on Energy and Environment. The two sides decided to establish Climate Change Policy Dialogue and Cooperation platform.

[1] This is not an exhaustive summary and includes only agreements after 1997. For more information about Sino-American agreements, see Haibin Zhang's work (Zhang, 2009). For a detailed summary related to agreements and projects on US-China cooperation on Clean Energy Relations, see Joanna Lewis (J. Lewis, 2012).

[2] For the full content of the MoU, see the EPA website: http://www.epa.gov/oita/regions/Asia/China/epa-ndrc-moc.pdf.

[3] For the full content of this document, see the website: http://www.China.org.cn/world/China_us_facts_2011/2011-07/13/content_22982313.htm.

Sino-American Joint Statement on Energy Security Cooperation 2010	Ministerial level	● as outlined in the Memorandum of Cooperation on Shale Gas between the US Department of State and China's National Energy Administration, the two countries signed the US-China Shale Gas Resource Task Force Work Plan between the US Department of State and China's National Energy Administration. ● announced the 5th US-China Energy Policy Dialogue and the 10th US-China oil and Gas Industry Forum will be held in September in the US ● reaffirmed common understanding reached in the Memorandum of Understanding to Enhance Cooperation on Climate Change, Energy and Environment; the Memorandum of Understanding on the US-China Renewable Energy Partnership; the Protocol on the US-China Clean Energy Research Centre; and the Memorandum of Further Cooperation on Nuclear Safety for the Westinghouse AP1000 Nuclear Reactor ● the two sides decided to conduct cooperation on energy conservation and improving energy efficiency under the TYF.
US-China Joint Statement 2011[4]	Head of state level	● applauded the progress made in clean energy and energy security since launch of the US-China Clean Energy Research Centre, Renewable Energy Partnership, US-China Joint Statement on Energy Security Cooperation, and Energy Cooperation Program (ECP). ● commended the progress made in clean energy and energy security since the launch of the US-China Ten Year Framework on Energy and Environment Cooperation (TYF, 2008). The two sides welcomed the two new Eco-Partnerships.
Joint US-China Statement on Climate Change[5] (2013)	Head of state level	● The US and China recognize that the increasing dangers presented by climate change measured against the inadequacy of the global response require a more focused and urgent initiative. ● they will initiate a Climate Change Working Group
A climate pact between the NDRC and California State 2013	NDRC-State Governor	● the two sides pledged to work together on sharing low-carbon strategies and create joint ventures on clean technologies. ● opened the California-China Office of Trade and Investment in Shanghai.
Strategic and Economic Dialogue		Climate change and clean energy is an important issue in this dialogue.

[4] To view the full content of the Joint US-China Statement in 2011, see the website of the White House: http://www.whitehouse.gov/the-press-office/2011/01/19/US-China-joint-statement.

[5] To see the full content of the Joint US-China Statement on Climate Change, see the website of US Department of State: http://www.state.gov/r/pa/prs/ps/2013/04/207465.htm

In the most recent joint statement on climate change, published on 15th February 2014, the two countries recognized the negative impact brought by climate change. Both sides agreed to contribute significantly to a global effort to meet the challenge brought by climate change in 2015. They agreed on the plan to cooperate in five areas to reduce carbon emissions: Heavy Duty and Other Vehicles, Smart Grids, Carbon Capture Utilization and Storage, Collecting and Managing Greenhouse Gas Emissions Data, and Energy Efficiency in Buildings and Industry ("US-China Joint Statement on Climate Change," 2014). These documents are wider in scope and more specific than Sino-American agreements and joint statements before 2009 (Zhang, 2009). These MoUs are signs that China and the United States are serious about cooperating on climate change and have set up the political system to cooperate by providing political support and incentives.

Projects

With strong support from the two governments, many projects and initiatives between China and the United States are progressing, as the figure below illustrates. It can be seen that the governments have tried to attract private actors into the cooperation. Their private sectors are playing a major role. United States companies have started to join in research projects with China and development programs with Chinese partners on both technology applications and some specific policies (Seligsohn et al., 2009).

One feature of bilateral cooperation between the United States and China is cooperation to provide a good political situation for the participants. The

governments provide the lead and their private sectors make financial investments as they anticipate business opportunities. This involvement of private sectors is the most obvious feature of Sino-American cooperation.

Sino-American cooperation has its own limitations. It is still narrow in scope, mostly in the area of academia. This might be a good starting point but more cooperation is required. For example, the Eco-Partnerships were organized to encourage environmental action at state and local levels, mobilizing investments from the private sectors and leveraging limited federal capital to produce positive results. Three of the six most-recently selected partnerships are direct cooperation between universities and research centres. As the two countries work together and share more common knowledge on issues such as IPR, more partnerships between Chinese and American companies are expected.

It is very interesting to note that, of all the departments in both governments, not one is in charge of foreign aid. There is no special financial institution to fund bilateral cooperation. In 2010, the United States Congress appropriated $1.3 billion to support these bilateral and multilateral efforts. The United States provides the largest financial assistance to the world (Provost, 2013). It provides international climate assistance primarily in three areas – clean energy, adaptation and forestry, which received 56 percent, 26 percent and 18 percent respectively in 2010. About a third of international climate assistance in 2010 was provided through bilateral programs, primarily via USAID. However, USAID is not running any kind of assistance program in China for climate change related issues.

Table 6: Sino-American Joint Projects

Project name	Participants	
US-China Ten Years Framework (TYF) for Cooperation on Energy and Environment (2008)		● the framework facilitates the exchange of information and best practices between the two countries to foster innovation and develop solutions to the pressing energy and environment problems they face. ● both sides are committed to implementing all five existing action plans and to expanding the work of the TYF through new action plans.
US-China Eco-Partnerships[6] **2008**	State, local governments, cities, states, companies, universities and NGOs in the US and China	● Eco-Partnerships initiative (Under the TFY) select five to seven programs each round as Eco-Partnerships. [7] There have been four rounds of Eco-Partnerships in 2009, 2011, 2012, and 2013.[8] The partnerships encourage environmental action at the state and local levels, mobilizing investments from private sectors and leveraging limited federal capital to produce positive results. Eco-Partnerships bring together experts and innovators from US cities, states, companies, universities, and NGOs, and their counterparts in China to work together, exchange best practices, and find solutions to local challenges. In 2013, six new Eco-Partnerships have been chosen.
The US-China Energy Cooperation Program (ECP) 2009[9]	Department of Energy (DOE), Department of Commerce and US Trade and Development Agency. Private companies	● This is a private sector initiated, managed and financed non-profit/non-government organization. The purpose of this public-private partnership is to leverage private sector business resources in both countries to promote commercially viable project development work in clean energy and energy efficiency, and to support the sustainable development of the energy sectors in both countries. Currently, the members of this Program are running 37 projects in China.

[6] The Eco-Partnerships program is a creative manifestation of US-China cooperation on energy and environment issues. Established under the TFY, Eco-Partnerships provides formal platform between US and Chinese stakeholders. It aims to bring together experts, innovators from US cities, states, companies, universities and NGOs and their counterparts in China to work together and exchange best practices. For more information about US-China Eco-Partnerships, see factsheet from the webpage of the Department of State: http://ecopartnerships.lbl.gov/partnerships.

[7] The Chinese name is 中美能源环境十年合作框架下的绿色合作伙伴计划框架. This Eco-Partnerships framework was signed by China and the US during the fifth US-China Strategic and Economy Forum.

[8] For more information about detailed Eco-Partnerships each round, see the website of ECO-Partnerships: http://ecopartnerships.lbl.gov/partnerships#map-view.

[9] The ECP was founded in September 2009 by 24 US companies. Since its establishment, the ECP has received official recognition from both the US and the Chinese governments. For more information, see its website: http://www.usChinaecp.org/.

The US-China Renewable Energy Partnership[10] 2009	Companies	● This initiative was brought up during the first US-China and Bio-fuels Forum. The two countries will chart a pathway to wide-scale deployment of wind, solar, advanced bio-fuels and a modern electricity power grid in both countries and cooperate in designing and implementing the policy and technical tools necessary to make that vision possible[11].
The US-China Electric Vehicles Initiatives 2009	DOE and China's Ministry of Science and Technology	● This initiative includes the joint development of standards for charging plugs and testing protocols of batteries and other devices, demonstration projects in paired cities to collect and share data on charging patterns and consumer preferences, joint development of technical roadmaps, and public education projects.
Energy Efficiency Action Plan 2010	American and Chinese officials from government, industry, academia and advocacy groups	● Both governments are working with their private sectors to develop energy efficiency building codes and rating systems, benchmark industrial energy efficiency, training building inspectors and energy efficiency auditors for industrial facilities, harmonize test procedures and performance metrics for energy-efficient consumer products, and exchange best practices in energy efficiency labelling systems. ● The US helped to establish the University Alliance for Industrial Energy Efficiency, which is a coalition of Chinese universities that train students to conduct in-depth industrial energy assessment after the successful model of the US universities alliance program.
21st Century Coal 2011	The National Energy Technology Laboratory (NETL) and the Pacific Northwest National Laboratory (PNNL), the Chinese Academy of Sciences (CAS)	● The two countries are bringing US and Chinese scientists and engineers together to cooperate on developing clean coal and CCS technologies.
Shale Gas Resource Initiative[12] 2011	DOE and US government agencies and their counterpart in the Chinese	● The two governments are working together to assess China's shale gas potential, promote environmentally – sustainable development of shale gas resources, conduct joint technical studies to accelerate development of shale gas resources in China, and promote shale gas investment through industry forums,

[10]American companies, such as Boston-based Second Wind, are already benefiting from the REP cooperation in terms of potential job creation and expanding exports.

[11] For more information about REP programs, see the website: http://www.Chinafaqs.org/library/Chinafaqs-US-China-renewable-energy-partnership.

[12] For more information about the two bilateral initiatives between the EPA and China, see the website of EPA: http://www.epa.gov/smartway/forcountries/index.htm.

	government	study tours, and workshops.
Energy Efficiency Promotion	EPA	● EPA worked with China to enhance its capacity to design and implement effective, voluntary, energy efficiency endorsement-labelling programs – drawing on the lessons, experience, information, and tools available from the successful Energy Star program.
Smart-Way for Countries	EPA private companies	● The EPA provided technical guidance for a successful Green Truck demonstration pilot in Guangzhou which offers 2 percent to 18 percent fuel savings.

China and the United States have jointly started many projects in recent years, listed above. There has been much academic collaboration. The governments have tried to encourage the involvement of the private sector with limited leverage finances. The private sectors have not fully engaged in bilateral cooperation. Another indicator might be that China's innovation capacity has improved because of its national or collaborated cooperation. However, this has not been applied to the enterprise level.

Dialogue and forum

To improve communication between the two countries and encourage more cooperation and innovation on clean energy, many forums have been set up to meet the need in different areas. These have facilitated many successful initiatives to strengthen Sino-American cooperation. Many were set up according to United States and China's joint MoUs. For example, the Climate Change Policy Dialogue and Cooperation was set up in accordance with the Sino-American MoU signed in 2009. In these forums, many more agreements on Sino-American cooperation on clean energy were signed. For example, at the fifth US-China Strategic and Economic Dialogue, the two countries signed the Eco-Partnerships Framework. These forums have brought together

government officials from different departments, academics and private sector firms. Some forums are newly set up; others were established as early as 1998. Some forums were convened only once.

Table 7: Table 8: Sino-American Dialogues and Forums

The US-China Strategic and Economic Dialogue (S&ED) [13] **2009** **The US-China Climate Change Working Group (established in 2013)** [14]	● The Dialogue helps bring about more cooperation between China and the US. This bilateral dialogue occurs at the highest official levels of government and is the first of its kind between the two countries. ● During the fifth dialogue (2013), China and the US both signed the ECO-Partnerships Framework which aims to encourage more cooperation. During the sessions, the US-China Climate Change Working Group agreed to five new initiatives.
The US-China Smart Grid Dialogue	● The first Dialogue was held in 2012.
Climate Change Policy Dialogue and Cooperation	● This forum was set up in the MoU to Enhance Cooperation on Climate Change, Energy and the Environment in 2009. Its aim is to strengthen communication about climate change strategies; exchange opinions about solutions and academic findings; promote cooperation on specific projects, adaptation to climate change, and capacity building and pragmatic cooperation on climate change between cities, universities, and states of the two countries.
US-China Oil and Gas Industry Forum[15]	● This forum is a public-private partnership involving government and industry representatives from the US and China. This first meeting was held in Beijing in 1998 and the most recent in Xi'an in September 2013. The OGIF aims to explore solutions to existing challenges and promote commercial oil and gas opportunities.
US-China Electric Vehicle and Battery Technology Workshop	● The first workshop was held in September 2010. The workshop brought together over 100 US and Chinese scientists, engineers, and representatives from government, industry and academia to discuss areas of common technical interest.

Source: China and the US governmental websites and their joint statements

[13] The first S&ED was held in Washington in 2009 and later it was held on an annual basis rotating between the countries. This structure expands on the narrower Strategic Economic Dialogue (SED). The purpose of the S&ED is for China and the US to address shared opportunities and challenges in the 21st century.

[14] The idea of establishing the US-China Climate Change Working Group was published in the Joint US-China Statement on Climate Change. The Working Group is led by Todd Stern, US Special Envoy for Climate Change and Xie Zhenhua, Vice Chairman of the NDRC. The purpose of this Working Group is to make the S&ED more effective and innovative. To view more information about the establishment of the Climate Change Working Group, see the media note published by the US Department of State on its website: http://www.state.gov/r/pa/prs/ps/2013/04/207465.htm.

[15] US-China Oil & Gas Industry Forum (中美石油和天然气工业论坛). For more information about this forum, check its website page: http://www.usChinaogf.org/.

Academic

The United States, a leading power in research related to climate change, has many research centres that focus on climate change. In 2011, China and the United States jointly started the CERC and each country pledged an equal amount of financial support from public and private sources in the following five years. The five year financial support shows the two countries' intention to maintain this research as a long term project. Along with other initiatives, there is a component comprised of a large amount of joint research. One project the United States helped establish, the University Alliance for Industrial Energy Efficiency, is a coalition of Chinese universities that train students to conduct in-depth industrial energy assessments based upon the successful model of the United States Universities Alliance Program. Cooperation among companies is represented at times by joint research related to a certain product.

As scholars have suggested, it is apparent the United States and China are trying to make sure, in their new partnerships program, that all actors – key government agencies, academics, NGOs and the private sectors in both countries – are able to work together to contribute effectively (Seligsohn et al., 2009). Currently, the Sino-American research interest focuses on advanced coal technology, building energy efficiency and clean vehicles.

5.3 Sino-Indian cooperation

Historically, there has been more competition than cooperation between India and China. They started to cooperate in the area of energy in 2004 (Yue, 2014). Cooperation on renewable energy is still in its primary stage (Huang,

2007). India is a country of scarce energy resources and relies heavily on external energy supply. Although they have an agreement on climate change and have expressed their interest to cooperate, they have not created an implementation plan, nor do they have a special agency to try to implement their agreement (Huang, 2007). However, recent criticism of big developing countries has drawn China and India closer than before. They have formed a solid political alliance for the purpose of negotiating a global climate agreement (F. Wu, 2012). As their economies grow and become bigger emitters, their interests have diverged from the other developing countries, although they formed the BASIC group with South Africa and Brazil. The focus of most of the studies with respect to Sino-Indian climate change cooperation is political: how the two countries could achieve a political advantage related to climate negotiations by cooperating with each other. With the growing price of energy, India proposed that China and India could bid together to economize (Kumaraswamy, 2007). In climate negotiation, China has realised the importance of working together more closely with other big developing countries.

There are some challenges and obstacles the two countries need to sort out before they can launch in-depth cooperation on climate change. China and India, adjacent to each other territorially, are emerging powers on the global arena. Nevertheless, they are competing powers. Especially, they were competing fiercely with respect to the exploration of oil and gas for future development purposes. Both are seeking to maintain their economic growth and both have received criticism that they should endeavour to commit to emission reduction. In recent years, they have realised that there is more opportunity to cooperate in the area of climate change (Siddiqi, 2011). They

formed an alliance during the negotiation of an agreement related to climate change. According to some critics they succeeded, unfortunately, in “weakening the latest global warming agreement" (Rapp, Schwägerl, & Traufetter, 2010). They are exempt from any binding reduction targets as they are considered developing countries. Yet, they are big emitters and their emissions are still growing. The international community exerts huge pressure on both to undertake mitigation. They are both heavily reliant on coal for energy. In recent years, they planned to expand their already established cooperation on climate change from a political alliance to other areas. Their cooperation on climate change will play a significant, perhaps a dominant, role in shaping environmental governance (F. Wu, 2012).

Apparently, these two states very much welcome the bottom-up approach. Comparative articles focus on their current status in new energy such as bio-fuel (Fraiture, Giordano, & Liao, 2008) and wind power (J. I. Lewis, 2007). In the post-Kyoto period, the linkage of trade, finance, development policy and technological transfer is at the centre of negotiations (Walsh, Tian, Whalley, & Agarwal, 2011). The two countries have a lot of successful experience or technology to share. China and India rank in the top five for wind power capacity (Siddiqi, 2011). They are developing new energy sectors. China’s Suntech and India’s Suzlon Energy both rank in the top five developers of renewable energy in their respective areas ("Melting Asia-China, India and climate change," 2008). Both will benefit if China can transfer its solar technology to India and India transfers its wind power technology to China.

Existing communication channels

Table 8: Sino-Indian Joint Statements related to Climate Change

Joint Statement – A vision for future development 2013	Head of state level	● Further strengthen coordination and cooperation in multilateral forums including Russia-India-China, BRICS, and G20 to jointly tackle global issues such as climate change, international terrorism and food and energy security.
MoU 2012 between India's Oil and Natural Gas Corp (ONGC) and China National Petroleum Corp (CNPC)	Company	Strengthen existing exploration and production (E&P) operations in Burma, Sudan and Syria and look ahead to making joint bids on foreign oil and gas field for E&P in the future.
Agreement on Climate Change between the Chinese and Indian governments 2009	Ministerial level (Indian Environment Minister and Vice Minister at NDRC)	● Five year agreement on Cooperation on Addressing Climate Change ● Both countries promised to continue their coordination in the international climate negotiations ● Broaden joint research and development into emissions-reducing technologies
Memorandum of Cooperation in the field of oil and natural gas 2006		● Encourage collaboration between enterprises, including through joint exploration and development of hydrocarbon resources in third countries.
Memorandum of Understanding 2003	ministerial	● To enhance cooperation in the field of renewable energy, the MoU seeks to establish cooperation through joint research and development activities, exchange of technical expertise and information networking. The ultimate objective is to commercialize the result of such cooperation, create business opportunities and facilitate sustainable market development.

Source: China and the US government websites

Unlike the Sino-American cooperation, China and India lack bilateral agreements to enhance their cooperation on climate change. They signed their first agreement on climate change on October 21th 2009, forty days before the Copenhagen conference and hammered out their common position in relation to the conference. However, the principle to encourage collaboration between their enterprises (Kumaraswamy, 2007) is not consistent with China's bilateral cooperation with the United States.

Academia and forums

Currently, a regular ongoing forum between China and India does not exist, although at one time there was such a forum: at the India-China Joint Workshop on National Action Plan on Climate Change in 2009, experts from both countries shared ideas about plans, policy and action on mitigation, forests, adaptation and progress in climate change science.

5.4 China and developing countries cooperation

In recent years, China has started to provide aid to other developing countries in relation to the climate change challenge. Xie Zhenhua, vice president of the NDRC, announced in Durban that China will improve its cooperation with other developing countries in four areas: basic facility construction for adaptation to climate change; promotion of adaptation technology; promotion and application of energy saving; renewable energy products. ("Xie Zhen Hua: Zhong Guo Jiang Cong Si Fang Mian Yu Fa Zhan Zhong Guo Jia Kai Zhan Ying Dui Qi Hou Bian Hua He Zuo," 2011). China has planned to train another 2,000 officials and technicians for these developing countries. The training courses focus mainly on adaptation to climate change, technology transfer and areas related to the development of renewable energy. In 2012, during the UN Sustainable Development Conference, China pledged to provide $10,000,000 US dollars to help African countries, the least developed countries and small island states with climate change. China signed MoUs with twelve countries, providing training programs and workshops, while sending

more than 500,000 energy-saving lamps, 10,000 low-carbon air conditioners and 6000 domestic solar energy systems (W. Wu, 2012).

Among the 573 training programs the AIBO held in 2013, twenty-five are directly related to climate change and clean energy training. These training programs are normally a week long and each study group is a maximum of twenty participants.

In 2011, China published its first White Paper on foreign aid. Although China has not published how much money it is spending and what projects it is running to help other countries, this is a good start toward greater transparency in its aid policy. China stated that climate change is as an emerging new aiding area ("China's foreign aid," 2011). From 2005 to 2011 June, China has completed 121 aid projects in developing countries and has trained more than 2700 related personnel.

Table 9: Joint projects between China and developing countries

Project Name	Year	Content
Mauritania Solar Demonstration Project[16]	2012	Set up 404 sets of LED solar lights which light four streets and the city government house.
Cape Verde Solar Demonstration Project		China built two solar power stations for Cape Verde. China set up LED lights for the government buildings.
Union of Comoros	2013	500 sets of solar devices
Central African Republic No. 3 Hydro Station	2011	Upgrade no.3 and no. 2 hydro stations.
Training programs provided by Academy for International Business Officials (AIBO) [17]	All year through	Green Innovation Policy Workshop; green development workshop for senior officials; Small Hydration Station Technology workshop for African Countries (English);

[16] For more information about China's aid to foreign countries, see the webpage of Ministry of Commerce of the People's Republic of China Department of Aid to Foreign Countries: http://yws.mofcom.gov.cn/article/b/.

[17] For more information about the training programs, see the website of Ministry of Commerce of the People's Republic Training Center: http://pxzx.mofcom.gov.cn/.

		Solar and Wind Power Application Workshop for Arabian Countries; Green Low Carbon Industry and Climate Change Workshop for Latin American Countries; Solar Power Application Management Workshop; Small Hydration Station Technology Workshop for African Countries (French).
Mauritania Renewable Energy Technology Training Course (Organized by Ministry of Commerce of PRC and China Business and Gansu Natural Energy Research Centre)	2014. August	Fifteen officials from Energy Department of Mauritania will take courses related to solar energy, wind power.

Source: China's Foreign Assistance White Paper

China is now working closely with African countries in building hydropower stations and power grids, alleviating power crises. Since 2009, China has conducted more than a hundred clean energy projects in African countries, including biogas technology cooperation with Tunisia and Guinea, and solar and wind power generation in Morocco, Ethiopia and South Africa. In 2010, Chinese enterprises started to build the Malabo Gas Plant in Equatorial Guinea. China offered many concessional and commercial loans to African countries for their infrastructure construction. China has donated energy-efficient lamps, air conditioners and other devices to Nigeria, Benin and Madagascar (Wittneben, Okereke, Banerjee, & Levy, 2012). In its communication with African countries, China is playing the role of a donor, very different from the role it normally plays.

5.5 Analysis

Overall, China's cooperation with other countries on energy innovation is not very satisfactory. Its cooperation with other developed countries is vibrant.

China has a strong technological liaison with the EU and the Americas. China receives a lot of assistance from Japan in terms of technology and financial support. Its cooperation with other big developing countries is a little more complicated. They view China as a success and try to follow China in developing energy resources.

Brazil has established strong bilateral cooperation with China. However, Sino-Indian cooperation is quite weak. This is mainly due to the historical territory issue between China and India. Both are energy importing countries and are competing for energy resources. China and India are now joining together to win international bids for programs and energy. Both have been criticized because of the lack of initiative in combating climate change. China and India now cooperate in the political area. However, their cooperation is still at an early stage and has not expanded to other areas, such as energy innovation.

China's cooperation with other developing countries is already established. China paid particular attention to this area, but this cooperation is often better described as Chinese assistance. China has helped many developing countries in Africa build dams and hydro power stations. China helped to train African officials with energy policy and technology courses.

It is quite difficult to determine whether bilateral cooperation would be the same if the regime complex for climate change did not exist. As we can see from the case studies, bilateral cooperation between China and other countries is mainly based on what could be offered by the two sides. The biggest advantage of the regime complex for climate change is that it offers a flexible

platform where countries choose how to be involved in the global mitigation and adaptation to climate change. No mandatory rule or regulation is stipulated by the regime complex, but constant international conferences on creating a legally binding agreement do provide a sense of urgency for many countries to find an energy solution that does not hinder the economy but could reduce carbon emissions. Bilateral cooperation between two countries is built on the promise of joint gains in the long run by collective action. China has established itself as a proponent of green energy technology, indicated by its voluntary assistance to other developing countries in Africa.

The innovation system

Innovation related to technology and the various ways in which any two countries could cooperate is very important to address climate change. The innovation system is likely to determine the result of a technology transfer (J. I. Lewis, 2007). One of the advantages of the bottom-up approach is that it includes the participants at ground level and takes their efforts into consideration. And the variability of the participants increases the possibility of creativity in more patterns of cooperation. This chapter investigates the innovation system both at the policy planning level and at the application level. This chapter pays special attention to new forms of cooperation, the showcasing of new technology and new management styles.

In Sino-American bilateral cooperation, many innovative activities took place as both governments promoted the universities, NGOs and private sectors to cooperate. New patterns of cooperation have emerged, led by participants at

different levels. The Governor of California signed a climate cooperation agreement with Xie Zhenhua, the vice president of NDRC. China's provinces established government cooperation with individual states. These cooperation forms are comparatively new and involve more actors. It is worth noting that China and the United States have managed to achieve more cooperation at more levels, despite little financial support. The two governments are endeavouring to create a positive environment for private sectors in both countries to increase communication and investment. For example, in the Eco-Partnership projects, a number of cooperating organizations were selected each year to receive the honours. Whilst the Eco-Partnerships that have been chosen do not necessarily have financial support, they will have more opportunity to become better known, to communicate with representatives in China and the United States and access official advice. The governments can offer certain incentives by providing favourable policies.

For developing countries, even receiving technical transference requires innovation (J. I. Lewis, 2007). The rise of multinational corporations with global presence has created a new model for innovation through the global generation of technology. These multinational firms do not rely on national innovation systems but on global experience.

China and the United States are strengthening academic cooperation by establishing joint research centres for technological innovation. However, the IPR issue has to be figured out before participants from the two countries could really work together. Currently, China does not have many academic ties with other developing countries.

5.6 Conclusion

From the three cases studied in this chapter, it can be seen that Sino-American cooperation on climate change is the most mature. Especially since 2009, the two governments met frequently and signed many agreements and MoUs. They appointed officials to facilitate the implementation of argued policies. The two governments are concerned about the process of the joint initiative and they provide political support for these efforts. They formulated one solution to apply government leverage to encourage the participation of private sectors. However, technology transfer and innovation has not reached the level achieved by Sino-Japanese bilateral cooperation, although this has decreased as the global economic situation intensified and the Chinese economy improved. Sino-Indian cooperation lacks both political support and ground level collaborative projects. The governments appear to lack genuine motivation and willingness to cooperate. Cooperation on climate change between China and developing countries is almost a one sided story: China provides assistance while countries in Africa receive it.

China was one of the first countries to transfer the development of clean energy sources, such as biogas and small hydropower stations, to other countries. China has helped developing countries in Asia and Africa build small and medium-sized hydropower stations and projects. China provided biogas technology to many developing countries in the 1980s, and shared this technology with Guyana and Uganda by way of bilateral aid. In recent years, China has continued sharing its biogas technology with other developing countries such as Tunisia, Guinea, Vanuatu and Cuba. China assisted in the

building of hydropower stations in Cameroon, Burundi and Guinea. China cooperates with Mongolia, Lebanon, Morocco and Papua New Guinea in exploring solar energy and building wind power stations ("China's foreign aid," 2011).

The Chinese government provides three types of financial resource: grants (aid gratis), interest-free loans and concessional loans. The first two derive directly from the state budget and the concessional loans are provided by the Export-Import Bank of China. The Ministry of Commerce and other departments under the State Council are responsible for the management of foreign aid. Each year, these departments submit budgets for foreign aid projects to the Ministry of Finance for review ("China's foreign aid," 2011). These are all indications that China defines itself as the green leader and would like to enhance this image by providing assistance to other developing countries. It seems that other big developing countries accept this image and pursue a similar strategy to develop their own energy technology.

It sounds unusual that bilateral cooperation on climate change between two of the top economies in the world is not as well-developed as it could be. Apparently, financial support invested in China is not on the regular list of USAID. India and China lack financial cooperation. China has not only been a big assistance receiver; it has become a big donor related to the climate change issue. As an emerging giant, many countries have stopped bilateral assistance to China and for these reasons China wishes to start renewed relationships with mutual benefit on an equal footing.

There has been Sino-American and Sino-European cooperation in academia for innovation. The governments involved are trying to widen cooperation to include more areas. With regard to climate change research and joint projects to reduce carbon emissions, China and India appear to lack genuine interest to cooperate. Nevertheless this issue remains a pressing matter for the two governments to work together, to encourage cooperation officially from a top-down approach to a bottom-up one focusing on activities at the grassroots level.

It appears that China is pursuing academic communications through training. China has attended training programs offered by Germany, the United States and others. In turn, China offers training courses on technology and policy to address climate change in English and French. Both the Chinese government and the United States government encourage the engagement of private sectors. Clearly, with the full participation of the government and the private sector in both countries, it will be possible to bridge the financial gap and facilitate the transfer of technology. However, such cooperation has not been strongly supported by governments employing bilateral cooperation, as studied in this chapter. Sino-Indian cooperation and bilateral cooperation between China and other developing countries in Asia and Africa are still in their initial stage.

Based on the three cases, the chapter has found that bilateral cooperation is mainly built on realist politics. To establish a healthy and effective energy innovation imitative, both sides must have something to offer, unlike the cooperation between China and the developing countries, which helps expand efficient energy use, but does not enhance China's energy innovation capacity.

Although there is an indication that bilateral cooperation was mainly established for the mutual needs of both sides, this chapter adopts counterfactual analysis to consider what if the regime complex for climate change did not exist. Compared to other climate regimes it offers more flexibility. States choose their preferred platform to contribute to climate change mitigation and adaptation, which has offered more opportunity to engage in the regime complex. The bestowal of authority mechanism explains the heightened interest for many countries to develop their energy innovation power. The continuous global negotiation over a legally binding agreement has pushed the big emitters to find other ways to satisfy energy needs. The learning facilitators mechanism explains why China emulates the developed countries and assists other developing countries. China received many training courses offered by developed countries, such as Germany and Japan. It is now doing the same and offers a variety of courses to government officials and technicians in African and South East Asian countries.

On the whole, innovation power is in the hands of several powerful countries. They control some technology that is useful to address climate change. However, these technologies could not freely flow to where they are needed because the owners do not have enough incentive and do not want to lose their leading place. For the most part, these technologies are owned by private companies that are highly motivated to profit from their products and services. This situation has blocked the flow of the spill over system to some extent.

The chapter concludes that bilateral cooperation is mainly built on the basis of what could be offered by each country. The more each country could offer in

this relationship, the more likely it could contribute to the energy innovation of both countries. The regime complex for climate change has some impact on China's bilateral cooperation, enhancing its energy innovation capacity. Mechanisms such as bestowal of authority, learning facilitators and role definers are at work in this area; without them, China's energy innovation capacity could not have been improved.

Chapter 6 : China and Climate Clubs: A Big State in Small Groups

6.1 Introduction

This chapter explores how China improves its energy innovation capacity through participation in climate club activities. Recently, scholars have been devoting a variety of efforts to explore the current status of climate clubs, their preferred features, and whether or not they have authority and leverage to close the emission gap. A close look at the specific impact of club efforts on enhancing member states' energy innovation capacity is quite unique. This chapter applies a counterfactual analysis to study the impact of the regime complex on China's energy technology innovation capacity.

In the context of this thesis, climate club refers to a group of countries and other entities working together cooperatively to solve the climate change challenge. These climate clubs are normally much smaller than the United Nations in membership. It is also noted that climate change issue is a very complicated issue and requires improvements to be done in various aspects from family to industry and some changes need to be fundamental. For example, we need a revolutionary technology upgrade to reduce millions of tons of carbon that we emitted on road every day. So the definition of climate club is very wide. Some clubs may seem to be not related to climate change but actually could be seen as a climate club in the author's opinion. G20 is an example. In addition,

climate clubs are usually less formal and have not reached the degree of institutionalization of an international organization (Weischer, Morgan, & Patel, 2012). To be considered as a climate club, the major participants must be nation states. Currently, it has become more difficult to define clubs as we are more accustomed to referring to them as consisting only of states. Although NGOs have developed close relationships with clubs these days, states still remain the main participants. For example, among 385 member organizations of REEEP (Renewable Energy and Energy Efficiency Partnership), only 45 are classified as national governments. Other members include businesses, NGOs, industry associations, financial institutions and other civil society entities. Most funding is derived from national governments rather than the other participants (Weischer et al., 2012) and so clubs are under the control of national governments. For this reason their actions reflect the strategy and policy of these governments. This provides clear evidence that national governments are trying to mobilize private sectors' power to deal with climate change as well as many other issues.

Scholars refer to these clubs as 'climate clubs' based on their importance to climate change. In recent years especially after 2009, more climate clubs have come into existence (Widerberg & Stenson, 2013). Many existing organisations have also paid more attention to climate change and energy issues. Examples are G7 and G20. As climate clubs have grown both in scope and number, some scholars have suggested they could replace the UNFCCC; others argue they are complementary to the UNFCCC. It is too soon to draw conclusions, since all other methods to summon cooperation against climate are still experimental (Hoffmann, 2011). Before we find more substantial evidence

that there is a reliable way to solve the climate change problem, attention should be evenly placed on each segment of the regime complex for climate regime.

The first section of this chapter discusses the size of climate clubs that scholars have proposed, which might change the effectiveness of the regime complex. The second provides a general description of the current landscape of climate clubs. The third offers an analysis of China's participation in the climate clubs to enhance its energy innovation capacity. The fourth applies counterfactual analysis to see the role played by climate clubs in enhancing China's energy innovation capacity. The final section sums up the findings in this chapter.

The size of climate clubs

Research into climate clubs fall into two categories: study of the preferred feature of the 'two degree clubs' and analysis of the existing clubs. Scholars believe climate clubs may offer more advantages than other sectors in the climate regime. One of the most important reasons for their distinct advantage is their size. Biermann and his colleagues outlined four aspects - speed, ambition, participation and equity - to explain why clubs might offer expedient alternatives to promote change and solve the current issue, as clubs offer the possibility for more meticulous actions among a smaller number of relevant and influential parties (Biermann, Pattberg, Asselt, & Zelli, 2009). A smaller club facilitates understanding and trust among its member countries. Less powerful countries can make their own decision as to which club to participate in to ensure their voice is heard. Victor also suggests the creation of clubs of a few important

countries might be a very important feature of the solution required to create significant international cooperation on climate change (Victor, 2006). A small group size will also reduce the possibility of a member not contributing or taking a free ride (Isaac & Walker, 1988; Olson, 1965). These scholars believe that, due to their smaller size, climate clubs are significant and hold a promising position that can enable their members to know, understand and trust other. Small size also increases the effectiveness of the club, allowing nation states to be more serious and take more responsibility for their contribution to solve the problems of climate change. Some scholars also argue that a regime with small trade penalties on non-participants can induce a large stable coalition with high levels of abatement (Nordhaus, 2015).

Especially, this theory depends upon the assumption that the principal members of clubs are national governments. As mentioned earlier in this chapter, although governments play a dominant role in clubs, most members are non-governmental entities. This has increased the average size of climate clubs. Clubs constituted of purely national governments are rare today. National governments have realized that private sector participation is necessary to solve climate change. But the impact on the final decisions played by those private sectors is yet determined.

The existing climate clubs

Initially climate change institutions were clustered around the UNFCCC. National governments from different countries cooperated to fulfil the targets or tasks assigned by the rules and mechanisms of the United Nations. However,

as the UN process has been blocked by big emitters such as China and the United States, an alternative is to forge sub-global alliances. The United States established the Asia-Pacific Partnership on clean development and climate (APP), the members of which account for more than half the world's economy, population, and energy use (Kim & Chung, 2012). Then the Major Economy Meeting on energy security and climate change (MEM) of seventeen states and the United Nations was organized. The MEM was further developed and renamed as the Major Economies Forum on Energy and Climate (MEF) in 2009. The MEF has adopted an approach to reduce the energy intensity of the global economy by identifying climate-friendly technologies and accelerating their deployment through its global partnership for low-carbon and climate-friendly technologies. Existing global economic organizations such as the World Economic Forum attempt to redesign existing institutions, policies and restore growth with global leaders and multi-state holders (Kim & Chung, 2012). The establishment of G20 intends to provide an informal mechanism for dialogue among industrialized countries and emerging markets with a view to promoting international financial stability. Although this goal is purely economic and financial, the size and importance of G20 makes it an important platform for sustainable development and energy.

One of the most obvious features of these clubs is their variety. Clubs distinguish themselves by focusing on different sectors. The sector with the most clubs is renewable energy (REN 21). Other sectors include clean energy technologies (Clean Energy Ministerial) and implementation groups, such as REDD. The most recent additions are initiatives to promote the green economy and sustainable development. Scholars have found most of existing clubs fall

into one of two categories: dialogue forums and implementation groups. Dialogue forums focus on the interaction of information and position among states while implementation groups focus on specific technical or project initiatives. Their economic sources also vary. Half the implementation clubs seek to finance activities through pooled contributions that flow to an international secretariat. The other half's funding flows directly to developing countries. This chapter specifically looks at clubs that focus on clean energy innovations, and so affect China's energy innovation technology.

Although clubs may focus on different issues and conduct their activities in different fashions, they have two main functions (Weischer et al., 2012). First, they enable improved understanding among countries of their positions and mutual interests. They ensure sharing of best practices, and provide support for mitigation strategies and activities. G7 and G20 forums give opportunities to major economies and emitters to exchange conversations and understandings on climate change regularly. Second, some clubs implement projects by providing financial assistance, expert advice and other support. As an example, the Climate and Clean Air Coalition (CCAC) provides both country strategies on a sectorial level as well as financial and technological assistance on a project level on thousands of sites in its member states. These clubs facilitate a network that connects changing actors at different levels.

From the study of these clubs, several changes are discovered. Clubs are becoming more specific. The members and visions are changing. G7, a club with a long history, functions mainly as a dialogue forum to promote mutual understanding among member states on important issues. Its membership has changed several times throughout its history. Newly established clubs (after

2009), are geared to a more specific agenda in a particular area or toward promoting a policy framework. For example, GMI and CCAC (Climate and Clean Air Coalition to Reduce Short-lived Climate Pollutants) are focused on reduction of specific greenhouse gases. These specialized clubs are also designed for particular purposes to facilitate specific projects around the world or in member countries.

The variability of clubs is both a blessing and a curse. On the plus side, the global community has been launching various attempts to solve the climate change problem, by trial and error. Attempts were made according to different local conditions. By testing different methods of dealing with climate change, the good ones will be found and can be used by other clubs in other regions. This is the “spill-over effect.” The drawback of this variety for scholars is that it poses tremendous difficulties to identify which characteristics result in the effectiveness or ineffectiveness of one specific club. The categorization of these clubs is part and parcel of this article and will be discussed as a separate section below.

The categories

Categorization provides the basis for case selection. Climate clubs could be categorized in various ways. They could be grouped by their targets. Some are specifically focused on energy, such as the International Energy Agency (IEA). Some are focused on promotion of green growth, for example, Global Green Growth Institute (GGGI). There are some focused on general climate issues, such as the Group of Seven (G7) and the Group of Twenty (G20); there are still some focused on emission reduction of specific greenhouse gases such

as the Global Methane Imitative (GMI). Others promote a certain kind of energy or a certain kind of policy; an example is could the Global Biology Partnership (GBP), organized to promote bio-energy to the public for sustainable development.

Clubs operate on four levels: global, national, sectorial and project. Categorizations could be made on these levels. The global clubs include G20, G7 and MEF. Examples of national clubs are the GGGI and the International Partnership on Mitigation and Measurement, Reporting and Certification (M&MRV). Sectorial clubs include REN21 and Clean Energy Ministerial (CEM). An example of clubs at project level is the Asia-Pacific Partnership on Clean Development and Climate (APP), a project that has been concluded.

Climate clubs have different memberships in term of size and economic power. Some are only for wealthy members, such as G7. Some are mixed, open to countries with high, middle and low incomes. For example, GMI has almost equal membership from both high and low income countries (Weischer et al., 2012). These clubs have better reputations for equity. A recent trend is to bring various actors into clubs. For example, members of CCAC includes academic institutions, states, IGOs, NGOs and public-private initiatives.

Another interesting categorization is traditional effort and experimental effort. Traditional effort means familiar action that we used to take. For example, the United Nations Framework Convention on Climate Change adopts a traditional way to deal with climate change. Some initiatives aim to help states to fulfil their responsibility in UNFCCC. For example, CCAC is initialized by several states and UNEP to address climate change issue in the near future, as an

effort made under UNFCCC ("About-Climate and Clean Air Coalition"). All other efforts could be accounted as experimental. For example, the e8 Network of Expertise for the Global Environment is a non-profit international group of nine major electricity companies from G7 countries, promoting sustainable development through electricity sector projects and capacity building activities worldwide. This group set its own target, unrelated to UNFCCC or other United Nations efforts. Groups like this are numerous.

Scholars have placed a lot of attention recently on the issue of regional clubs. Supporters of regional clubs argue that a group of actors under some conditions could achieve collective action (Conca, 2012). History also suggests that, as the scale of the actors rises, the chance of success drops. Regions, many argue, are appropriate scales for collective action. These scholars also suggest that regional clubs might enjoy the advantages of a lower cost for monitoring of information systems, a manageable numbers of actors, the self-evident shadow of the future found in a shared neighbourhood, and culturally embedded norms of proscriptions and responsibility (Conca, 2012). Based on this notion, we could safely deduce that regional clubs enjoy several advantages over similar non-regional clubs.

Table 10: China's Participation in Clubs

Name	***Topic***	***Founding year***	***Is China a member?***	***No. of members***
IEA Multilateral Technology Initiatives	*Energy*	*1974*	No	43
G7[18]	*General climate*	*2014*	*No*	*9*
G20	*General climate issue*	*1999*	*Yes*	*20*

[18] G7 was the name of a forum for the governments of a group of seven leading industrialized countries. It was originally formed by six countries in 1975 and subsequently extended with two additional members. Russia was excluded from the forum for its invasion of Crimea in Ukraine on March 24, 2014.

Renewable Energy and Energy Efficiency Partnership (REEEP)	*Energy*	*2001*	*No*	*45*
Carbon Sequestration Leadership Forum (CSLF)	*Energy Fossil fuel*	*2003*	*Yes*	*25*
REN21 Renewable Policy Network for the 21st Century	*Energy*	*2005*	*No*	*14*
GBEP Global Biology Partnership	*Renewable Energy*	*2005*	*Yes*	*23*
Major Economies Forum on Energy and Climate Change (MEF), preceded by Major Economies Meeting on Energy Security and Climate Change (MEM)	*General climate*	*2009*	*Yes*	*17*
Clean Energy Ministerial	*Energy*	*2009*	*Yes*	*23*
REDD+ Partnership	*Energy, RE, EE and fossil fuel*	*2009*	*No*	*73*
Global Methane Initiative	*methane*	*2010*	*Yes*	*41*
Global Green Growth Institute (GGGI)	*Low-carbon development: green growth*	*2010*	*No*	*13*
International Partnership on Mitigation and Measurement, Reporting and Verification (MRV)	*Low carbon development*	*2010*	*Yes*	*39*
LEDS Global Partnership	*Low-carbon development*	*2011*	*No*	*13*
Climate and Clean Air Coalition to Reduce Short-lived Climate Pollutants (CCAC)	*Methane, soot and HFCs*	*2012*	*No*	*20*
BRICKS	*International Trading, Finance, Climate Change, Sustainable*		*Yes*	*6*

	Development			
Clean Development Mechanism	*Encouraging emissions-reduction projects in developing countries*		*Yes*	
Asia-Pacific Economic Cooperation (APEC)	*APEC has a Energy Working Group (EWG) launched in 1990, seeks to maximize the energy sector's contribution to the region's economic and social well-being.*	*1989*	*Yes*	*21 + 3 observers*
International Energy Forum (IEF)	*Energy security*			
The Association of Southeast Asian Nations (ASEAN) PLUS China	*Bio-energy APT forum on oil market; APT forum on energy security; APT forum on new and renewable energy and energy efficiency and conservation*	*1967*	*Yes*	*10+3*
The energy working group of the Shanghai Cooperation Organization (SCO)		*2001*	*Yes*	*6members+5 observers*
The Sector Coordinating Committee of the Central Asia Regional Economic Cooperation (CAREC)	*Electricity trade and regional power network; energy cooperation*	*2001*	*Yes*	*10+6 multilateral development partners*
The World Energy Council	*Communication of knowledge, policy and decision-making process*	*1923*		*3000 member organizations located in over 90 countries (governments, private and state corporations, academia,*

				NGOs and energy-related stakeholders
The Energy Charter	*International flows of investments, capital and technologies for energy sector*	*1991*	*observer*	*65 （2015）*
The Asia Cooperation Dialogue		*2002*	*Yes*	*29*
The East Asia Summit			*Yes*	*18*
The BoAo Forum for Asia		*1998*	*Yes*	*28*
IPEEC	*Energy efficiency, energy security, climate change, and sustainable economic development*	*2009*	*Yes*	*16*

The clubs studied in this thesis are world-renowned. However, China has joined only some of them. The sizes of these clubs range from seven to seventy-three members. The clubs are no longer only constituted of national governments but also include international organizations, corporations, research centres and experts. Local governments also participate. The clubs and non-club networks of government, research centres, corporations, and individuals are playing an increasingly important part in the climate change regime.

6.2 Method

The formation of the regime complex is due to fragmentation of interests induced by climate change and lack of incentive to a stronger legal architecture toward climate change (Biermann et al., 2009; Keohane & Victor, 2011).

Countries are influenced by climate change in varying degrees of difference. For example, for some low-lying island countries, climate change means much of their territory will be inundated by the sea. For them, actions to counter climate change are imminent and inevitable. Such countries are often under-developed. For others, the impact of climate change is not so urgent at this stage and they are less willing to take action immediately. Theoretically speaking, fragmentation due to different interests that has blocked international negotiation and agreement could be avoided by participation in clubs. Countries with different interests could participate in different clubs and only join a specific club when they have a shared interest on a particular issue.

This author recognizes that many flaws exist as a result of the process of global negotiation, which might also have caused the entire system to be less productive or as effective as it might. The climate club may offer more hope to close the emission gap. To improve efficiency, close-up analyses are required. The following aspects may play an important part in determining a club's efficiency or at least help to distinguish it from others. This chapter selects a number of climate clubs with an emphasis on energy innovation, then conducts a close look at the aspects of each club. These aspects enhance our understanding of these innovation clubs. To conclude, this chapter analyses the impact of the climate change regime on China's involvement in these clubs.

The Members

On the whole, the clubs need to include as many of the biggest emitters and as many of the wealthiest countries in the world. It is not necessary for the

so-called biggest emitters to join every club. Different combinations might do better to avoid certain interest disparities that may arise among them. Big emitters and wealthy countries must be included in these clubs because they are capable of achieving reductions to close the emission gap, and they can provide financial and technological stimulus to the big emitters to achieve a much needed balance. Every member has to be in a position to benefit from club membership. The size of the club might also have an influence on its efficiency. Too many states in one club, for example, may result in problems similar to those currently encountered by the United Nations. A proper combination of members is an advantage to a club.

Shared Vision

A shared vision is crucial to a club. The members have to agree with each other on at least one aspect of the climate issue that the club is trying to work on. Otherwise, the club is another place for endless UNFCCC negotiation. One advantage of clubs is that their initiatives are put into action without waiting. A specific immediate target is preferred for the club to be effective. Vague shared vision might limit ambition to reduce emissions. The shared vision of club members determines how deep cooperation goes, which might be enhanced by frequent communications and building mutual trust. One problem of international negotiation is that the size of the negotiation group makes the shared vision too limited or too vague.

China's Engagement in these clubs

It is not enough to understand how clubs operate within the energy area. The aim of this thesis is to ascertain China's role in these clubs. This chapter attempts to assess and evaluate China's participation in these clubs, as well as how China benefits and also what China contributes, particularly to energy innovation.

6.3 Case studies

G20— Group of big carbon emitters

G20, an informal group of nineteen countries and the European Union, was created to address the issue of the global financial crisis. Finance ministers and central bank governors of major economies began meeting in 1999, at the suggestion of G7 finance ministers; a finance ministerial meeting has since been held every fall. In November 2008, President George W. Bush promoted the creation of G20 by inviting the leaders of these major economies to Washington DC to coordinate the global response to the financial crisis: the first G20 summit. G20 has the optimal size. The other groups the author examines all have more than twelve members.

Climate change is not new to G20. At the first G20 summit, the leaders paid attention to the importance of climate change. However, it was not until the Pittsburgh Summit in September 2009 that the issue came onto the agenda in a serious way. The leaders pledged to reach an agreement in Copenhagen on the

United Nations Framework Convention on Climate Change (UNFCCC), to reduce inefficient fossil fuel subsidies, to stimulate investment for clean and renewable energy and to transfer clean energy technologies, particularly to developing countries. They also asked their finance ministers to report back on a range of climate financing options.

Pittsburgh produced the most climate-intensive communiqué, with seventeen of its total of 128 commitments (13.28%) addressing climate change and energy. The Toronto Summit in June 2010 concluded with only four out of 68 commitments (6.56%) touching broadly on the issue.

In recent years, G20 has placed an emphasis on the problem of climate change as well as the solution to it, the green economy. However, pressures to settle currency disputes and solidify regulatory and international financial institution reforms, along with other constraints, have pushed climate change further down the list of priorities. Climate change was absent from the agenda in 2013 and 2014 ("G20 Priorities" 2014). However, in 2015, climate finance and energy sustainability has come back to the agenda, due to support from China and the United States.

In 2013, G20 members signed an agreement to reduce emission of HFCs. The Chinese and the United States both agreed to establish a contact group on HFCs under the Montreal Protocol that will examine some practical issues surrounding HFC scale-down ("G20 agreement to reduce greenhouse gases vital to tackle climate change- UN agency" 2013) ("G20 pledges action on climate change, Greenhouse gases" 2013). At the end of 2014, G20 published G20 Energy Efficiency Action Plan to encourage networked devices to increase

energy efficiency. It was scolded for not making any effort to enhance global commitments. However, as a group of large emitters of carbon emissions, G20 still represents a potential forum to discuss financial and energy issues.

Members

There are 19 countries plus the EU in G20. Among them are eleven high income countries, six middle income countries and one low income country. Almost all member countries are big carbon emitters. Only three are not on the list of the Top 20 carbon emitters. G20 represents two-thirds of the global population, 85% of global GDP and more than 80% of global trade (Kim & Chung, 2012).

On average, although G20 members might not be as wealthy as G7 members, this does not signify that they have less say on climate change issues. The G20 group includes every country that can make a significant change to global climate problem. This advantage of G20 has enlarged hope for it to provide a complete solution to climate change.

G20 members vary in their national measures facing climate change. Brazil and Japan both have set ambitious targets (Bracht, 2010). The United States, Australia, the United Kingdom and Canada remain the largest per-person emitters. Apart from these government members, the International Monetary Fund and the World Bank are also participants in G20.

Shared vision

Since their first meeting in 2008, G20 leaders have supported the focus of their finance ministers and central bank governors on achieving “sustainable economic growth.” They also agreed to start funding developing countries in deploying clean energy technologies, reducing forest-related emissions, and adapting to the impacts of global warming. G20 intends to address issues such as financing, fossil fuel subsidies and institution-building.

In their most recent document, they only briefly mentioned that they stand ready to work towards bringing the Green Climate Fund (GCF) to fruition as part of a balanced outcome to neutralize the disheartening outcome in Durban Summit. They remain fully dedicated to UN climate negotiations. They strongly focus on the concept of green growth. Economic growth is the sole destination of all policies. At this point G20 does not have a reduction target, either short-term or long term. As declared in its document, it will guarantee the best attitude toward climate change and make every effort to deal with the danger it poses. There is internal disagreement on climate change and energy as well in G20.This is similar to the problem encountered by the UN.

China’s participation in G20

The 2016 G20 summit will be held in Hangzhou, China. This is a sign that China is playing a more important role. This is also reflected by the fact that although Australia was trying to downplay climate change, the agreement between China and the United States managed to put this issue back on the

agenda (O'Malley, 2014; Taylor & Branigan, 2014). China is now involving in the work of the Global Superior Energy Performance Partnership (GSEP) and the Energy Management Partnership Action Network (EMAK) working groups ("G20 Energy Efficiency Action Plan“, 2014).

Global Methane Initiative

On 1st October, 2010, thirty-eight governments (membership had grown to 42 in 2014), the European Commission, the Asian Development Bank and the Inter-American Development Bank launched the Global Methane Initiative (GMI) to encourage stronger international cooperation to advance climate change while developing clean energy and prospering economies. This initiative builds on the existing structure and success of the Methane to Markets Partnership (MMP) to reduce emissions of methane, while enhancing and expanding these efforts and encouraging new resource commitments from country partners. GMI is a club in which middle income countries out-number high-income countries. This phenomenon is unusual in that the other clubs examined by the author are comprised mostly of high-income countries.

As its name indicates, GMI is an implementation group focused specifically on reducing the threat posed by methane. The United States and Mexico jointly led the creation of GMI. The voluntary nature of this club allows its member countries to willingly participate without the concern of legal responsibility related to any reduction target.

The members

Members of GMI include countries that are big methane emitters. These countries are interested and have special expertise in developing projects to reduce methane emissions. Among its members, there are twelve high-income countries, twelve middle-income countries and thirteen low-income countries. These countries are responsible for more than 70% of global methane emissions.

The structure of GMI comprises four levels of departments. The Steering Committee at the highest level is under the supervision of the United States EPA. At a lower level, there is an Administrative Support Group. At a third level, there are five sub committees, each co-chaired by several member countries: Coal, Oil and Gas, Municipal Solid Waste, Agriculture and Wastewater ("About the Initiative"). At a fourth level, there is a Project Network wherein private sectors can join and share their information about their reduction projects. The members of the Project Network are also able to access technical advice from experts in GMI and from its government officers.

Shared vision

The Initiative expects to achieve significant economic, environmental, and energy benefits. When GMI was launched in 2004, experts estimated that, by 2015, the Initiative will have the potential to deliver an estimated annual methane emission reduction of over 180 million metric tons of carbon dioxide equivalent (MMTCO2E). If this estimate is achieved, these reductions could lead

to stabilized or possibly declining global atmospheric concentrations of methane. To achieve its goal, the Project Network was established, a body comprised of representatives from local government, the private sector, the research community, development banks, and other governmental and nongovernmental organizations. In this way, GMI is more effective in mobilizing private sectors and is able to identify barriers that the private sector encounters in trying to reduce methane emissions. Its governmental representatives in GMI can then address these issues to facilitate similar attempts as private sectors advance with their climate mitigation efforts.

China's participation in GMI

China joins GMI in two ways. The government joined GMI as a partner country, while Chinese actors from the private sector can join the Project Network. Those in the Project Network can access professional advice and the GMI database to see how other methane emission projects were carried out. China assigned representatives in each subcommittee ("Subcommittee members from China"). Currently, thirty-one members in China have joined the Project Network. These include companies from the private sector, Chinese government research centres, financial institutions, universities and NGOs ("Project Network members in China"). GMI is also cooperating with other networks in regard to specific projects in China. GMI acts like an all-round supplier, coordinating and facilitating projects by connecting them with domestic government, foreign governments, NGOs and research centres. In this way, GMI provides assistance to obtain financial, technical, and policy advice.

Currently, forty-one projects in China related to coal, oil and gas sectors share project information with other members on the GMI database. This database includes sites, active methane projects, studies, technical assistance documents, outreach events, training, workshops, meetings and other related activities. The Chinese projects were published because they receive support from the United States, which would want this information to be accessible to other entities working on mitigation reduction projects.

6.4 The two mechanisms

GMI aims to identify suitable technology and facilitate private sector activities to reduce methane emissions by providing financial and technical advice to the private sector and by establishing direct communication between the private sector and governmental officials. Although innovation related to advanced technology is not its primary mission, GMI nevertheless fulfils the role of introducing advanced technology to specific projects that might benefit from accessing knowledge.

In relation to the spill-over mechanism, GMI has established an information network for the use of private participants working at ground level, government representatives, and experts on financial institutions. Expert advice, technical advice and suggestions from governments can be accessed by this network. The GMI also shares a lot of other information within this network. The GMI published energy profiles of thirty-seven of its member countries. The Executive Summary provides tables that include statistics on coal reserves, coal

production, methane emissions, and CMM project activity. The international Coal Mine Methane Projects Database (Morton, 2008) accompanies this document. It contains detailed and comprehensive information on more than 200 CMM recovery and utilization projects around the world. To make collection easier, GMI asks its participating actors to submit information in relation to their projects. This activity has kept GMI aware of current market movement (Meyers). GMI shared this database with the public. These private sector corporations submit their projects to GMI and seek expert advice from GMI technical subcommittees and from specific country representatives ("Global Methane Initiative-Frequently Asked Questions"). These actors from the private sector can also access information related to other projects conducted in other areas to see how they have been carried out. In this way, actors from the private sector have benefited from the network.

6.5 Counterfactual analysis

Among all the case study chapters, the role played by the regime complex for climate change on China's club engagement to improve its energy innovation is most significant, especially for those clubs focussed on the project level. Without the networks of clubs, it would be more difficult for China to identify the most appropriate technology and apply it to local projects.

Table 11: The Behaviour Changing Mechanism identified in Case Study

The Behaviour Changing Mechanism identified in Case Study	
Unity modifier	The settings and assistance provided by GMI has encouraged China to carry out more projects concerning energy saving and adopt more advanced technologies.

Enhancers of cooperation	The resource network established by project clubs such as GMI benefited all parties by providing what they need. This win-win situation has strengthened the network.
Learning facilitators	The policy and technology suggestions provided by GMI in the local projects might diffuse to other projects carried out in China.
Role Definer	International society has been trying to persuade China to be more responsible and active in its carbon emissions reduction. China has been comparatively reserved in meeting international expectations but is constantly making progress. In G20, due to efforts made by China and the United States, the climate change issue came back on the 2015 G20 agenda.
Agents of internal realignments	Not only in GMI, there is a trend in many project level clubs to directly connect with actors within a state. This could break the original balance and vie for changes.

6.6 Conclusion

The members

The flexibility of the regime complex has enabled states to fully participate in club activities. Different types of clubs concerning climate change and energy were formed for various purposes. This chapter has chosen two different clubs in terms of membership, G20 and GMI. G20 is composed of states and the EU only, while GMI has members from governments to private entities. GMI has a much larger number of members. GMI is also different from many other clubs as its mid-income member outnumbers high-income ones. On the other hand, G20 only has one low-income member. The member setting has affected the function of the club. The G20's annual agenda is dominated by a few countries in the club which could be shown from its attitude changes toward climate change and energy issues. The GMI is more consistent in its policy and strategy on the same issue.

Shared View

The two cases are also different in term of goals. The G20 has a more general goal. Originally, it was established to promote international financial

stability and this still its purpose today. But given its size and members, it is also an important forum to discuss climate change and energy issues. As happened in the United Nations, G20 has always been tangling with internal disagreement on how much commitment its member countries should take towards climate change and even whether climate change and energy issues should be on the agenda. The implementation clubs are more confident in announcing their short-term targets ("About-Climate and Clean Air Coalition").

One more shared view between the two types of clubs is that most do not focus directly on energy innovation but the spread of advanced energy technology. Especially for project-level clubs that value more cooperation with private sectors such as research centres, they also put their main effort on creating a network among entities at different levels from governments to individuals, to help these entities identify more efficient technology in their network. This is an indirect way to contribute to energy innovation, compared to China's national initiatives and bilateral cooperation.

Benefit of Wealthy States

The formation of climate clubs may be for a number of reasons. Sometimes, they are the result of various conferences and negotiations, such as REN21 and MEF. An individual government may have also created a club for political reasons. The Bush Administration created both MEM and APP. Some clubs are strongly driven by states that wish to establish themselves as green leaders, such as Germany and the United States. Since most country members are high income countries and most often they are the initiators or contributors of the climate club, it is necessary to study what measures could be taken to stimulate

their interest in climate clubs. The middle and low income countries would like to take part in these clubs because of the financial and technological assistance available. It is interesting to consider why wealthy states take part in clubs and initiate them. Wealthy countries might contribute more than others because they are morally obligated. However, in a special period of time such as financial crisis, this incentive might not be strong enough for these wealthy countries to take action. In the earlier part of this article, it was noted that scholars point out that a two degree club has to provide strong enough interest to each group member including the wealthy countries, and therefore it is worthwhile to devote more thought to explore reasons and incentives for wealthy countries to be motivated to support and participate with clubs.

China's Participation

As a result of increasing involvement in international organizations, China has become more willing to participate in international cooperation and more confident when dealing with climate issues (Yan & Xiao, 2010). China has become socialised by its participation in various international organizations and these engagements have changed China's decision-making process (Guo, 2013; H. Yu, 2007). China has received help in its participation in the climate clubs in terms of financial assistance, policy advice and technology transfer. This has indirectly contributed to China's energy innovation capacity. However, its participation could be considered passive in that China did not initiate any climate club. Nevertheless, China has improved its image and it is now known as a more responsible world power.

It is interesting to see China has different positions in G20 and GMI. The G20 was born to legitimize G7 initiatives to the wider world by securing a broader consensus for G7-generated ideas. So China, as one of eleven non-G7 countries in G20 was destined to play a limited role during G20's foundation. However, China's role in G20 is improving and China is said to be one of the leading developing countries in G20 (Kirton, 1999; Y. Yu, 2004). Jointly, China and the United States have brought back climate change to the agenda of G20 in 2015.

In GMI, however, China does not receive special attention nor does it provide special aid to GMI. Many projects related to GMI conducted in China receive assistance from other countries and IGOs such as the United States and the World Bank. As indicated in the introduction, such difference (paradox) is quite common in the study of China. China's economy has been developing at an astonishing speed in recent decades. However, many other aspects of China are not developing equally and China still lags behind developed countries. Especially, on the technology and political institution front, China is receiving assistance in these areas from various entities.

The impact of the regime complex for climate change on China's energy innovation capacity

As part of the regime complex for climate change, club cooperation represents an alternative platform to the United Nations for a comparatively large number of countries to work together on climate change and energy issues. The existence of a variety of clubs has provided a flexible environment for many countries to forum shopping in all kinds of clubs. China is member of

many energy clubs. Not only has China participated in club activities as a state; many entities from the private sector are now involving in club activities, since it is also a main target of clubs to motivate private sectors.

However, such vigorous participation does not create much direct benefit for China's energy innovation capacity. Compared to China's national initiative and bilateral cooperation with other countries on China's energy technology innovation, the role of clubs is limited. The reason is that club activities mainly focus on the spread of advanced energy technology. Normally, clubs achieve this by transferring information, financial resources, technological suggestions and political advice to the private sector. Clubs identify the most suitable advanced energy technology for a certain actor, and provide policy and financial assistance. Clubs have close relationships with many research centres and individual experts. Clubs that operate on lower levels such as GMI are particularly concerned about developing a network, since it can directly facilitate projects to increase energy efficiency or to reduce unwanted emissions. Clubs at national levels mainly function as a forum wherein governmental actors and IGOs can communicate and formulate policies. Clubs at lower levels focus on efficiently utilizing resources provided by IGOs and national governments to facilitate efforts made by private sectors to increase their energy efficiency and to reduce their emissions.

The implementation clubs at sectorial level discussed in this chapter are quite straightforward in announcing targets. The GMI has a much clearer strategy. It is determined to make a difference through establishing a global network among governments and private sectors. Different clubs have different strategies to achieve their goals.

Apart from those clubs that are the result of international conference and negotiations, most clubs are initiated or jointly initiated by high-income states that intend to establish a green leader profile. It is necessary to explore how to stimulate the interest of high-income countries to contribute to climate clubs and how to balance their interests by providing them with more benefit, with a view to understanding that those high-income countries might be the engine for the next increase in the number of climate clubs.

Climate clubs are changing and innovating. In the development process, the targets of clubs have become more specific and with more immediate timelines and now clubs include members other than nation states. Their targets and strategies to achieve them have changed, through internal discussion. Private corporations, civil society and NGOs are playing a greater role in climate clubs. The structures of these clubs are different from each other and the measures they take to achieve emission reduction are multiple. Clubs in the Climate regime complex are innovative.

The variety of clubs in terms of their sizes, members, aims, and functions suggest they have the potential to innovate. They are now concentrated on a number of different topics and are at different levels in the climate change regime. Among the fifteen clubs this chapter examined, China only belongs to seven. In the clubs that China has participated in, China is also at different positions. However, China's role in GMI is almost invisible.

Many clubs established project networks to directly use the resources to help projects initiated by private sectors. Databases have been set up so members of GMI could gain access to similar projects. IGOs, NGOs, research

centres, individuals and private corporations in the climate regime have access to complex information. These clubs do not have their own research centres, yet they have developed close relationships with research entities, which provide GMI with the latest technology available to reduce methane emissions. This information could be delivered by GMI to other government members and project network members.

As identified in this chapter, clubs influence China through a number of mechanisms: unity modifier, enhancers of cooperation, learning facilitators, role definer and agent of international realignments. These mechanisms are shaping China towards a more socially acceptable and responsible global power. These mechanisms also encourage cooperation and internal change that can induce China's behaviour change.

However, clubs are playing a limited role in advancing energy innovation compared to China's national initiative and bilateral cooperation, where innovation and research centres are receiving much more direct assistance in terms of financial and political support. This does not only apply to China. In fact, the main target of clubs is to identify the most appropriate technology, strategy and resources and make improvement accordingly.

Chapter 7 : Conclusion

This project aims to explore the effectiveness of the global regime complex for climate change in improving China's energy innovation capacity. By studying several specific cases in China's sub-national initiatives, China's bilateral cooperation with other countries, and China's participation in climate clubs, the thesis has envisioned a more promising scenario for international society to mitigate climate change than most other studies have done. This study has confirmed the role played by the climate change regime complex in enhancing China's energy innovation capacity. In terms of how the regime complex influences China's behaviour, this thesis has also identified several mechanisms at work. These mechanisms altogether have delivered a positive effect on China. The case studies have shown how these mechanisms fuelled by the constituents of climate change regime managed to enhance China's energy innovation.

There were numerous articles published in the area of China's climate policy and engagement in global climate change regime due to the Chinese government's generous support. Among these works, there is no shortage of literature on China's innovation capacity and sustainable economy. However, these studies are inconclusive to answer vital questions at the global regime level whether the current regime complex for climate change is effective or not in providing China support to combat climate change. To fill the gap, this study attempted to answer the following three questions:

1. Is the climate change regime complex effective in improving China's energy innovation capacities?

2. How does the climate change regime complex influence China's energy innovation capacities? What mechanisms are involved in this process?
3. How does the bottom-up approach influence the effectiveness of the regime complex?

This chapter consists of five main sections. The first section summarises the conclusions from each of the case study chapters, based on the empirical findings. This thesis has come to the conclusion that the regime complex has a positive effect on China's energy innovation capacity. The regime complex functions through several mechanisms. The second section explains in detail how China enhances its energy innovation capacity in the selected constituents of climate change regimes. The third section summarises the use of the bottom-up approach in the case studies. The fourth section assesses theoretical and policy implications of this study. The fifth section discusses the limitations of this study. Finally, this chapter points out areas where future study could be conducted.

7.1 An effective regime complex

In accordance with most studies on regime effectiveness, this project demonstrates that climate change regime also makes a positive difference on state behaviour (Miles et al., 2002, p. 435). In general, the behavioural changes brought by regimes are considered to be significant. Specifically, this project has found the regime complex of climate change plays a positive role in enhancing China's energy innovation capacity as well. The counterfactual analysis carried out in this thesis has confirmed this argument. Without the regime complex,

especially without the resource pool and international social pressure, China would not have pursued its energy innovation policy at its current level.

7.2 Mechanisms at work

The literature review has drawn attention to several mechanisms through which the regime functions. These mechanisms have taken place and supported the functioning of climate change regime complex. The **Utility Modifier** took place when the regime complex changed China's behaviour towards a more sustainable way, by offering additional incentives such as financial and technical support. These incentives have changed the cost-and-benefit analysis of China. We can see from the case studies that China have been benefited from the climate change regime complex by attending trainings provided by countries such as Germany and United States. Many cities in China are also benefited from the knowledge of the most advanced way to address environmental issue in city.

With the long perspective, the **Enhancers of Cooperation** encourage China to engage in bilateral cooperation on research with developed countries and provide assistance on energy efficient products and technology to other developing countries. The long-term benefit envisioned by both sides is the driver of such cooperation. China and the United States are engaged in several mutual agreements on jointly investing in developing automobiles that do not consume gasoline.

Bestowers of Authority exert influence as China is increasingly influenced by mainstream values and place more attention on climate change

and energy issues**.** China is more willing to contribute to climate change now. This is partly driven by its internal need and also by the mainstream values of global society (Gao, 2014, pp. 156-200).

Learning Facilitators work, since China constantly draws lessons from the regime complex and applies it on its national initiative, bilateral cooperation and club participation. For example, China has benefited from attending international training projects conducted by developed countries. China in turn helps other developing countries by providing training courses. The regime complex acts as a driver and a trigger for energy innovation policy diffusion in this way.

The **Role Definer** constantly defines China as a developed and capable country to contribute more on climate change. The regime complex for climate change also tries to create changes at sub-national level to vie for influence within a state.

In another word**, Agents of Internal Realignment** shift the regime's attention on non-state actors. Altogether, these mechanisms have improved China's performance on climate change and energy issues.

7.3 A change of direction

After the establishment of the UNFCCC, international society and the climate change regime have been working to address climate change by setting reduction targets for framework members. As discussed in earlier chapters, an adjustment of the target of the current global climate change mitigation effort has been discovered by scholars. The new target is to put aside the issues of

reduction target and reduction responsibility and focuses on incremental progress to increase energy efficiency and reduce carbon emissions. The initiatives put forward by international organisations are mostly indirectly related to carbon emissions reductions but focusing on the development of a more sustainable environment for human beings. In this project, the author has chosen one important criterion, the innovation capacity of China, as an indicator to shed light on how the regime complex of climate change has influenced this state.

This alternative strategy has changed the landscape of the climate change regime complex. A group of clubs, such as the GMI and the REN21 that focuses on specific areas was established. These clubs focus their work on either the reduction of a certain greenhouse gas or the facilitation of a smooth transition from traditional to renewable energy. China's bilateral cooperation with the United States has also averted the negotiation of the reduction target and responsibility and focused on areas vital to the two countries' economic development. China incorporated it first reduction target in the 12th FYP in 2011 and assigned targets to provinces and industries (National People's Congress, 2011). China invested $54 billion on clean energy in 2013 according to the annual Pew Charitable Trusts report (Magill, 2014). China is not an exception. The United States and Japan are also investing heavily in renewable energy. However, a limitation is spotted here since this focus has not been adopted by all governments and participants. Clubs mostly have a limited membership, thus are only capable of facilitating projects in a certain number of countries, most of which have mid and high income levels. Case studies of China's bilateral cooperation with the United States, India, and other developing countries also

suggest bilateral cooperation between China and many other countries is quite different in terms of cooperation channels, method and focusing areas. The ongoing prosperous Sino-US cooperation is very much an exception. Bilateral cooperation between China and many other developing countries such as India (Huang, 2007; Siddiqi, 2011) and southern states is still in its primary stage. This suggests the approach international society chooses will not necessarily be equally acceptable to all participants in the global climate change regime.

In summary, the case studies in this thesis witness indications of change of direction at the regime complex level, from the traditional global deal strategy to a more process-oriented method. The case studies in three constituents of the climate change regime complex all agree with this argument.

7.3.1 A focus on the private sector

Private sector is a type of Agents of Internal Realignment as we mentioned above. Climate change regime complex now has a new target, to focus on incremental progress by using more efficient energy and renewable energy. How does the plan work? The case studies in this thesis suggest the IGOs, NGOs, national governments and local governments are trying to achieve their targets by encouraging the initiatives of private sectors. As shown in this thesis, many clubs such as the GMI and REN21 established a project network that aims to provide direct assistance to private sectors. Such assistance includes financial and technical support, and also policy advice. Sino-US cooperation follows this trend. In their recent cooperation scheme, the two governments are mainly responsible to create a forum for government officials, business leaders,

and experts to meet and communicate. Instead of providing subsidies, the two governments create platforms that involve the private sectors and governmental representatives in different areas and provide private sectors with a chance to communicate among themselves with governmental representatives in both countries. As in the case of the ECO Partnership, universities, research centres and business corporations met and formed partnerships to jointly conduct research or cooperation in climate change related areas.

7.3.2 China is going with this trend

As the puzzle part in the introduction observed, China has been acting paradoxically in the area of climate change. This is a sign that China has been adjusting its positions in the global trend against climate change. The study has observed the development of China's strategy.

In the 12th FYP, China assigns reduction targets not only to provinces but also to a number of big industries in China (*Top-10'000 Energy-Consuming Enterprises Program*, 2011). The Central Chinese Government has widened the scope of industries and established direct relationships with these big emitters. Local governments also signed contracts with local businesses directly to ensure they can meet the reduction target. To increase incentives for local corporations to achieve the targets, local governments stipulated different awards and sanctions ("Haidian District provide carbon reduction stimulus fund in 2013 Hai Dian Qu Fa Fang 2013 Nian Du Jian Pai Jiang Li Zi Jin, 2014). These measures taken by the Chinese national government and local governments aim to include the private sectors in domestic mitigation efforts.

The private sector is deemed the potential actor to take ambitious initiatives to reduce carbon emissions. The Chinese government and international society have plenty of reasons to pay attention to private sectors as industries are the main energy users. In China, industry's consumption of energy takes up 77 per cent of total consumption (The World Bank, 2010). Without their cooperation, effort and willingness, it is difficult to control the increase of greenhouse gas emissions. This thesis and many ongoing governmental policies all support this argument.

China is not the only country with this private sector-focused perspective. It could be seen that the United States is also pursuing such a strategy, judging from the Sino-US bilateral cooperation case study. However, there are many other governments that follow the same preeminent principle. For example, the New Zealand government announced its energy–efficiency plans in early 2014 to demonstrate to New Zealand's business sector how efficient energy use could save money, boost productivity and reduce emissions (Ihaka, 2014). Business consumes 70 per cent of New Zealand's energy usage and the New Zealand government believes that if these businesses are provided proper information related to efficient energy usage, they will make smarter energy choices than they are currently doing.

7.3.3 The emergence of innovation mechanisms

Previous literature has covered the issue of National Innovation System (NIS). However, this thesis discusses NIS in the context of global regime complex to see how three specific constituents of the regime complex enhance

China's energy innovation capacity. In this way, NIS is seen as a porous entity that constantly exchanges information and resources with the outside world. In our modern society, each state is operating in a network with other states and entities. How the international and domestic participants contribute or limit a country's innovation capacity is a question worthy of discussion.

It is shown in the thesis that China heavily invested in the climate change area as early as 2007. The Central Government has included Research Centre of climate Change in its bureaucracy.[19] Many famous universities established climate change study centres to strengthen related research, such as Peking University and Fudan University.[20] The National Climate Centre has sponsored an academic journal called Advances in Climate Change Research. In the realm of energy, there are many more research centres in both government bodies and universities. The Central government of China directly and indirectly funds many long term programs.

Even so, China's innovation capacity is limited at the general level. China does not hold the most advanced technology in regard to wind power energy. Still, China has already invested the largest amount of money in renewable energy. Therefore many corporations associated with renewable energy have emerged in a comparatively short period. However, the core technology is still in the control of Western corporations. For example, China mainly updates its wind

[19] The CCRC (Climate Change Research Centre) was established to support Chinese climate diplomacy. This research centre has gathered a group of experts from areas such as physics and climate sciences, and government officials from the climate change department.

[20] The Research Centre for Climate Change is jointly built by Chinese Academy of Sciences and Peking University. This centre was established to produce more practical policy suggestions for the national technology and social development. Fudan-Tyndall Centre was a joint research centre cooperated by Fudan University and Britain's Tyndall Centre.

farm technology through purchasing licences from international corporations. This is definitely a limitation, since without self-innovation capacity China will not be able to become a strong and irreplaceable power in wind energy.

Some countries, the United States and those in the EU have developed more mature bilateral relationships with China. Their cooperation principles are clearer on the aspect of creating such a forum to facilitate private sector effort. The multiple and diverse ongoing annual workshops on many aspects related to climate change and new energy were organised by governments and attract business representatives. Although the governments of the two sides do not directly invest, they focus on creating opportunities for more communication. Much bilateral and transnational cooperation occurred between and among private sectors in China and the United States. China has established bilateral research centres with a number of developed countries such a s the United States and the United Kingdom.

Many climate clubs, especially those focusing on specific projects, are fully aware of the importance of fostering a spill-over mechanism and therefore include private sectors in their mitigation efforts. These clubs established many project networks that connect governments, IGOs, private corporations, research centres and individual experts. In this sense, those clubs lack the ability to directly contribute to China's energy innovation capacity. Those clubs have established a database of ongoing projects to decrease greenhouse gas emissions. The published information about these projects includes the sites, time, evaluation report and measures taken to address related issues in these projects. The aim of these databases is to make this information available to more private sector participants who have the will and capacity to be pro-active

and do something to curb climate change, yet lack information of how to proceed or what the benefit of adopting new energy is.

China's innovation mechanism, especially on the technology side is comparatively weak. Although capable of producing large quantities of wind turbines and solar panels, China does not hold licences for most of the advanced technology. Whereas financial support has been focused on research, it takes time for China to become stronger in the research area.

China's spill-over mechanism, thanks to many countries and clubs, is already in a good shape to import and export useful information and technology. Participants at different levels in China are involved in different clubs and bilateral cooperation wherein they can establish multiple connections with actors within China or with international actors in the same area. This means any actor in China, no matter if it is a central government official, local government official, research centre, private corporations or individual, is capable of making connections to a range of actors ranging from domestic to international, governmental to non-governmental, to gain access to the information it requires. This is a massive network and the knowledge pool that the network can access is huge. Judging from the case study carried out in this thesis, the number and scale of the participation of private sectors from China is not as optimal as possible. In the GMI case, their projects information was published due to the fact that the United States is assisting with these projects in China; and the United States has the right to publish the information in the database. The United States as one of the founders of the GMI wants to contribute to the GMI database. It is still unknown to the researcher whether the Chinese participants

would like to share their information about their projects and include it in the database.

Table 12: The effect of climate change regime on China

The mechanism	National	Bilateral	Club
Utility modifier	√	√	√
Enhancers of cooperation	NA	√	√
Bestowers of authority	√	√	√
Learning facilitators	√	√	√
Role definers	√	√	√
Agents of internal realignments	√	√	√

7.3.4 Different roads but the same goal

The value of this research is that it has applied a different approach to the current climate change regime and China's participation. A different prospect of current mitigation efforts was envisioned, and a different set of policy suggestions formed. This change of perspective is necessary and represents what is recommended at this stage.

There is no doubt that the most straightforward and most secure way to address climate change and to stop the global average temperature rising by *2°C* is to set a cap for carbon emissions. Each country has a reduction target and a responsibility to achieve it. However, we have been sticking to this measure for the last two decades and no prominent progress has been made. It is time for us to reconsider the best strategy to cope with climate change challenge.

The bottom-up approach that international society is now working with, although indirect and possibly not as efficient and effective as it could be in the short term, is well accepted by many countries, especially by some big emitter countries such as China and the United States. This is the bright side of the story. The other side the studies have discovered is that the efforts the bottom-up approach espouses are affected by the fragmentation of the regime complex of climate change. The two main mechanisms on which we rely are also fragmented. Evidence could be the uneven share of renewable energy technology among the international society and the often small membership of climate clubs. China's bilateral cooperation with different countries differs dramatically in terms of depth and breadth. The members of clubs are also partial, with a predominance of mid and high income level countries. Poorer and less well developed countries are not as involved as rich countries.

7.4 The Paris COP in 2015

The Paris Conference (21st yearly session of the Conference of the Parties) took place in December 2015. During this conference, a global agreement on the reduction of climate change has been achieved. This agreement has become legally binding on its member states on 4 November 2016. Thirty days after 55 parties to the Convention accounting in total for at least an estimated 55% of the world's greenhouse gas have ratified the Agreement. This is significant improvement in the history of mitigating climate change. However, it is noted that even though this agreement has come into force, the reduction goal of the member state remains to be voluntary.

Another historical change of the Paris COP is that the Paris agreement singled out the role of cities, regions and local authorities and encourages these entities to scale up their efforts to reduce emissions, building resilience against climate change and support regional and international cooperation on climate change. At the same time, Paris Conference, as previous conference has made efforts to mobilise financial tools (100 billion USD per year by 2020). This change also embarked the solution transition from reliance on national governments to various governing bodies such as cities, local governments, industries, NGOs, research centres and so on.

7.5 Answers to research questions

Is the climate change regime complex effective in improving China's energy innovation capacity and how?

The national initiatives section of the regime complex and the bilateral cooperation of China both play a direct role in enhancing China's energy innovation capacity. The national government of China achieves this by providing financial and political assistance to research projects and research centres. Bilateral cooperation between China and other countries also provides financial and political assistance, although concentrated more on joint development and ownership of research costs and outcomes. By sharing the technology and knowledge in a certain energy related area between the two countries, the outcome is substantially better. Compared to these two constituents, the clubs' activities contribute to China's energy innovation capacity in an indirect way. Most clubs identify the best financial assistance and

technological support for a local project and establish a network of resources. In that sense, a club may strengthen China's energy capacity to some extent but its influence remains indirect.

7.5.1 The bottom-up approach

All three constituents of the regime complex address the climate change and energy issue in a bottom-up approach. The application of this approach may introduce immediate initiatives to reduce greenhouse gas emissions. It is accepted by some major emitters, such as China and the United States, as empirical studies have shown. The network built by clubs also aimed to bring together the resource from multiple levels from international organisations to individual researchers.

The governments and many members in international society now have put a lot of effort on the actors at the bottom level at the centre of activity, interest and attention. Private business has become the new focal point and focus of policy. To assist the reduction efforts made by private sectors has become the one leading principle that many participants working at different levels have followed. The three case studies respectively examine the operation of the bottom-up approach in China, China's bilateral cooperation and China's participation in climate clubs. This thesis has learned that China is involved in this bottom-up approach to different extents via these climate change regime constituents.

In China, although central government has recognised the importance of private sector and ground level participants, its unitary political system has

featured this policy transition to a bottom-up approach with a top-down fashion. Central governments began directly monitoring some big private businesses. Even though domestic business clubs that incorporate government representatives and local business representatives have been created, they are also fragmented since only some businesses have taken part by becoming members.

Bilateral cooperation between China and other countries is also featured by the guidance by the two governments. The governments mainly focus their work on establishing a networking centre or forum, so private sectors from both countries have more chance to communicate with each other, to exchange information among individuals, groups or institutions and cultivate productive relationships, to find answers and solutions to the common problem. In this context, the two governments are using a softer approach than in China's domestic case.

In climate clubs, the government role is even less dominating. However, some national governments are the leaders or the founders of certain clubs and so still play an important role in them. Other governments join the climate clubs as participants and do not play a dominant role as they do in domestic and bilateral mitigation efforts.

The result of this thesis is shown in the table below. As the three case studies show, without exception, the focus is on private sectors in the three constituents of the regime complex. This is an indication that the bottom-up approach is adopted by a number of participants in the regime complex. However, different constituents of the regime complex adopt bottom-up in

different ways and to different extents. The following table provides a summary with the answers to the research question.

Table 13: The Summary of the Bottom-up Approach in the Case Studies

	Is there a focus on private sector?	Has the bottom-up approach been adopted?	How does the Innovation mechanism function via China's participation?		How does the spill-over mechanism function in China's participation?	
Domestic mitigation efforts in China	Yes	To an extent, but this approach is carried out in a typical unitary political system	A lot of investment from government each year was spent to encourage climate related research. The Chinese wind farm companies mainly access the advanced technology by purchasing licences.		A spill-over mechanism under strong central governmental leadership is established, to encourage local attempts to address climate change and collect successful experience for circulation. Business also formed its own alliance to share related information about new technology.	
Bilateral mitigation efforts of China	Yes	To an extent, a feature of government guidance is noticed.	Government supported research centres on climate change and related technologies have been established. Many universities and research centres cooperate with those in other countries.		Supported by the two governments, many annual workshops and meetings focusing on different areas have been held each year with the presence of government officials, business actors and others.	
Mitigation effort in climate clubs of China	Yes	Yes. Climate clubs, especially those focusing on projects levels now aim to facilitate reduction initiatives carried out by private sector.	Some clubs create project networks with connections to research centres and individual experts yet lack innovation capacity on technology.		The project-networks set up by clubs are a good place to share experience of mitigation and are a potential forum for spill over to take place.	

7.6 Theoretical and policy implications

As this study has shown, all the six behaviour changing mechanisms are influencing China in the three sectors of climate change regime covered in this research. China's experience in national initiative, bilateral cooperation and club participation to enhance its energy innovation capacity indicates that the fragmentation feature restricts the regime's influence. The following section makes suggestions to different decision makers on how to eliminate fragmentation and take advantage of the bottom-up approach.

To climate clubs:

According to this study, the main target of climate club regarding to energy innovation is to relocate the resource to achieve the best result. The variety of information about assistance and technology could be accessed by different entities from governments to companies and individuals. The China case study suggests that its participation in clubs relies mostly on the climate change regime than in the other two constituents. Without the project network, it is comparatively difficult for a single country to access such a resource pool. However, the global participation of climate club is fragmented. The fragmentation has limited the size of the resource pool as well as the numbers of countries which can utilize this pool. It is vital to guarantee the equal participation of each country in the club.

Clubs should also notice fragmentation, since not all the private sector in all the countries joined the network. However, the network only works for the private sector that has the vision and information to join these clubs. It is the priority for these clubs to bring in more actors from the private sector. At the

same time, the clubs should focus on attracting actors from private sectors in developing countries and relatively poor and third world countries. The information, financial support and technology suggestions will make a huge difference to these countries and help stop emissions of greenhouse gas. In this way, poor countries could catch up with the most recent green technology and most efficient energy instead of following the traditional treatment after pollution finds it way in their development process.

On the general level, as the trend recognised in this thesis, many clubs have already adjusted their strategy to encourage more initiatives to reduce greenhouse gas emissions from the private sector. The climate clubs have done a wonderful job to create a spill-over mechanism by establishing the project network. These networks aim to share the most recent information about financial, technological resource and experience among actors from different levels from individuals to governments. It is strongly suggested that these clubs further strengthen the network by carrying on collecting more information on projects and new technology and incorporate all this knowledge into this network. The benefit of accessing such an abundant resource pool could attract more members. Gradually, this trend would collapse the fragmentation of the regime complex.

Innovation is not the clubs' strong suit, especially on the technology side. However, they can work to create an international environment that values technological innovation by protecting IPR and guarantee that less-developed countries can access these technologies at a fair price. To summarise, each club should maintain and strengthen its current role to guarantee equal access to its pool of resources for all participants in the climate change regime complex.

Additionally, clubs should consider issues such as IPR and offering guidance and supervision.

7.6.1 Relevant to the Chinese government:

The Chinese government should be aware that the regime complex for climate change is influencing China. The Chinese central government is more and more devoted on the issue of climate change and energy technology development. At the same time, the regime complex is fragmented and the influence of the regime is limited. The local government, companies and individuals may not share the same zeal on energy innovation as the Central Government of China does. It is a time-consuming task to implant a new idea in a nation. The Central Government is trying to do so by promoting the concept of 'ecological civilization'. More needs to be done to create common sense on climate change and energy innovation in China.

More efforts on energy innovation capacity are a signal of a transformation of China's climate policy from focusing on adaptation to mitigation. Adaptation policy is often pursued by developing countries and it focuses on foreign aid provided by developed countries. Developed countries tend to adopt mitigation policy as they possess technological advantage and would like to enlarge its global market for energy products. China's transformation is taking place but not yet finished.

One of the most important aspects related to the China's transformation is the development of energy technology. Without holding a strong position in

global sustainable energy market, China would not pursue a policy fully on mitigation.

As is discovered in the process of this study, although the regime complex tries to vie for changes from the internal of the country, it mainly operates on the country level by providing additional incentive, defining the role of the country and socially engaging China into its knowledge system. This study also shows that the Central Chinese Government is more concerned with the reduction of carbon emissions and the upgrade of energy technology. It is vital to pass the same passion to other actors within China. The Construction of Ecological Civilization is not a new word but has regained attention

The study in this thesis suggests that many improvements could be made to improve the efficiency of the Chinese government's strategy to increase its energy innovation capacity. Apparently, it takes time to make fundamental changes. The Chinese government has already heavily invested and subsidised its renewable energy sector. The Chinese government should invest in one particular area, then expand the technology advantage. Buying licences is not necessarily a shortcoming of China's industry, as long as these licences are sold at a fair price. Buying licenses could help avoid repetitive research investment on the same solution and thus make the distribution of global resources more efficient.

China could further develop its cooperative relationship with other developing countries, such as India and Brazil. Developing countries are trying to take this economic transition an opportunity to develop. This is a contest between the developing and the developed countries instead of a competition

between developing countries. Developing countries should share their experience and develop together. With more cooperation among developing countries, the fragmentation of climate change regime could be partially eliminated and it is easier to create a fairer international society for all the countries. However, the current cooperation status suggests that cooperation between China and other developing countries on energy technology innovation is not so common or deep as that between China and other developed countries.

7.6.2 To business leaders:

Business has been recognized as an actor that can make important contributions to climate change mitigation and energy development and thus the focus in all the three constituents studied in this research. Substantial opportunities such as political assistance, financial support, and technological guidance have been provided to business in related areas.

Business should recognize the green economy represents the best as well as the only option for every business. The earlier they intend and plan to include carbon emission costs in cost-and-benefit analysis, the better to prepare for present challenges and the future. Business leaders should endeavour to be initiators. The challenge is an opportunity for businesses. As a start, business leaders should join the multiple networks organised by peer business, project-network organised by clubs and national governments, and workshops and conferences organised by governments and universities. These events could update business leaders with the current policies, trends, technologies and case experience related to a variety of climate change solutions. This will also keep

business leaders well-informed in the areas that might influence their businesses and cost. By analysing these policies and cost-and-benefit of new technologies, business leaders could decide details and timing, including when and how their company makes the transition to more efficient use of energy. Rather than being forced to reduce emissions by regulation, or buying extra carbon credits, businesses should accept assistance provided by governments, clubs and so forth and start to reduce emissions now.

7.7 The limitations of this study

As there is a certain limitation of space and effort, this thesis has chosen three constituents of the climate regime complex. The consistency among these three cases does not necessarily indicate that all the parts share the same characteristics. More case studies could be conducted in the multiple areas related to climate change. With sufficient case studies in these areas, the thesis could have made its argument more convincing.

The other limitation of this thesis is that it unintentionally downplays the value of traditional global strategy to negotiate a reduction schedule to solve climate change. Here the author clarifies that the strategy is valuable as one approach that has successfully resolved many global issues. Examples could be ozone depletion and many international laws ranging from protection of the sea to trade among nations. These laws and regulations that rule current international affairs are the result of global negotiation. The strategy fails to address climate change because the big emitters have not shown serious intent to take action. The bottom-up approach focuses on areas where these countries

would like to contribute and is also more cost efficient. Immediate actions could be taken in this way. A global deal could be formed when big emitters are prepared to take responsibility.

By applying Young's theory to analyzing the efficiency of climate regime on China, this thesis has discovered that Young's theory is very powerful in confirming that the climate regime has a positive impact on China through a number of mechanisms. All the mechanisms that he mentioned are functioning in China. However, Young's theory does not indicate which mechanism(s) is(are) more important than others for the success of climate regime and in different backgrounds, which mechanism(s) is(are) more likely to be successful than others in that particular country.

7.8 Future study

The author urgently calls for more research at the project level about how private sector actors respond to the climate change, how they perceive the incentives that government and IGOs have provided to take more reduction action, and so forth. This should include the government's measures, the international organisations' measures to provide incentive and study of the effectiveness of these incentives in inducing action by the private sector in search of cleaner energy and more efficient energy use. It is the belief of the author that these research studies will show the most recent progress achieved in international society to incorporate climate change in their economic development.

It is recommended that further studies be carried out related to developing countries. There is a lack of case studies of developing countries' participation in different climate change constituents. Developing countries are potential contributors to substantial emission reduction, as the private sector in these countries is growing. More research related to their cooperation and options to participate could help them to make environmental decisions without incurring extra cost.

Previous study has suggested that most regimes are effective but fall short of providing functionally optimal solutions (Miles et al., 2002, p. 435). More studies of the evolution of regime complex to strengthen its efficiency are needed.

7.9 Conclusion

This thesis has conducted three set of case studies to explore how China's national initiative, bilateral cooperation and club participation improve its energy innovation with the assistance of climate change regime complex. This thesis has found that the behaviour changing mechanisms identified by Oran Young are functioning in the regime complex of climate change. Without these mechanisms, China would not have pursued energy innovation at the current level. The study also examines how the three constituents strengthen China's energy innovation capacity in different ways. Climate change regime complex functions through five behaviour changing mechanisms and these mechanisms are taking place at China's national government, local government and private sector levels. The actors on these levels received incentives and benefit to

make positive changes. They are also assimilated in the process and have become more accepted to the mainstream value of climate change and energy innovation.

The case studies have shown that the bottom-up approach has been widely adopted by many parts in the regime complex for climate change. With the help of the bottom-up approach, the innovation mechanism in China is capable of integrating a portion of China's domestic resources with the resources derived from other governments, IGOs, research centres. These resources were organised and categorised in databases for the benefit of the private sectors. This trend is the most obvious in the club than in the bilateral cooperation that China engages to improve its innovation capacity. In national initiatives, the application of the bottom-up approach also exists but with a strong feature of unitary state control.

One of the assumptions of this thesis is that the extent to which the mitigation effort of climate change has successfully involved the private sector determines how successful the climate mitigation is going to be. This thesis has discovered that the influence of the five mechanisms are functioning at China's participation in bilateral and club activities as well as at its national initiatives. However, the thesis further comes to the finding that the influence of the five mechanisms is not evenly distributed among multiple levels within China. This means that the private sector in China has not been fully involved in climate change mitigation. Local government has adjusted the policy to suit their own interest. The comparatively powerless private sector in China is therefore another reason to explain why the influence of global climate regime is difficult to trace in China's private sector.

Appendix

Appendix 1: Cooperation Pattern in Climate Change Regime

Name of the Cooperation Patterns	**Participators**	**Examples**	**Whether this part will be discussed in detail in this thesis?**
UN Legal Regimes and special UN Agencies	Countries	UNFCCC; GEF; global political agreements	No
Specialized UN	WMO; UNEP		Yes (limited discussion)
Bilateral Cooperation	Governments at different levels; universities, research centres, transnational corporations, companies	Many projects between China and the US	Yes (chapter five)
Expert Assessments	Academic researchers, research institutions	IPCC; national assessments	Yes (limited discussion)
Unilateral Action	National governments, local governments, private companies, NGOs and individual people	California or Industry rules on offsets	Yes (chapter four)
Clubs	Countries	G8, G20	Yes (chapter six)
Multilateral Development Bank	International financial institutions	World Bank PCF, Forestry and Adaptation funds	No
Montreal Protocol	Countries which signed the Montreal Protocol		No

Appendix 2 Table 14 China's Reports and Plans Related to Climate Change

Year	Title	Contents
2015	The forthcoming of the 13th FYP (2016-2020)	● Is expected to include a carbon cap for China.
2014	China's Policies and Actions for Addressing Climate Change	
2013	China's Policies and Actions for Addressing Climate Change[21]	● pointing out new trial areas to promote low-carbon such as low-carbon products, low-carbon industrial park and communities. ● encourages those at the local level to undertake low-carbon pilot trials according to local characteristics ● 495 million Yuan in funds and donations had been arranged to invest in research on climate change and climate policy ● the Government Offices Administration of the State Council organized a range of energy-saving training sessions in public institutions for government leaders and university directors. ● enhance China's scientific capacity through the research and participation of many departments
2012	China's Policies and Actions for Addressing Climate Change [22]	● initiated pilot programs for carbon emissions trading ● a carbon intensity reduction index has been included in the comprehensive evaluation of regional economic and social development initiatives and the cadre performance appraisal system ● studying and starting trials related to low-carbon industry parks, communities and commerce ● beginning trials of low-carbon products ● carrying out green and low-carbon pilot and demonstration projects in key small towns ● establishing research and advisory institutions
2011	China's Policies and Actions for Addressing Climate Change[23]	● outlines the objectives included in the country's 12th FYP. ● specifies how China is going to fulfil the target: legal system building and strategic planning, accelerating economic restructuring, optimizing energy mix and developing clean energy, continuing to implement key energy conservation

[21] For an English version of this report, please visit: http://en.ndrc.gov.cn/newsrelease/P020131108611533042884.pdf.

[22] For an English version of this report, please visit: http://www.ccchina.gov.cn/WebSite/CCChina/UpFile/File1324.pdf.

[23] For an English version of this report, please visit: http://www.chinausfocus.com/library/government-resources/chinese-resources/documents/white-paper-chinas-policies-and-actions-for-addressing-climate-change-november-2011

		projects, developing a circular economy, steadily launching low-carbon pilot projects, gradually establishing a carbon emission trading market, enhancing the capacity of carbon sinks, enhancing the capacity of adaptation to climate change, continuously strengthening capacity building and carrying out all-directional international cooperation on climate change.
2009	China's Policies and Actions for Addressing Climate Change	● adjust economic structure and promote the optimization and upgrade of industrial structure ● 178 pilot projects have been launched to explore the effective modes of a circular economy
2008	China's Policies and Actions for Addressing Climate Change [24]	● provides background information regarding the reasons addressing climate change is very important to China ● outlines how China is going to deal with climate change at the general level: adjusting the economic structure, to save energy and improve energy efficiency, develop renewable energy and optimizing energy mix, developing recycling economy ● mentions many pilot projects wherein work has been launched in the energy conservation area, renewable energy area and so forth ● continuously increasing financial support to climate related scientific and technological projects and programs
2005	11th FYP	● maintain farmland reserves at 1.818 billion mu ● cut water consumption per unit of value-added industrial output by 30 percent and increase the water efficiency coefficient in agricultural irrigation to 0.53 ● non-fossil fuel resources will grow to 11.4 of primary energy consumption ● energy consumption per unit of GDP will decrease 16 percent and CO_2 emissions per unit of GDP will decrease 17% ● make significant reductions in the total emissions of major pollutants ● pilot scheme for comprehensive report of the public service

[24] For an English version of this document, please visit:
http://www.ccchina.gov.cn/WebSite/CCChina/UpFile/File419.pdf

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