



**GREEN ENERGY TECHNOLOGY DEVELOPMENT:
CASE STUDIES OF CHINA AND INDIA**

BY

MR. APIDECH KUMNANE

**AN INDEPENDENT STUDY SUBMITTED IN PARTIAL
FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE
OF MASTER OF POLITICAL SCIENCE IN
INTERNATIONAL RELATIONS
FACULTY OF POLITICAL SCIENCE
THAMMASAT UNIVERSITY
ACADEMIC YEAR 2019
COPYRIGHT OF THAMMASAT UNIVERSITY**

**GREEN ENERGY TECHNOLOGY DEVELOPMENT:
CASE STUDIES OF CHINA AND INDIA**

BY

MR. APIDECH KUMNANE



**AN INDEPENDENT STUDY SUBMITTED IN PARTIAL
FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE
OF MASTER OF POLITICAL SCIENCE IN
INTERNATIONAL RELATIONS
FACULTY OF POLITICAL SCIENCE
THAMMASAT UNIVERSITY
ACADEMIC YEAR 2019
COPYRIGHT OF THAMMASAT UNIVERSITY**

THAMMASAT UNIVERSITY
FACULTY OF POLITICAL SCIENCE

INDEPENDENT STUDY

BY

MR. APIDECH KUMNANE

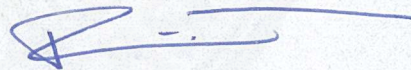
ENTITLED

GREEN ENERGY TECHNOLOGY DEVELOPMENT:
CASE STUDIES OF CHINA AND INDIA

was approved as partial fulfillment of the requirements for
the degree of Master of Political Science in International Relations

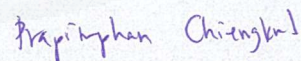
on January 10, 2020

Chairman



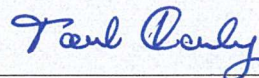
(Asst. Prof. M.L. Pinitbhand Paribatra, Ph.D.)

Member and Advisor



(Prapimphan Chiengkul, Ph.D.)

Dean



(Asst. Prof. Tavid Kamolvej, Ph.D.)

Independent Study Title	GREEN ENERGY TECHNOLOGY DEVELOPMENT: CASE STUDIES OF CHINA AND INDIA
Author	Mr. Apidech Kumthane
Degree	Master of Political Science
Major Field/Faculty/University	International Relations Faculty of Political Science Thammasat University
Independent Study Advisor	Prapimphan Chiengkul, Ph.D.
Academic Years	2019

ABSTRACT

Since climate change has gained popularity for the public around the world as well as significant debates amongst scholars due to its impact on political and socio-economic aspects. The international community has then noticeably put much effort in tackling with the issue however, it does not seem to be successful. This includes the negligence of states on one of the most sustainable and efficient ways in dealing with climate change; the development of green energy technology. Although, there are certain areas of cooperation amongst states but it is inadequate. According realism in which the research has adopted as the theoretical framework since it provides a more relative and applicable in explaining the development of green energy technology, particularly focusing on China and India as the case studies. The research refers to John Mearshiemer's arguments and concepts which suggest that the hegemonic power like the United States plays much important role in this development as it tends to create obstacles e.g. Intellectual Property Rights (IPRs) and, trade disputes through World Trade Organization (WTO), to block the new emergence powers from achieving their goals, presumably, expanding more economic power. His concept of 'latent power' also clearly explained the intention of China and India in developing green energy technology. In other words, their intentions are the mixture of the concern on climate change issue as well as the willingness to expand their own economic powers. As a result, the research is optimistic in a way that these conflicts will somehow reflects in

certain progress of resolving climate change issue as states are determined in power competition which encourages more advanced innovation and so on.

Keywords: China, India, United States, Green energy technology, Realism, Latent power, John Mearsheimer, Hegemony, Intellectual Property Rights (IPRs), Trade disputes, World Trade Organization (WTO), Solar power, Wind power



ACKNOWLEDGEMENTS

It has been very grateful for me to be able to accomplish my Independent Study with the kind assistance of my advisor, Dr. Prapimphan Chiengkul. I am appreciated the time, feedbacks and advice given during the past several months as it help improving my papers until it has completed with satisfactory result.

I would like to thank Asst. Prof. Dr. M.L. Pinitbhand Paribatra for the valuable feedbacks on my papers to help narrow down my topic to be more focused and worth reading during proposal and final defense as a committee.

Lastly, I would like to thank Ms. Kanjana Kamhun for administrative works she has done throughout the whole program, my classmates who have helped me during my studies as well as my family and girlfriend who have always loved and supported me in any possible ways.

Mr. Apidech Kumnane

TABLE OF CONTENTS

	Page
ABSTRACT	(1)
ACKNOWLEDGEMENTS	(3)
CHAPTER 1 INTRODUCTION	1
1.1 Background and significance	1
1.2 Research question	5
1.3 Summary of theoretical framework	5
1.4 Main arguments	6
1.5 Methodology	7
1.6 Chapter outline	8
CHAPTER 2 LITERATURE REVIEW	10
2.1 Climate change and its effects in Asia	10
2.2 The importance of green energy technological development	13
2.3 Global overview of green energy technological development	15
2.3.1 Existing schemes of green energy technology transfer	16
2.3.2 China and India's attempt to develop green energy technologies	18
2.4 Conclusion	23
CHAPTER 3 THEORETICAL FRAMEWORK	25
3.1 Realism school of thought	25
3.2 Evaluation of realism and liberalism in analyzing climate change issues	27
3.3 Evaluation of John J. Mearsheimer's offensive realism approach and green technology development	30
3.3.1 Latent power and green technology development	32
3.4 Conclusion	35
CHAPTER 4 GREEN ENERGY TECHNOLOGICAL CATCH-UP EFFORT IN CHINA	38
4.1 Energy consumption in China between 1949 and 2014, and concerns about climate change	39

4.1.1 Hydropower	41
4.1.2 Bioenergy	41
4.1.3 Wind power	41
4.1.4 Solar power	42
4.2 A detailed analysis of wind turbine and solar PV manufacturing industry catching up	43
4.3 Obstacles and challenges towards green energy technology development	46
4.3.1 Intellectual property rights and World Trade Organization	46
4.3.2 Trade disputes and the World Trade Organization	49
4.3.3 Analysis on the conflict between China, the United States and the European Union through a realist perspective	52
4.4 Conclusion	53
CHAPTER 5 GREEN ENERGY TECHNOLOGICAL CATCH-UP EFFORTS IN INDIA	56
5.1 Energy consumption in India between 1970 and 2014 and concerns about climate change	57
5.1.1 Hydropower	58
5.1.2 Biomass energy	58
5.1.3 Geothermal energy and tidal wave energy	59
5.1.4 Wind power	59
5.1.5 Solar power	60
5.2 Wind turbine and solar PV manufacturing industry catching up	60
5.3 Obstacles and challenges towards green energy technology development	65
5.3.1 Intellectual property rights	65
5.3.2 Trade disputes and World Trade Organization	66
5.3.3 Analysis on the conflict between India and the United States through a realist perspective	68
5.4 Conclusion	70
CHAPTER 6 AN EVALUATION OF THE CASE STUDIES AND CONCLUSION	72
6.1 State motivations in the promotion of solar and wind powers	73
6.2 Wind and solar power catching-up development of China and India	74

6.3 Trade conflicts and IPRs amongst China, India and the United States	76
6.4 The analysis of realism towards green energy technology development and lessons learnt	77
6.5 Lesson learnt for Thailand and future research areas	78
REFERENCES	80



CHAPTER 1

INTRODUCTION

1.1 Background and significance

Climate change has become one of the most important issues in international relations, and it has been perceived as an eminent threat to states. Many scientific studies have conducted on the effect of climate change, and there are also social science studies that have been debating how states would combat with climate change in various scenario. According to the latest report from UN Intergovernmental Panel on Climate Change (IPCC) – Global Warming of 1.5 °C, addressed the serious threat of climate change if international community fails to maintain the global surface temperature to 1.5 °C which is a new threshold comparing to the previous carbon control at 2 °C. The report was produced by a group of scientists and provided scientific evidence regarding the situation and impact of climate change towards humanity for policy maker in order to take immediate action to prevent the world from future's catastrophe. It is confirmed that climate change is happening and will only be worsen in the case that international community fail to implement concrete action plans in order to maintain the world's temperature as of 1.5°C. It provided the forecasts of the impact that might have happened – droughts and floods are expected to occur more often, soil erosion and sediment load, terrestrial and wetland ecosystems, ocean system, food, nutrition security and food production systems (including Fisheries Aquaculture), human health, key economic sector and services (tourism, transportation and energy system), livelihoods and poverty as well as the changing structure of communities such as migration, displacement and conflict (Hoegh-Guldberg, et al., 2018).

An interesting findings of a report called *The Stern Review: The Economics of Climate Change*, (Milczek & Kosjek, 2015); which was published in 2006 suggested that all countries will be affected by climate change, however, the poor countries with large populations seem to be more vulnerable such as sub-Saharan Africa and South Asia. The report presented with the figure of IPCC Third Assessment Report, showing that geographical exposure determines a country's growth and development prospects

which it found that developing countries are vulnerable because most of them located in tropical areas, it usually suffers from climate extremes such as monsoon, El Niño and La Niña cycles. Further, the heavy dependence of agriculture and ecosystems that has a high risk to be destroyed would definitely affects the country's economic system to shift its focus to manufacturing or services sector. As a result, the damage costs can relatively impact to the overall country's economy which particularly, poor countries are having an economic structure that is highly sensitive and, low incomes that constraint their ability to adapt. The economic development, on the other hand, helps reducing the vulnerability of climate change since the country has necessary tools to utilize once it faces the unexpected natural disasters. There is the possibility that the country might be able to adopt technological advantage which it possesses in order to help reducing the risk of such disasters.

In order to deal with the threat of climate change, international community has initiated international environmental cooperation. Examples include the adoption of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, Kyoto Protocol within the same year as well as Paris agreement in 2015 which aims to substantially reduce global greenhouse gas emissions in an effort to limit the global temperature increase in this century to 2 degrees Celsius above pre-industrial levels, while pursuing means to limit the increase to 1.5 degrees (UNFCCC, n.d.). One important subject that has been included in the agreement is Nationally Determined Contributions (NDCs) in which it can be seen as a core guidance of each country to collectively set out its own agenda to reduce national emission and climate change adaptation. Besides, international organization such as the United Nations Environment Programme (UNEP) plays an important role to promote the coherent implementation plans and initiatives e.g. Africa Renewable Energy Initiative and UN Environment Finance Initiative (United Nations Environment Programme, n.d.).

Although international community seems to be proactive with regards to prevention and mitigation of climate change's impact, there is one prominent issue that has received relatively little attention, which is the development of green energy technology. It is one of the solutions that can help mitigate greenhouse gas (GHG) and slowing down global warming. However, it was oftentimes over-sighted and being neglected. Green technologies include technologies that provide alternatives for energy

extraction by avoidance of destruction of natural resources, fossil fuel resources in particular. For example, using solar-PV to generate electric power instead of constructing power plant. Arguably, the digital age is unfolding and the world is now moving towards the future in which technology has become essential to humanity. It is, in fact, due to technological advancement since the Industrial Revolution that has damaged environment and, the problem has been worsen in the course of time. Given that the collective action is required in order to solve this particular problem, states should cooperate more in order to come up with concrete plans on how green energy technology could be developed and disseminated around the world, which would substantially prevent the threat of climate change. This includes both domestic and international development of such area. China and India are amongst the most vulnerable areas, including that of other developing countries, where climate change's impact will be severe. However, the economic growth rate of the two countries have been increasing in the past decade, and therefore, they have higher capabilities to deal with climate change compare to other developing countries. Indeed, they are taking the leadership role in the international community to develop its own green energy technology project.

China has been very active in combatting climate change as the country came to realize that, due to its rapid urbanization and fastest economic growth, this unavoidably makes China one of the largest countries that import energy and resources. Domestic demand significantly increased following the positive trend of country's economy over the years. The fear that the country lacks of capability to supply such energy to its own population and heavily dependent on other country which it is unfavorable for China, the country then has taken step forward with regards to green economy and the plan to reduce energy consumption which was indicated in the 11th Five-Year Plan in 2006-2010 (von Hippel, et al., 2015). It can be seen that this was the first stage of the process of a strategy to develop its own green energy technology project in order to tackle the mentioned concerns.

India is also one of the other developing countries which has been facing similar circumstances with China due to its world's second largest population right after China and, notably, one of the fastest economic growth countries in the world. Certainly, rapid urbanization causes the same problem in which the high demand in

consumption of more energy is expected and therefore the country would have insufficient energy to supply. India has then laid out the 2008 National Action Plan on Climate Change (NAPCC) in which there are eight national missions to help tackle and mitigate the problem of climate change. The main goal is to promote the development without degradation; for example; National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, etc. (Ahmad & Choi, 2000).

Besides the reason mentioned above, China and India have been focusing on the development of green energy technology as they have come to realize that they are one of the countries which produce major share of greenhouse gas to the world. According to United Nations Framework Convention on Climate Change (UNFCCC), it reports that both countries are taking the lead on global renewable energy transition; both China and India aims to increase renewable energy capacity more than the past years; for example, China aims to increase the capacity by 38% compared to 2015 levels and India, has successfully installed solar and wind by 43% and 116% more than the annual goal in 2016 (UNFCCC, n.d.). In fact, they play the key role in renewable energy technology, solar and wind, alongside with the US which is in line with Paris agreement goals, as there is significant amount of investment have been poured into the countries. Yet, the US pursues “America First” policy in 2016 and therefore proceeded to withdraw itself from the agreement. As a result, China and India have taken over the leadership of renewable energy development field as well as European countries.

It seems that China and India have potential to develop their own green energy technology to meet the reduction target of greenhouse gas. The question remains, however, whether these two countries will take advantage of advanced green technology to expand their economic powers, or will their domestic green energy technology be useful for the benefit of international community and help to curb climate change. Thus, it is worth studying the real attention of China and India. As stated previously, green energy technology development has been neglected by the international community, even though it is one of the most significant solutions that can help mitigate the severity of climate change impact. However, China and India have shed some lights to the globe. Nevertheless, one might argue that this could be one of the tools in which the countries utilize to increase their economic and political powers.

This research therefore seeks to examine how China and India have developed the green energy technology, particularly solar and wind renewable technology at the domestic level, the state's intentions, and the obstacles they face from challenging the established power of the United State, rules and regulations posed by World Trade Organization (WTO), including Intellectual Property Rights (IPRs) issue. It also can be seen that the research differentiates from other existing academic literatures since such topic which conducts through realist theoretical perspective is unlikely to be found.

1.2 Research question

To what extent have China and India been able to develop green energy technology and what are the obstacles that they face, given contemporary global political economic arrangements?

1.3 Summary of theoretical framework

In order to support the research question, the research adopts neorealist as a theoretical framework to study this particular topic as it seems to be the most appropriate theory to answer the given question. Generally, realism separated into two camps which are classical realist and neorealist. These two camps have some similarities but also differences in terms of key concepts, in Classical realists mainly focus on human nature that causing catastrophic due to selfishness. Neorealists, on the other hand, attempt to explain certain events by scientific evidence and international system structure. Kenneth Waltz and John J. Mearsheimer are amongst the well-known scholars in International Relations. The research however selected Mearsheimer's argument to explain green energy technology development in China and India, as he studied and developed further the idea from Waltz regarding the pursuit of power by states. He also associates with offensive realism – power maximization, unlike defensive realism – security maximization, which Waltz argued in his work. Importantly, the concept of 'latent power' is a core argument of the research in which it clearly explained the motivations of China and India in developing green energy technology since it argues that socio-economic power is one of the most crucial goals for states, besides military power. In fact, economic power is the main driving force for

the army. Thus, Mearsheimer's argument seems to be more relevant in analyzing intention of great powers like China and India, whether or not they desire to seek more economic and political power by leading green energy technology development. This theoretical frameworks also allows for the analysis of the response from United States, mostly creating obstacles and blocking emerging powers, as an established hegemon. All in all, the research will discuss the theoretical framework in greater details in Chapter 2.

1.4 Main arguments

The main argument of the research is that China and India have perceived climate change as a threat to their states, therefore, they have been progressively developing green energy technology in response. However, they also have intention to expand their economic and political powers through such development by taking the leadership role in global arena. As mentioned, the green energy technology is the most sustainable and efficient solution to combat climate change and ensure domestic energy security, even though the issue is neglected by international communities. Any country that firstly grasps the opportunity to take up the leader role in world market will receive satisfyingly advantages from economic, and also, political aspects as well as more negotiation power. An existing established power such as the US has countered the emerging powers by using IPRs and WTO process to obstruct such developments from both countries. For instance, the case of trade dispute between US and India over solar cells in which the US filed a complaint with WTO challenging India that it violates core provisions on national treatment and trade-related investment measures, protecting its own domestic market by discriminating imported products, resulting the US to win the case (Miles, U.S. takes India back to WTO in solar power dispute, 2017). The main argument of the research based on Mearshiemer's offensive realist theoretical perspective. In other words, China and India are concerned with their own national interests by admitting that climate change would have a negative impact to the country, they then develop green energy technology to combat with the problem as mentioned, and they have no intention to share their technologies. Furthermore, offensive realism suggests that not only states always seek power in anarchic world, it also attempts to block the other rival states in the case that there is potential state to become hegemon.

This can explain clearly the action which has been taken by the US. Another important example is the current trade war between US and China which the US started to impose the tariff on certain goods including solar panel import in the implementation of “global safeguard tariffs” (Wong & Koty, 2019). Apparently, China, as the world’s leading manufactured solar power (Larry 2018), receives a huge negative impact. In other words, China could face a slow pace of development due to the US’s trade protectionism policy (“Trade wars,” 2019). Thus, China responded to such acts in the same manner.

Even though China and India have been facing some obstacles in the field of green energy technology development in particular, it can be argued that renewable energy such as solar and wind under their leadership have achieved much progress. They have succeeded to become one of the world’s top renewable energy producers due to their high potential of this particular field and as a rising power. It is expected that the domestic projects and initiatives of green energy technology could be further developed despite some challenges from the US and WTO.

1.5 Methodology

This research requires the collection of data from both primary sources and secondary sources, and analyze them through the theoretical framework discussed above as well as in detail in the theoretical chapter. In this particular topic, the primary sources are statistics reported in government websites, while academic books, journal articles, bibliographies, reference books including reports and news used, can be considered as secondary sources. The example of reliable media would be news agencies; CNN, BBC as well as website such as The Economist, The Diplomat etc. In addition, the reports that have produced by international organization are important to look into. For instance, United Nations High Commissioner for Refugees (UNHCR), United Nations Development Programme (UNDP), World Bank, Intergovernmental Panel on Climate Change (IPCC), United Nations Framework Convention on Climate Change (UNFCCC), Greenpeace, Local NGOs etc. Furthermore, the research will adopt the ‘data triangulation’ technique in order to gain the most accurate and reliable information as well as avoidance of biases which comes from a single dimension of

perspective by utilizing different types of sources. Importantly, the comparison of the two case studies, China and India, also helps analyzing the issue more explicit.

1.6 Chapter outline

The research will be separated into five chapters. The first chapter is literature review, it includes the overall situation of climate change and the development of green energy technology in China and India. It also includes some of the challenges and obstacles in which the two countries have been facing which obstructs such development. The reader will understand the importance of green energy technology as one of the most effective ways to combat climate change in which China and India are taking the leader role in global arena. Further, the current cooperation between states in regards to green energy technology by sharing its own technology with the focus on China and India as they have high potential originated from domestic level.

The second chapter will discuss the theoretical framework that the research adopts, which is the neorealist perspective. It should provide reason why neorealism is the most appropriate IR theory and evaluation of how the theory can be used to explain this particular issue by presenting a strong and applicable argument from one of the well-known scholar, John J. Mearsheimer. The chapter also provides the clarification on similarities and differences between classical realist and neorealist, as well as the key concepts of realism school of thought towards climate change issue.

The third and fourth chapter will discuss catch-up efforts of China and India with regards to green energy technology development, the obstacles e.g. WTO and IPR and conflicts with the hegemonic power, the United States. The chapters will provide details and sample cases of trade disputes by focusing on renewable energy projects, particularly that of solar and wind, in which the two countries have been developed. The reader will understand overall comprehensive situation and the attempt of the US to block the two countries from further developing their own renewable energy by using WTO as a tool to solve trade disputes.

The fifth chapter will provide evaluation of the case study of China and India, comparison of the experiences regarding the catching up of green energy technology development particularly solar and wind powers, the motivation of the development e.g. climate change, economic power, energy security etc. It will also

comparatively discuss trade conflicts and IPRs issue amongst China, India and the US. Lastly, this chapter will provide an analysis of the offensive realist theoretical perspective on green energy technology development, and discuss the lessons can be learnt, including future prospect of the trade conflicts and climate change.

The research will also provide a conclusion, which is a summary of the main arguments that realist perspective is the most appropriate to explain green energy development situation. China, India and the US have evidently acted in accordance with neorealist key concepts e.g. balance of power, national interests. The chapter will also include future areas of research and policy recommendations on how Thailand can learn or apply from the case studies with regard to the development of its own green energy technology project, in order to help mitigate climate change impact.



CHAPTER 2

LITERATURE REVIEW

This chapter begins with the review of academic literatures with regards to the overall situation of climate change impact with the focus particularly in Asia. Climate change has long been discussed amongst scholars and it is perceived as one of the non-traditional security threats in International Relations. The level of severity of climate impact does not only depend on geography but also, the capabilities of certain country to tackle the issue; economic situation. Further, the chapter is included one of the most important solutions to combat climate change, which is green energy technology development, which in recent years has been spearheaded by China and India. It shows that the two countries have progressively developed such technologies and successfully became world's leaders in this field. Nevertheless, there are various obstacles in which the two countries have been facing. In sum, the chapter suggests the importance of green energy technology development as a tool to mitigate climate change impact. It points out obstacles and problems in which China and India have been facing due to their intentions to taking the lead in this particular field. It also differentiates the research from other existing literatures in studying such topic through realist perspective which rarely found. A more detailed discussion of China's and India's attempts to catch-up with green energy technological development will be provided in the following chapters.

2.1 Climate change and its effects in Asia

Many literatures have long been discussing and debating over this issue as well as forecasting the level of severity and the effect of climate change. According to a research which studying the impact of climate change towards tropical forests in Asia. It found that climate change has an impact on many plants and animal species. In other words, it poses potential threat to the extinction of such plants and animals (Deb, Phinn, Butt, & McAlpine, 2018). Similarly, as mentioned in previous section, the recent report by the Intergovernmental Panel on Climate Change (IPCC) emphasizes on the impact of climate change towards human beings and ecosystems which is currently happening.

It also provide forecasts that it significantly causes drought and flooding, sea levels are expected to increase more than 10 cm which will be effected millions of people. More importantly, the loss of biodiversity, which it is expected that around 18% of insects, 16% of plants and 8% of vertebrates will lose their geographic range. The report, suggests that these impacts will be worsen in the case that the world fails to maintain its temperature of 1.5 °C (IPCC, 2018, p. 10).

Another research supports the findings of IPCC report in 2013, and suggests that there is obvious evidence that the Earth's climate has effected heavily by human-generated greenhouse gas pollution (GHG). The global average of temperature continues to rise for both land and ocean by 0.85°C between 1880 and 2012, and the global mean surface temperature increased by 0.12°C per decade between 1951 and 2012 (Hopkins, McKellar, Worboys, & Good, 2015). Further, sea level is also rising since the mid-19th century but, it was accelerated recently compared to the past thousands of years. The research emphasizes on the findings from IPCC report that the global surface temperature is projected to be likely higher than 2.0°C in 2100 and could exceed 4°C in the case there is no action plans to be adopted in the near future. It refers to the climate change as one of the greatest threats to species and ecosystem the humanity is currently facing. The main focus of the research is relevant to the impact of climate change towards protected areas which means that the areas where provides a wide range social, environmental and economic benefits to people and communities worldwide, as well as studying on the governance and management of such areas (Hopkins et al., 2015).

An interesting example of the climate change's impact is in Australia, according to Hennessy (2011), he suggested that climate change impacts will increasingly, be experienced first through extreme events rather than gradual changes in mean temperature of rainfall. Consideration of current vulnerability to extreme events helps to establish the context for assessing changes in vulnerability due to future changes in extremes. He continues with a case a study of climate change that has happened in Victorian Bushfires event in early February 2009. The conditions leading into that fire were extreme, with high temperatures, low humidity, high winds, and very dry fuel, as a result, of yards of drought, all of which combined to produce an extreme forest fire danger index (FFDI). Furthermore, one of the most important examples of a

threat of global warming and rising sea levels is the countries located in Pacific Ocean that has been experiencing the impact of climate change such as the nation of Tuvalu, it comprises of nine island atolls totaling an area of 26 square kilometers. However, as one of the world's lowest lying countries Tuvalu and its 11,000 residents are in serious danger. Some Tuvaluans have already relocated to Fiji, New Zealand, and other neighboring islands, as a result, of the impacts of climate change (Cleugh, Smith, Battaglia, & Graham, 2011).

Not only small island countries that are under the threat of climate change, it reports that South Asia affected by the rising sea level. A mean sea level rise of 15-38 cm, is projected along India's coast by the mid-21st century and of 46-59 cm by 2100 (Cleugh et al., 2011). Specifically, the report published by NGOs – Germanwatch also suggests that countries in Southeast Asia are vulnerable to climate change as the regions consists of developing countries (Eckstein, Künzel, & Schäfer, 2017). An interesting example for the case of Thailand, according to (Mark, Climate change and Thailand: Impact and response, 2011), suggests that as evidenced by the recent drought in which negatively affected at least 7.6 million people in 59 of the country's 76 provinces, climate change is an important issue for Thailand in both the medium and long term (Mark, Climate change and Thailand: Impact and response, 2011). Floods, droughts and tropical storms – which cause numerous natural disasters annually – will only multiply in frequency and intensity. Myanmar is another example that was impacted by climate change, the event of Nargis which reportedly, kills millions of people and causing a lot migration, people leave their home and never turns back.

Another important effects of climate change concerning Asia as a region is that of climate induced migration or Environmental refugee. The issue has been complicated since the 1951 Refugee Convention does not cover this group of people as refugee, therefore, no protection, assistance including cooperation are established and it has been neglected by international community. With regards to the recognition of environmental refugee, there has been the debate regarding the appropriate term to be used for them. According to (Jayawardhan, 2017), he used the term environmentally displaced persons (EDPs) in his work regarding the issue of 1951 Refugee Convention in which it does not cover this group of people, hence, they were not protected. He provides complementary on the term since it is preferable by UNHCR. On the other

hand, he mentioned that the term “climate refugee or climate change refugees” frequently used in politics and media. Moreover, according to (Jaswal & Jolly, 2013), the term “environmental refugees” has used interchangeably of climate refugee. Although, Environmental Displace Persons (EDPs) is the most preferable term by UNHCR, but its definition including internal movements as well, hence, it might not be appropriate. This is a prominent issue for Asian countries since the area is expected to be the most vulnerable to climate change impact and, the region comprises of several least developed and developing countries in which the lack of capacity to deal with the issue due to its economic factor as well as political will are the main obstacles. For example, the natural disaster which occurred in Myanmar in 2008, Nargis cyclone, caused the loss of lives and the damage to their homeland. More than 2 million people was effected and 800,000 were displaced from their home (Seekins, 2009) which there is possibility that this group of people became Environmental refugee. Thus, it is important for the region to prevent or at least, mitigate such disaster resulting from climate change in the future.

2.2 The importance of green energy technological development

In order to demonstrate the importance of green energy technology, it is firstly necessary to understand the definition of the terms such as green technology, clean tech as well as green energy technology since these terms somewhat have overlapped meaning while there are also similarities. According to the book called “*The Role of the Patent System in Stimulating Innovation and Technology Transfer for Climate Change*”, suggests that there is no explicit definition of the term “green technology”. It mentioned that “the term can be used interchangeably with the similar meaning, for example, “clean tech” covering four main sectors, i.e., energy, transportation, water and materials. This usually refers to product, service, or process that delivers value using limited or zero non-renewable resources and/or creates significantly less waste than conventional offerings” (Kim, 2011). It is indeed the broad topic in which the research will only study specifically on green energy technology; which is; “the form and utilization of energy that has no or minimal negative environmental, economic and societal impact, is essential to achieve the ultimate goal of sustainability, and may be better achieved through energy diversity with local energy

resources, such as solar, hydro, biomass, wind, geothermal and other renewable resources; Green energy can be utilized to reduce the negative effects of hydrocarbon energy resources and their emissions during electricity generation, especially greenhouse gases” (Midilli, Dincer, & Rosen, 2007). This definition apparently demonstrates the scope of which the research complies with as well as the significance role in which green energy technology plays in mitigation the impact of climate change that caused mainly by greenhouse gases. Thus, states such as China and India, have been developing and advancing such technology in order to make use of green energy at a maximum level.

Arguably, climate change impact can be tackled in various means both by individual level and at a state level for example, adopting certain policy to limit the use of cars which causing emission as well as banning single use plastic. However, the most sustainable method is to change or replace the conventional sources and processes of energy consumption and extraction as the world’s population has been growing which, unavoidably, results in environmental degradation by anthropogenic impact – human activities impact on environment. Moreover, the current energy sources e.g. fossil fuels is also the major cause of climate change and it does not seem to be permanent. Thus, renewable energy is a hopeful alternative for the future world. With reference to an international journal of green energy in which it supports that green energy technology is indeed more durable, flexible and the cost of operation is relatively lower than traditional fossil fuels operation. Green energy is also provide sufficient energy requirements in both regional and local application (Midilli et al., 2007). Further, the report from Intergovernmental Panel on Climate Change (IPCC); “*Renewable energy sources and climate change mitigation*”, suggests that the consumption of fossil fuels by human activities causing most of the greenhouse gas (GHG) emission and there are many options to lower the rate of GHG emissions while the global demand of energy will not be affected. The report advises that renewable energy (RE) or green energy is potentially one of the options in which it can mitigate projected impact by climate change and provide wider benefits; “RE may, if implemented properly, contribute to social and economic development, energy access, a secure energy supply, and reducing negative impacts on the environment and health” (Intergovernmental Panel on Climate Change, 2011). These evidences confirm the need of green energy therefore the

development of technology is essential in order to serve as a tool to utilize green energy and eventually providing the most sustainable way in mitigation of climate change impact.

Nevertheless, it is important to note that the concept of green energy technology has been around with humanity even before the industrial revolution. As mentioned, the issue regarding the excessive usage of fossil fuels in which it could have a negative impact to the earth has been receiving much more attention from scholars since it seems that the world has now witnessed such dramatic changes in the past decades. Each countries have different approaches to deal with this issue, the development of green energy technology is considerably to be one of the most sustainable way, as stated. Unfortunately, a huge amount of investment and knowhow are desperately required for developing countries particularly Asia region in which it is one of the most vulnerable areas that is projected to face with the climate change impact. Some obstacles which prevents the region from developing green energy technology also have persisted, as one interesting research studied on domestic initiatives in regards to green energy technology innovation adoption in the transportation industry in Malaysia, which is written by (Zailani, Iranmanesh, Nikbin, & Jumadi, 2014), shows that Asian countries have substantially attempted to develop their own implementation plan when it comes to green energy technology. Nonetheless, there are certain obstacles such as Intellectual Property law, taxes, domestic policy etc., the country is discouraged to collaborate internationally instead, individually working on its own plans to avoid all the complications. This can be seen that green energy development has been neglected by developing countries due to certain obstacles, funding and perhaps, the lack of political will.

The following sections provide a global overview of green energy technological development, which includes discussions about existing international schemes of green energy technology transfer, and also a brief overview of China and India's attempt to develop green energy technologies.

2.3 Global overview of green energy technological development

Although, the development of green energy technology does not seem to receive much willingness from the governments in Asia. However, significance

projects have been pushed by the two Asian countries, China and India, over the past decades. Surprisingly, a research shows that China has been leading global investment in clean technology since 2010, followed by Germany and the US, India also shows strong growth of investment later in 2011. Chinese and Indian companies also have made the top 10 ranking of wind turbine producers in 2010 such as United Power, Dongfang, Goldwind, Suzlon etc. (Never, 2013). Furthermore, the report from the International Energy Agency's (IEA) Renewables 2017 suggests that the three countries which are China, the United States and India will be the main the actors in leading green energy technology industry as the large amount of investment has been in progress (International Energy Agency, 2017). This trend has apparently continuously remained and improved for the developing countries like China and India, therefore, it is predictably that the US as a world's hegemonic power had to respond in order to slow down such progressive development by imposing the tariff for Chinese solar cells on a low level. Nevertheless, the US was not the first country to do so since European Commission initiated anti-dumping measure against Chinese producers (Never, 2013). This evidently raising the debates on state's intention as it is very likely that both countries have been catching up and taking the lead in this particular field, not only for the objective of tackling climate change and energy security issue but also, they tend to receive certain benefits specifically in regards to economic aspect etc. and essentially gaining more power. The following chapters explore this issue in greater depth.

2.3.1 Existing schemes of green energy technology transfer

It is necessary to note that there have been major international cooperation among states regarding green energy technology development through international institutions which are Climate Technology Centre and Network (CTCN) and Mission Innovation (MI). The former is operating under international organization such as UNFCCC, UNIDO and UNEP. The latter was initiated by member states in response to Paris agreement core pillars. With reference to Climate Technology Centre and Network (CTCN), it established to provide guidance, assistance and, to promote the transfer of environmentally sound technology at the request of developing countries. It also provides technology solutions, capacity building and policy advice for necessary

procedures to accomplish the whole process of transfer. According to *Progress Report* (CTCN, 2018); it has been successfully promoting sustainable solar photovoltaic technologies in Tanzania, providing technical assistance in which it aligned with national commitments and the long-term goals of Paris Agreement. Furthermore, UNFCCC has designed National Designated Entity (NDE) to serve as national entities for the development and transfer of technologies, including the role of focal points for interacting with CTCN (UNFCCC 2011). It also assigned to ensure that the requests which were submitted through reflects its own circumstances and priorities as well as supporting the articulation and prioritization of requests and proposals it helps support. Currently, there are 160 countries represented. In sum, CTCN is the main institution to help consolidate and act as a center to facilitate countries in regards to technology transfer. Each countries might have its own limitations and challenges, by collaborating with other countries can help lessen all the constraints. However, it eventually depends upon political will to implement certain policy and working towards the common goal (Nussbaumer, et al., 2015).

In regards to Mission Innovation (MI), it is relatively new initiative since it was established by the group of 23 countries and European Union which was launched at the Paris agreement conference in 2015. The objective is to strengthen and accelerate global clean energy innovation to make clean energy widely affordable. According to the report *MI 2020 Solutions: 3rd MI Ministerial 2018*, it highlights some of successful stories in which countries have developed their own initiatives regarding green energy technology for example, the innovative HYBRIT project from Sweden which aims to reduce carbon dioxide emissions from iron-making to zero by using hydrogen produced from clean electricity to eliminate the need to use fossil fuels for iron ore reduction; and; Surya Jyoti Micro Solar Dome (MSD) from India, it was designed to tackle the problem of access to lighting for remote and underdeveloped communities. It also expected to lead an emission reduction of 12.5 million tons of CO₂. In addition, it appears that there is a desire to introduce innovative technologies and solutions from Sweden to India, The Sweden-India Innovations Accelerator (ISIA) was then initiated in 2013 by the Swedish Energy Agency (Lindström, 2018). The programme has developed as one of the most important tools for collaboration between small, medium and large sized companies, in the fields of technology for new, renewable, efficient

energy. These global initiatives, CTCN and MI, have succeeded and played important roles in international community regarding providing guidance, facilitate, assistance to the countries in need to develop their own green energy technology.

Furthermore, it is important to emphasize that the transfer of green energy technology is indeed helpful not only for the China and India as a tool to gain benefit economically, it also plays a significant mechanism in an indirectly way to mitigate GHG emission; “The primary benefit of replacing a fossil-fuel-based infrastructure in developing countries is a reduction in CO₂ emissions, contributing to the global public good of a stable climate” (Schüller, 2012). As stated, green energy technology has potential to reduce GHG emission therefore the more countries, including Least Developed Countries (LDCs), implement it, the better chances that climate change will be slowing down. However, due to some obstacles which have prevented the countries from proceeding with the transfer of green energy technology conveniently such as Intellectual Property (IPRs) and trade disputes blocking by the US as mentioned previously. The other obstacles is the concept of national interest since the developed countries are unlikely transferring much of such technology due to the loss in their economic interests. In addition, most of the time the technology was created in industrialized countries hence, it is difficult for developing countries to utilize such tools appropriately at local level. The insufficient international mechanism which helps consolidate common data in an inclusive and accessible way in regards to the development of green technology and environmental R&D can be seen as one of the challenges as well (Schüller, 2012). Thus, China and India need strategies to catch up on their own and countries also does not have political will to push forward any relative projects which seems to be in favor of the transfer of green technology.

2.3.2 China and India’s attempt to develop green energy technologies

China has been very active towards the issue of climate change. It acknowledges that its own country has significantly contributed greenhouse gas pollution (GHG) to the world. It therefore lays out the concrete implementation plans to reduce the utilization of carbon dioxide emissions by establishing laws and regulations. One research suggests that during the period of 2006-2010, it plans to “reduce the consumption, reducing energy consumption per unit of GDP by 20 percent,

reducing the discharge of key pollutants such as sulfur dioxide (SO₂) and Chemical Oxygen Demand (COD) – a measure of the pollutant load of organic material discharged to water – by 10 percent, reducing water use per unit of industrial value-added by 30 percent, and reforestation to increase the forest coverage rate by 1.8 percent annually” (von Hippel, et al., 2015). Further, China is the world’s largest exporter of solar cells and the world’s largest solar water heating market (von Hippel, et al., 2015). Similarly, India has voluntarily taken action to combat climate change with the adoption of National Action Plan on Climate Change (NAPCC). It lays out principles, approaches and institutional arrangement for eight national missions for managing climate change agenda. One of the key features is national solar mission in which it is planned to increase the share of solar energy in the total energy mix and decentralized distribution of energy. It aims to create affordable, convenient solar power systems and storage (Ahmad & Choi, 2000). As a result, several companies from both countries in the top rank of solar and wind energy market by gaining 30% share of global market for wind turbine producers (Never, 2013, p. 227).

Furthermore, an interesting research by Christopher M. Dent (2011) presents the significant findings in regards to the leadership of China and India on renewable energy such as solar and wind power. It states that “China has become a leading global player in this sector, increasing its wind power capacity from just 1.2 GW in 2005 to 25.8 GW by 2009 (Dent, 2011, p. 133). This makes it currently the world’s third largest wind power producer by nation, and it is set to become the largest within a few years. China now has around 50 wind turbine producers, the three largest of which – Gold Wind, Sinovel and Dongfang Electric – are in the world’s top 10 in terms of size (Dent, 2011, p. 133). Four of the world’s top 10 solar power companies are also Chinese: Suntech, JA Solar, Trina Solar and Yingli. India too has made significant progress in developing its wind and solar energy sectors. It more than doubled its wind energy production capacity from 2005 (4.3 GW) to 2009 (10.9 GW) and is now ranked fifth in the world, and is making large-scale investments to increase its solar power capacity” (Dent, 2011, p. 133). Accordingly, due to the success of both countries, it is affirmed the leadership role including their capabilities and, potential technology sharing to other developing countries. In fact, it can be seen that there is the possibility for both countries to pursue the hegemonic power in the region as well as

global by taking advantage of the leading roles in the field of green energy technologies, in the case of China, which drives them to actively taking concrete actions, not to mention that the established hegemonic power, the US, has taken step back as a leader in regards to climate change issue.

Given that China and India have noticeably high potential in green energy technology development at domestic level, there is possibility that the two countries willing to share certain knowledge to other developing countries in order to gain benefits economically and politically. The research of Zhang (Fu & Zhang, 2011) studied the topic of how the two countries have developed and shared its own green energy technology, the solar-PV industry in China and India. It suggested that the collaboration between these two countries are having some progress. To illustrate, solar-PV or photovoltaic technology helps converting sunlight into electricity directly. Both country have developed such technology in different ways however, the result is quite similar. In other words, China has taken a more “home-based” outside-in technology transfer and indigenous innovation model which means that the green energy technology development has occurred domestically by universities or research institutions. India, on the other hand, can be seen as a “go-global” active technology acquisition model. It mainly focuses on joint R&D (research and development) with Multinational Corporation (MNC), conducting overseas R&D laboratory as well as cross border merging and acquisition. Furthermore, India – private-led innovation system, and China – state-led have focused relatively equal regarding the conventional technology transfer such as licensing; it is necessary in terms of transferring patented and codified knowledge in which it costs less than in-house R&D. The research concluded that both countries are playing a leader role in regards to the development of environment-related industries and the transition to green economy.

The other research examines the similar topic of India and China on how have they shared their own green energy technology, the rise of China and India in green energy technology sectors. It argues that the importance of technology sharing of both countries are separated in two period – taking off and catching up – in which there has been different processes – conventional technology transfer mechanisms and, unconventional technology mechanisms – to be utilized appropriately according to each period. The research found that foreign direct investment (FDI) and licensing were

important in the phase of industry formation (conventional). However, R&D partnerships and acquisition of foreign firms are important to catch-up phase (unconventional) (Lema & Lema, 2012). In addition to the previous research which specifically focuses on the rise of China and India in green energy technology sharing, a research by (Hall & Helmers, 2010) emphasized on the role of patent protection regarding green energy technology transfer. It found that the strengthening of Intellectual Property Rights (IPRs) for the group of emerging countries such as Brazil, China, India and Mexico, will likely have positive impact on the domestic development of technology, and its transfer from developed economies more than less-developed countries. In fact, this is the beneficial gain for the green energy technology development in China and India in which the hegemonic power, the US, has been trying to make an effort to create obstacles and obstruct their developments, one of the ways is by using WTO as the stage to solve trade disputes, as the following paragraphs discuss. As stated, an important issue which seems to be one of the barriers with regard to development of green energy technology in particular for both China and India is that of the trade disputes between the United States. Both countries have requested World Trade Organization (WTO) dispute consultations with the US. For china case, it is noticeably that the dispute has brought up due to the fact that the US and China are in amidst of trade war. China directly addresses the issue regarding renewable energy particularly solar cell duties against the US (WTO 2018a). Furthermore, the US, as a complainant raised the issue of India's National Solar mission that it violates National Treatment (NT) – under General Agreement on Tariffs and Trade (GATT) – to WTO in 2013. Its Appellate Body later investigated and found out in 2016 that India indeed attempted to disadvantage foreign products in order to benefitting its own local products to be more competitive. During the same year, India as a complainant challenged the US through WTO's Agreement on Subsidies and Countervailing Measures (SCM Agreement) with the target to the US's Subnational Renewable Energy Measures (Meyer, 2018). The US has also challenged to China over similar issues. This confusion has been created in the recent years as the demand of renewable energy has significantly increased, both developed and developing countries are investing heavily in this sort of technology development. Accordingly, it emphasizes the fact that there is China and India have been facing with important challenges and will still remain in the future as

the current hegemonic power, the US, apparently desires to stay in the power. As the following chapters discuss further, Mearsheimer's realist theoretical perspective is the key to explain this circumstance.

Another important issue that is an obstacle for developing green energy technology is Intellectual Property Rights (IPRs) in which international cooperation adopted the Trade-Related Intellectual Property Rights (TRIPS) agreement as it is the major central issue in WTO. The issue marks as one of the controversies since it provides overall benefits of technology transfer but, arguably, preferential to developed countries rather than the least-developed and developing countries. An economist, Ha-joon Chang (2001) argued that there is little evidence that shows the technology transfer from advanced countries to developing countries have been increased although the strong protection of international PIPR. In addition, he argued that, "TRIPS will reduce the ability of the developing countries to catch up through imitation and adaptation of advanced technologies through 'informal' channels" (Chang, 2001). In this case, an informal channels means modification and developing further patented chemical substance which seen to be more favorable to developing countries. Similarly, the book called "*Fair Trade for all*" suggests that, "By strengthening intellectual property rights in developing countries, it is likely to increase the royalty payments demanded by technology holders there, and also to create or reinforce monopolistic positions in small markets. It also restricts reverse engineering and other important methods of imitative innovation, thereby limiting the ability of firms in developing countries to reduce their technological disadvantage" (Stiglitz & Charlton, 2007). These clearly explain the negativity of implementation of IPRs towards developing countries since they need to bear an expensive costs and certain restrictions for further developed the technology.

Nevertheless, it is also important to note that IPRs is indeed provides benefits to international technology transfer to some extent. According to the United Nations Conference on Trade and Development (UNCTAD) report, which is written by Lall (2003), provides four key benefits of IPRs which are the stimulation of private innovation; the use of the new knowledge in productive activity; the dissemination of new knowledge to other agents; the stimulation of innovation by other enterprises. Moreover, significance benefit of strong IPRs is the facilitation of technology transfer; "IPRs are probably beneficial for countries launching into serious R&D activity in

terms of promoting local innovation and attracting certain kinds of FDI and other technology inflows” (Lall, 2003). As mentioned, these gains are all in merely particular group of countries. It does not seem to be the case for developing world as most of the country has weak IPRs in which it causes dependence of local firms where the lack of creativity and innovation in society are one of the setbacks that draw countries from being able grasp the market opportunity. In order to avoid such problems, developing countries need to ensure its own enforcement regarding IPRs to attract other countries investment. Therefore, the research will explore more on these issues regarding IPRs and trade conflicts with the United States, including other major powers as well, in greater details in Chapter 4 and 5. It will also evaluates these seemingly two competing perspective on whether IPRs is beneficial to developing countries.

2.4 Conclusion

This chapter presents various academic works and official reports by international institutions, which have discussed and demonstrated scientific evidence regarding the projected impact of climate change. It includes general situation of climate change which specifically focuses on Asia region, since it is one of the most vulnerable areas in the world. The chapter then points out that green energy technology is seen to be one of the most sustainable and efficient ways to mitigate greenhouse gas (GHG) which is the main factor that drives climate change. However, it has been neglected by international community since it requires a huge investment and knowledge transfer in which it is difficult for developing countries due their lack of economic capability. In contrast, the world has witnessed some cooperations through international institutions regarding technology transfer. Interestingly, the two Asian countries, China and India, are also very competitive in the development of green energy technology due to their high potentials. However, the motivation of such development might arguably be stemmed by climate change issue as well as national interests (economic benefits and increasing their powers). These countries also face obstacles, specifically trade disputes and Intellectual Property Rights (IPRs), which were initiated by the United States – an established hegemon, perhaps as attempts to block emerging powers from further expanding their economic and political powers.

This also demonstrates the lack of academic literatures in studying this topic through realist theoretical perspective and thus, the research substitutes such gap.

The next chapter seeks to analyze the issues discussed above based on a structural realist perspective by John J. Mearsheimer. It also provides an evaluation on how his argument is relevant to the research topic.



CHAPTER 3

THEORETICAL FRAMEWORK

The research has selected realism as a theoretical framework to analyze and examine the issue of green energy technology development. The world has been witnessing the attempt to achieve the goal of combatting climate change through various means, but there seems to be certain obstacles to prevent states from being successful. As mentioned in previous chapter, green energy technology is one of the most efficient and sustainable ways to mitigate climate change impact, states therefore desire to play the leader role in international arena in order to gain and expand more economic and political powers. Apparently, China and India are seen to be the highest potential countries to develop green energy technology. To help analyze these contemporary issues, this chapter discusses offensive strands of realism and suggests that Mearsheimer's offensive realism is the most appropriate theory to analyze green energy technology development by China and India. The chapter will cover the general information and details of realism school of thought, compare realism with liberalism, as well as provide the evaluation of John J. Mearshiemer's view, particularly the concept of 'latent power', as a theoretical framework for the research towards the development of green energy technology in which China and India have been progressed.

Latent power – socio-economic power, is seen to be the most significant concept which clearly helpful in analyzing such development as it concerns about economic benefits in which both countries aim to receive and, arguably, further translating into political and military powers.

3.1 Realism school of thought

Realism has been one of the most significance theories since the beginning of academic IR after World War II. The key concept of realist focuses on the examination of human nature. Human tends to be selfish in which it reflects as an actions that have been taken by both individual and society. Realist has agreed upon the three main concepts which dictates international relations globally are statism,

survival and self-help. Statism is the belief that the most pre-eminent actor in world politics is the state, no other actors are more significant and therefore tend to disregard them. Survival refers to the primary objective of states which is national interest. In other words, the first priority of state's leader is an attempt to bring most benefits to the state, not necessarily in accordance with public demand but as leader's aspirations, leader can also utilize any means in order to survive in certain situation. Lastly, realist believes that international system is anarchic, which means that there is no global authority or institutions in which states can be relied upon and guaranteed its survival. This sort of structure does not permit friendship and trust, coexistence is achieved through the maintenance of the balance of power and limited cooperation. Thus, states need to rely heavily on themselves, which is called "self-help".

Despite the generic description of realism discussed above, realism can be categorized into two major camps – classical and neorealism – which have their own assumptions (Dunne & Schmidt, 2017, pp. 85-97). While classical realist emphasizes on the examination of human beings – born to pursue power and to enjoy the fruits of powers, which inevitably brings them into conflict with each other; struggle for power – stay in the status quo, being imperialist and demonstrating its power; and, power politics (Morgenthau, 1948, pp. 4-7). Neorealist, on the other hand, aims to explain any conflicts in international system basing on scientific evidence and focusing centrally on the structure of international system rather than bad nature of human. In other word, all states face the same structure but their capacities makes them different (Dunne & Schmidt, 2017, p. 92).

In the twentieth-century, however, the most popular debate falls into neorealist camp. The two major contributions were made by Kenneth Waltz and John J. Mearshiemer. As mentioned, neorealism has shifted the focus from the analysis of human nature by classical realist and, instead, it tends to focus on the anarchic world which stimulates states to seek power. Mearsheimer builds on Waltz's argument concerning the stability of bipolar system as compared with multipolar system, as well as assent to Waltz that anarchy compels states to compete for power. However, in his view, states also seek hegemony to increase their relative powers and achieve. He views the distribution and nature of military power as the main source of war and peace, and believes that great powers are always searching for opportunities to gain more power.

This perspective can be referred to as “offensive realism”. In contrast, he referred to Waltz’s ideas that often times states do not seek power, and that instead they tend to seek more stability and status quo by limiting their powers and maximize security, as “defensive realism” (Dunne & Schmidt, 2017, p. 92). Most importantly, Mearsheimer emphasizes the concept of ‘latent power’ (Mearsheimer, 2001, p. 45) – socio-economic power, in which not only states would like to achieve but also, attend to be mindful of how other rival states control over such power. Since China and India have large population size and rapid economic development over the past decades, the established hegemon like the US therefore perceived these rising powers as a threat.

After evaluating between different ideas in the realist school of thought, this research adopts John J. Mearsheimer’s realist perspective as the most appropriate framework to help analyze the issue of green technology development by China and India under the current global political economic context. The implementation of such project leading by China and India can be seen as a tool to achieve certain goal, gaining more power both economic and political, which found to be the similar idea of power maximization (Dunne & Schmidt, 2017, p. 92). The reasons for adopting this approach will later be described in further details.

3.2 Evaluation of realism and liberalism in analyzing climate change issues

This section provides general view of realist perspective towards climate change issue. It is necessary to understand this basic foundation to further support the evaluation of John J. Mearsheimer’s theoretical perspective with regards to the development of green energy technology. As mentioned in previous section, the two camps of neorealism – offensive and defensive focuses on two different goals for the states. In other words, states either seek power or security maximization which in turn, reflecting the contrasting action in global politics. However, both camps have similar goal which is to maintain national security, once the perceived threat has been occurred, states must respond accordingly. It is important to note that realist merely focuses threats which comes from the states. Climate change is apparently a new concept of a global threat, which has therefore neglected. In other words, “traditional realist accounts usually dismiss climate change as a security threat” (Beeson & Bisley, 2010, p. 55). Nevertheless, it is argued that climate change should be recognized as a different

kind of security threat, and that the idea of the military threat should be replaced, since the issue requires solution at its root cause and not only the surface of the problem (Beeson & Bisley, 2010, p. 55).

It can be argued that the most appropriate theoretical framework in International Relations to help analyze the success and failure of international cooperation might be Liberalism. However, realism can be used to analyze the issue in a different perspective. For instance, it is widely accepted that all states perceive climate change as a new external threat – non-traditional threat – in international community. Tracing back in the history, most of the threats occurred due to the conflicts between states as well as expansionism and so forth, every states need to maximize their own military capabilities in order to respond or counter-balance hegemonic power. In other words, the external threat comes from states. Nonetheless, in the post-Cold War period, the global threats have changed the forms to something in which only a single state alone is incapable to deal with e.g. epidemic, terrorism etc. Climate change thus can be categorized among those threats since it is transboundary which requires cooperative action and can be seen as a different kind of threat (Beeson & Bisley, 2010, p. 55) as mentioned. Thus, it is very likely that the only approach in which there is possibility for states to succeed, when combatting with such issue, is through cooperation.

However, liberalism lacks the capacity to explain the response from China and India, as well as the US, towards climate change threat and the reasons why China and India desire to gain leadership by developing green energy technologies of their own, since there have been conflicts instead of peaceful cooperation amongst them. Although, liberal might argue that the cooperation could be occurred even though states do not trust each other but, they tend to put aside those hates and working together towards certain goal regardless of their own national interests are ignored or, “absolute gain” (Powell, 1991, p. 1303). In this case, the cooperations regarding climate change issue have come to failure and it emphasizes the assumption by realist for “relative gain” (Powell, 1991, p. 1303) – international conflicts and cooperation. The more states concern about relative gain, a state gains and the other will be lost, cooperation is unlikely to occur. Therefore, realist perspective is better explaining why states like China and India are able to receive advantages from developing green energy technology which, also allows them to tackle climate change and energy security. It is

also able to explain why these countries have conflicts with the US during the process of green technology catching up.

In accordance with the above conceivable point which states could fight against climate change as a threat. The world, unfortunately, has witnessed the failure of the cooperation which has been adopted by international community due to the notion of national interests and also lack of vision; for example, the withdrawal of the US in Paris agreement (2015). Arguably, the bill seems to be unsuccessful since the hegemonic power like the United States is absent from the participation as it was reluctant to commit in certain target to reduce GHG emission, even though it is one of the most major GHG contributions in the world. This example can be best explained in another dimension that states always uphold their own national interest. To explain further, by reducing GHG emission, it is likely that state will need to restructure its own economic system since the major factor which drives economic growth in every countries, not necessarily only developed country, is the businesses that are relatively damaging environment e.g. the consumption of energy such as oil and gas, the use of plastic etc. It is in fact, almost every aspects of human lives which shares certain responsibility in contributing GHG emission. Therefore, it is expected that the economy in certain country, in this case the US, would have a huge impact if the government does not have a clear alternative plan. Thus, all states were not seriously taking substantive action since the US which seen as the global leader ignored the agreement (Pickering, McGee, Stephens, & Karlsson-Vinkhuyzen, 2018).

This issue is related to the argument proposed by Mearsheimer (2001) that international institutions are ineffective to control great powers to act accordingly (p. 364). One can argue that the growing number of international institutions e.g. the United Nations, is the tool which decreases security competition, establish cooperation and promote world peace with the hope that it could end the anarchic system. However, there is not much evidence that the UN is indeed achieving such goal. For example, the failure to end the war in Bosnia between 1992 and 1995. Mearsheimer suggests that there are possibilities in which states have selected international institution as a global stage to process certain issue and essentially received advantages from doing so. Nonetheless, it always seems to be the case where the most powerful state is the main actor who creates and shape rules and norms of institutions in order to maintain its

favorable outcome; “Institutions are essentially "arenas for acting out power relationships” (Mearsheimer, 2001, p. 364).

International institutions, therefore, can be seen as an instrumental tool which superpower creates to portray its power and further expanding such power to some extent. In this regards, international cooperation on environmental related issues which led by international institutions such as United Nations Environment Programme (UNEP) and other NGOs seems to have little impact if there is no political will to implement the concrete plans. As mentioned, the insufficiency of green energy technological transfer and the withdrawal of the United States from Kyoto Protocol 1991 and Paris agreement 2015, can be examples of the ineffectiveness and failure of institutions due to the absence of hegemonic power.

In sum, realism is a more appropriate theoretical framework in analyzing current climate change circumstances than liberalism, since the problem still persists and it seems to be worsen. Although there are cooperation on the issue but the lack of political will to implement the substantial action plan resulting the cooperation faces with failure through times. With this regard, realist concept is better explained such issue and thus liberal point of view is disregarded.

3.3 Evaluation of John J. Mearsheimer’ offensive realism approach and green technology development

It is important to note that the research uses primarily John J. Mearsheimer’s book called “*The Tragedy of Great Power politics*”, which contains the relevant ideas in explaining the current global politics since early twentieth-century. His concept of ‘latent power’ and the association with offensive realism which the research finds it helpful and convenient to examine the topic of green energy technology in China and India, including the response by established hegemon – the United States. His analysis and concepts which was proposed are very useful to explain variety of events in the past, perhaps, also in the future. The research employs key concepts which clearly explains the goals in which state is pursuing, and applicable to current situation of green energy development as follows.

Mearsheimer demonstrates the importance of the main concept of realism, anarchy and the struggle for power, which has shifted the focus from human nature as

classical realists mentioned. He argues that the structure of the international system is the major factor which affects state to act aggressively and always seek to gain power. Citing Mearsheimer, “my argument is that the structure of the international system, not the particular characteristics of individual great powers, causes them to think and act offensively and to seek hegemony” (Mearsheimer, 2001, p. 53). Furthermore, due to such international system in which there is no global authority – anarchic world – pushes all great powers to act aggressively in order to survive in the world – “In anarchy, however, the desire to survive encourages states to behave aggressively” (Mearsheimer, 2001, p. 54). This portrays the key concept of which why states act the way they do, seeking power and hegemony. He also suggests that great powers aim to achieve regional hegemon but not global as it is far more difficult mainly due to geopolitical factor. Evidently, China and India have adopted national policy framework to substantially invest in green energy technology over the past decades, this can be seen as an assertive move for both countries by catching up in this particular field and taking leader role in global stage in order to, arguably, achieve the regional hegemon. In other words, being the leadership provides them with a huge economic gain and essentially, more negotiation power at the international level follows, which can be seen as political advantages. Thus, this can be seen that both countries will satisfyingly receive economic and political powers from the development of green energy technology. Further details will be discussed in the following sections.

According to offensive realist perspective, great powers also try to block the emergence of other rival states in other areas of the world. They cannot allow such emerging states come into play since there is a risk that it could harm themselves, hegemon thus prefers to have two or more local powers in the key region in a hope that they would be occupied by solving the conflicts, which is likely to occur between them. This brings in the concept of ‘balance of power’ in which state tends play the aggressive role to oppose another state once it has been threatened. Further, Mearsheimer suggests “buck-passing” strategy – creating conflicts amongst regional great powers (Mearsheimer, 2001, p. 139). This can be seen in the recent case of the US construction of six nuclear power plants in India (Wroughton & Brunnstrom, 2019), the US attempts to create regional tension amongst India and China as this project shows the reliance of India towards the US and not China.

The US also adopts ‘economic strategy’ in terms of trade disputes which, explains clearly regarding its action towards China and India for example, accusing of China’s trade protectionism when it comes to solar photovoltaic industry as well as the violations of national treatment and trade related investment measure by India. Apparently, the US as the established hegemon does not remain calm once it perceives the imminent threats even though the rival states are located in the other parts of the world. Nevertheless, another possibility is that China and India will fight against each other. As Mearsheimer mentioned, the hegemon prefers to have a few great powers exist in the region, in the case that the power is not equally distributed, and that they will eventually be occupied by their conflicts (Mearsheimer, 2001, p. 141).

The other goals in which Mearsheimer suggests are the great powers always aim to dominate the balance of land power since it is the basic foundation form of domination of states as well as air and naval forces. Further, great powers seek nuclear superiority over their rivals (Mearsheimer, 2001, p. 145). Nuclear weapon is the most destructive tool in contemporary world hence, it provides the sense of security which promises state that no other enemies can harm it as seen from the history. In this case, the United States, and emerging powers like China and India are the nuclear weapon owned countries but, there is very unlikely chance in which either one of them will use such weapon to fight against one another although the war could emerge in the future, as its unprecedented catastrophic impact, not only to rival states but the whole world, is certainly expected. While the likelihood of conflicts involving nuclear weapons are slim, the more effective strategy for China and India is to increase economic power by developing and advancing their own economies in global arena, in which green energy technology development comes into play.

3.3.1 Latent power and green technology development

States are also determined to seek to maximize their wealth – ‘latent power’. As widely known, the economy is the most important element which drives state’s capabilities in almost every aspects particular military dimension. Economic growth is somehow what all states have been trying to achieve but, one of the factors that contribute such development is the number of population. In other words, the larger population the state has, the better chance the state is getting richer. Accordingly, China

and India are amongst those countries which their economies are noticeably growing in a significant rate over the past decades. Thus, they are considered as the threat to the US; “the mere fact that Germany had a large population and a dynamic economy was reason enough to scare Europe's other great powers,” Mearsheimer suggests, that “similar fears exist today regarding China, which has a huge population and an economy that is undergoing rapid modernization” (Mearsheimer, 2001, p. 144). It is necessary to note that Mearsheimer did not take India into account due to the rate of economic development still far different from China in the early twentieth-century, however, India is one of the largest population and therefore its economic development has been accelerated. Specifically, in terms of green energy development, as mentioned, it is one of the leading countries alongside with China which it has perceived as the threat, too.

Accordingly, the term “power” does not only refer to the aspect of military forces. It also includes the socio-economic aspect or, ‘latent power’, since it is seen to be the basic driving force for the establishment of defense as mentioned previously. As suggested by Mearsheimer, “Great powers need money, technology, and personnel to build military forces and to fight wars, and a state's latent power refers to the raw potential it can draw on when competing with rival states” (Mearsheimer, 2001, p. 55). The notion that the large population is one of the significant factors which drives state to accomplish its wealth was once evidently, a threat to the United States, that is, Soviet Union during Cold war period. It successfully developed various scientific projects such as the Sputnik satellite which was launched in 1957. The similar concern applies to China, and it is irrelevant to military capabilities as it is still weak, but as a large population country, it has more than 1.2 billion people and rapidly modernizing economy (Mearsheimer, 2001, p. 383). Apparently, its economy has been growing unprecedentedly. Likewise, India has very similar number of population with China as well as its economic growth rate and it also has an ambitious goal in expanding satellite projects which has recently been launched to the moon (“Chandrayaan-2,” 2019). Thus, these two countries unarguably possess potential latent power in hands. Latent power is seen as the most important concept to the research since it has explicitly explained the goal to achieve economic power of China and India and later, they are able to

translate into military and political powers. This issue will be elaborated further in the following paragraphs.

Mearsheimer argues that it should not assume that the population size is the only ingredient that helps boosting country's economy since both countries were not at all considered as either great power or superpower in the Cold war period. This can be seen that the wealth of great powers require a large population, however, the large population countries do not necessarily mean that it is a great power. Similarly, in economic aspect; "the size of a state's labor force is directly related to its population size, while the productivity of its labor force is directly linked to the state's level of economic development" (Mearsheimer, 2001, p. 63). It is also important to note that his views towards such countries are written since the early twentieth centuries, China nowadays is apparently considered to be one of the great powers. On the other hand, India is potentially achieving such status in international politics. He further defines the indicator of wealth which reflects the latent power of state, that is, "it must capture a state's mobilizable wealth and its level of technological development" (Mearsheimer, 2001, p. 62) and provided the definition of mobilizable which refers to the state-owned economic resources that is ready and well functioned to be utilize mainly for building up forces. This type of asset is much more important than that of the probability of economic gain from other means, as it is current and adaptive. It is also necessary for great power to have industrialized economic system which produces the most modern and sophisticated technologies in order to build a strong force.

The argument of Mearsheimer emphasizes that state only creates wealth in order to support its ultimate goal, military capabilities, is applicable in the current events of global politics. The development of green energy technology can be seen as an important example in the age of catastrophe climate change since China and India can gain economic power from it and translating into military or political power. However, it is uncertain that the two countries, China and India, aiming to develop such advanced technology, let alone the significant portion in which it is already under their ownership, is intended to expand further to military aspects. They surely receive enormous power as a result of economic growth by developing and being the leading global player in the field of green energy technology and thus it makes them succeed the status of powerful state. Accordingly, Mearshiemer provided an example of the steel

and jet aircraft in mid-nineteenth and twentieth centuries in which it was the period that it had dramatically influenced how great powers equipped by useful and devastating tools which, in turn, it had been weaponized; “The development of steel in the mid-nineteenth century and jet aircraft in the mid-twentieth century, for example, profoundly changed the arsenals of the great powers” (Mearsheimer, 2001, p. 62).

Given today’s climate change crisis, energy security has widely discussed and global community have been trying to find alternative resources to replace the traditional way of energy consumption since it has negative impact to environment. This could be a new era of international politics in which the state that is successfully adopting full capacity of alternative resources or renewable energy, although the technologies cannot be used for military purposes but, a state will be able to translate its economic power into military capacities e.g. developing advanced weapons. Interestingly, the US has shown its interest in developing wearable solar panel in the area of battlefield since 2013 (“Wearable, solar soldier power,” 2013), and the project has been continuously improved until recent year. The US has taken action by utilizing renewable energy in the US military bases in order to supply the huge amount of energy demand during military operations which risks being attacked in the battlefield (Gardner, 2017). This, although, demonstrates that the US attempts to take any possible opportunities particularly military innovation in order to remain its position as the hegemonic power. However, it has yet utilized the full potential of renewable energy. With this regards, it would be remarkable to observe the competition for the next hegemony due to the fact that not a single country has substantially achieved such goal. In this case, it is possible that China and India will grasp this opportunity by gaining even more ‘latent power’ as they have developed diversified and cheaper resources of sustainable energy as well as reducing their reliance on fossil fuels.

3.4 Conclusion

In the last chapter of his book, Mearsheimer (2001) emphasizes the relevant of realism towards contemporary world in which globalization seems to change the way states act (p. 360). Nonetheless, he argues that state still does not trust each other and seek to gain power at each other’s expense, state still cares deeply regarding balance of power, the international system did not change after the Cold War which means that

there is still no night watchman above all states. In other words, anarchy still exist although international institutions have emerged but fails to coerce great powers since there is not enough leverage power. It is also very unlikely that state will find the way to know each other's intention, which causes uncertainty. One might argue that war is unlikely to happen as state's main goal is to create prosperity as well as the possession of nuclear weapon by the great powers which causes fear of the world's catastrophe among them. However, he argues that it is in fact war among nuclear armed great powers is still possible as the both sides have offensive military capabilities. One of the most significant argument he proposed is that China is the threat to the United States in the contemporary world: "I argue that a rising China is the most dangerous potential threat to the United States in the early twenty-first century" (Mearsheimer, 2001, p. 362). As the following chapters will explore further, the US has been engaging in trade disputes with China as well as India, and these issues also relate to the latter countries' attempt to develop green energy technologies.

Accordingly, this chapter provided the clarification of two camps under realism – classical realist and neorealist. The two camps share major similarities, however, neorealist develop further the idea into more adaptive in contemporary world e.g. the focus on more scientific explanation and on structure of the international system. Mearsheimer and Waltz are amongst the famous and well-known realist which associates with defensive and offensive realist. The research evaluates Mearsheimer's argument and his relevant ideas towards green energy technology development in China and India since it is best explained the state's intention, in this case including the United States as an established hegemon. The view of realism and liberalism towards climate change have also discussed in order to address the incapability of liberalism to explain such efforts by China and India to develop green energy technology, the conflicts between the United States as well as the ineffectiveness of international institutions as Mearsheimer suggested that the international institutions are seen to be one the tools created by superpower in which there is no coercive power to control great powers to act according to its desire.

Furthermore, Mearsheimer's suggest that the key concept of balance of power, regional hegemony as well as providing the explanation that state always seek power and maximize their wealth or, 'latent power', are the most crucial concepts for

the research. He mentioned that the goal for state to gain more wealth is due to the fact that it is able to maintain and fuel up its own defense since military power as it is the ultimate goal of the state. He further defines that there are two kinds of powers which are military power and latent power, the socio-economic aspects or the country's wealth. In this case, the development of green energy technology helps boosting China and India economic powers by increasing their own capacity and being the leadership of this particular field in order to export such products to other countries. Although, the goal of state which is emphasized by Mearsheimer is to maximize power through military means. This, in turn, raises the question for China and India whether or not they will stretch their own latent power into military dimension. Certainly, one thing can be seen from this is that the both countries are being the great powers by benefitting from this particular development. The argument on hegemonic power is also heavily applicable since the United States has been acting in a way that it tends to block the emergence of other great powers, in this case by utilizing World Trade Organization to make trade disputes between China and India.

In sum, the argument of Mearsheimer is appropriate and applicable to explain current situation of green energy technology development which includes three major powers, the United States, China and India. The next chapter will discuss further in details on how China lays out its plan to develop such project, as well as the catching up process.

CHAPTER 4

GREEN ENERGY TECHNOLOGICAL CATCH-UP EFFORT IN CHINA

As the previous chapter explained the appropriateness of realist theory to examine the development of green energy technology in both China and India, this chapter further clarifies specifically situation in China. The chapter consists of three sections; energy consumption in China, wind turbine and solar PV manufacturing industry catching up, and; obstacles and challenges towards green energy technology development.

The first section will discuss historic and present situation of domestic energy consumption which has been changing over the years, with the focus on solar and wind powers. Further, it provides the reason why China has tried to shift the dependence of fossil fuel to alternative resources and, eventually, adopted national policy in order to mitigate greenhouse gas (GHG). The second section presents necessary following action plans as well as an attempt to catch up with other competitive western countries regarding this particular field. The last section examines some of the major challenges and obstacles in which China has to deal with, particularly a rising from rival states such as the United States and, to lesser extent, the European countries. The issues are separated into trade disputes including trade war and, Intellectual Property Rights (IPRs) which can be seen as the attempt to block an emerging power by established hegemon like the United States. The responses and actions taken by China in order to negotiate trade deal with the US is also included in this section.

In summary, the chapter provides evidence which support the argument that China's intention to develop green energy technology is to seek economic power which will further translating into military and political power. The argument is based on Mearsheimer's concept of 'latent power'. As a result, the US as a major power, needs to prevent such ambitious acts by creating obstacles, such as trade disputes.

4.1 Energy consumption in China between 1949 and 2014, and concerns about climate change

The change of energy management structure in China took around 40 years since the establishment of People's Republic of China (PRC) in 1949. It then became one of the greatest countries regarding energy production and consumption in the world. In addition to the increase in both demand and supply, China also intended to focus on environmental conservation and received satisfying outcome since it adopted all necessary tools such as administration, legislation, technical and economic measures to promote the cause (Qian, 1994). Furthermore, it is important to note that the policy in which China had been adopted was self-reliance, relying on its own capabilities as much as possible and essentially, it has replaced by "open door policy" in 1970s which resulting the foreign investments for total of 3 billion US dollars but, it found to be failure as the absence of rules and regulations, legal framework which protects of foreign investment (Suetsugu & Kambara, 1998). This can be seen that the China has started to shift its focus from traditional way of consuming energy to an unconventional method in recent decade whereas its success is unarguably accomplished. Another important aspect in which has been changed since the adoption of "open door policy" in 1970, although it received criticism that China still stuck in the protectionism, is the technology advancement, "an integrated system of exploration, exploitation, transportation, transformation, storage and utilization of energy was formed with the advance in theories and technologies of geology exploration, manufacture of mine, well and generation equipment and construction, operation and management of large mines, oil field, and power station and power system" (Qian, 1994, p. 66). These are noticeably important development for China in regards to science and technology fields, the capacity to construct a huge underground mines, oil field, refineries as well as thermal and hydropower stations.

Although, China's economy has been growing very rapidly but, the environmental problem has been worsened due to the excessive utilization of fossil fuels e.g. coal burning, oil and natural gas. This resulting the severe air pollution which has affected the citizen, "the air quality of about 70% cities in China is below the standard level, and the smog and haze in North China are increasingly severe and

frequent” (Peng & Sun, 2015). Furthermore, since the pollution and Greenhouse Gas (GHG) are the major factors that contribute to climate change, the Chinese government has realized that this could harm its national interest, it thus laid out the substantial plan, “the government therefore has realized that the country faces a difficult challenge of curbing emissions while not sacrificing economic growth. If it does not successfully set the right goals and implement the right policies, China will face numerous climate-related risks” (Mark, 2010). As a result, China has taken significant step to issue Renewable Energy Law in 2005 (Zhang L. , 2017) in order to sustainably develop its green energy along with economic expansion, which seen to be the support by the government that it had indeed concerned about environmental impacts from the dependence of fossil fuel, as well as the attempt to maintain its own national interest. Moreover, there is progress in the development of technology in order to protect environment and clean coal combustion by establishing a number of research institutions including colleges, universities, national defense systems as well as local energy research organization. These institutions have been modernized and advanced in order for the preparation their own personnel to be competitive in the global arena (Qian, 1994).

The information demonstrates that China paid particular attention to environmental degradation which causing by conventional energy consumption since early period. However, as the rapid urbanization occurs in recent years, China inevitably receives its negative impact and it was interestingly alarmed by a Chinese investigative report named Chai Jing, which she created the documentary film in 2015 called “Under the Dome” where it portrays the severity of air pollution in China. This can be seen that Chinese has exceeded the level of energy consumption such as coal burning in heavy industry, pollution from dirty road vehicles etc. (Mathews & Hao, 2015), therefore, the smog appeared constantly in China. Fortunately, China does not ignore the problem and has been trying to find the solution which is the replacement and reduce the dependence of conventional energy resource such as fossil fuels since it is unfavorable due to its disadvantage. Thus, renewable energy or green energy seems to be efficient alternative resources. Nevertheless, it is notable that the total consumption of coal was decreased even before “Under the Dome” phenomena, the wind power generation has remarkably increased in the over the years (Mathews &

Hao, 2015). In this regards, China depicts itself as a responsible global actor since the research shows that the emission rate contributed by China alone compared the all countries in the world is seemingly equivalent, “China now burns more coal than the rest of the world combined” (Mathews & Hao, 2015, p. 6). Accordingly, the following section will discuss on current renewable resources in which China has relied upon.

4.1.1 Hydropower

China is well known for the success of constructing the enormous dam projects since it is cost-effective method. Apparently, it is the most traditional renewable energy resource and also contributing the majority of power system in China. To illustrate, the famous and symbolic dam which is called “The Three Gorges Dam”, operating at close to its huge 22.5 GW capacity (Mathews & Hao, 2015, p. 50) in which the total power contribution to generate electricity is the double size of hydroelectric in Canada. Nevertheless, due to certain limitations and challenges with regard to the construction of the dam such as the period of development is a time consuming, environmental damage e.g. deforestation, displacement etc., it is expected that this type of renewable energy will eventually decline in 2020 (Jiang, 2017).

4.1.2 Bioenergy

Biomass has just been an early stage of China’s development since it cannot utilize its potential energy usage as much as expected due to the majority of biomass production is transformed to be foods such as rice, wheat, millet and corn etc. Therefore, Chinese government adopts a “non-food crops” policy to ban the utilization of crops such as corns as a raw material to supply or fuel a machine or industrial process for biofuel in order to refrain from the confusion over food and fuel production. However, China had increasingly installed around 10 GW of electric generation capacity based on biomass and biowaste but it has receive public resistance as the concerns on emissions from facilities (Mathews & Hao, 2015, pp. 53-54).

4.1.3 Wind power

This type of renewable energy, wind power, as well as solar power which will be discussed in the next section, are the main focus of the research since it is acknowledged that China has been taking the leader role in global arena for over a

decade now. According to (Mathews & Hao, 2015), it is notable that China has been attempted to increase wind power capacity by two times in every 18 months resulting the cumulative capacity for 115 GW in 2014 and, accounts for 26 percent of global cumulative wind power due to its largest industry which essentially, become the world leader of this field. The country also seems to be optimistic that it could reach the target of 200 GW by 2020. However, the capacity does not necessarily mean that all can be generated to electric power, the under-utilization of such capacity has pointed out and the government indeed pay much attention to the issue.

Furthermore, the wind farms in China is seen to have economic advantage as its capacity shows the ability to generate 6960 TWh, or 855 million tce, of electricity in which it is the amount that is more than twice of the total electric consumption in China in 2007 and is in excess of current electric energy production in 2014, which means that the improvement is still required. With this regard, its capacity, in theory, could also displace electricity generated from raw coal in China (Mathews & Hao, 2015, p. 55).

4.1.4 Solar power

Solar power is also another significant energy since its availability is unlimited, similar to wind power. It can be seen that China is the world's largest exporter of solar cells and the world's largest solar water heating market (von Hippel, et al., 2015, p. 151). The Chinese government had concentrated in this particular energy resources domestically, including wind power, since it acknowledge the need of these renewable powers in the future and its cost reduction is very competitive comparing to thermal coal power.

The solar power is predominated by large state-owned enterprises (SOEs) which is similar to wind power, "the top three solar power generation companies in 2013 were large SOEs including China Power Investment Co., China Energy Conservation Group and Guodian, all of which are central government controlled SOEs" (Mathews & Hao, 2015, p. 57) This is apparent that the government has taken serious action in regards to development of these green energies.

4.2 A detailed analysis of wind turbine and solar PV manufacturing industry catching up

The previous section has discussed already regarding green energy resources in China which, as mentioned, China focuses heavily on the wind and solar powers since they are cost-efficient compared to other resources and, the country has enormous capacities in utilizing such powers by further developing technology, which it made China become the top global for both wind turbine (Mathews & Hao, 2015, p. 55) and solar PV (von Hippel, et al., 2015, p. 151) manufacturing. Apparently, China can also be seen as the ambitious actor to scale up and diffuse its own technology other least-developed and developing countries regarding green energy development. According to Mathews and Hao (2015), they suggest that such development in which China has been pursued does not have any relations to climate change but, to secure its energy power and reduce as much as possible the dependence of foreign countries when it comes to the import of energy. On the other hand, a research on ecological construction in China argued that the country has a goal to develop the country with a more sustainable way, it then adopted a national strategy in order to improve the quality rather than quantity of the development in which the environmental protection is an important aspect of this plan (Liu, Liu, & Yang, 2016). This arguably that China's motivations might be mixed between the maintenance of its own national interest and the willingness to create ecological society in order to maintain social order and political popularity.

However, China has made significant step to promote manufacturing of renewable energy system, not only the promotion of renewable energy markets. It is notable that the wind turbine industry has been growing by the domestic market influential and later affected by government policies. Tracing back in the history in around the mid-1990s, wind farms were still small which funded and equipped by Western countries such as Denmark, Germany and Spain. The indigenous who are wind turbine manufacturers later catching up with foreign companies and essentially, resulting the exponential growth of the market in the late 2000s. Although, there was a period in which market was oversupplied due to the underutilization of some installed capacity, the market also faced with the highly competitive situation due to the

maintenance of product quality resulting some player exited the market. However, the situation has been improved. Furthermore, the development encouraged local competitors becoming the leaders mainly due to the competitive cost for new comers and “local content” policy (Mathews & Hao, 2015, p. 60) which restricts the turbine content in concession that was made locally. As a result, foreign companies have largely failed the market since they cannot compete with local manufacturers due to the higher production costs (Mathews & Hao, 2015, pp. 60-63). Not only domestic market, Chinese manufacturers also export the product to other countries such as the United States, Cuba, Chile and Belarus which can be seen that its capacity is competitive to international market (Sun & Huang, 2014).

With reference to the development of solar PV manufacturing industry, it takes the different path with wind turbine since it has begun with the international trade that resulting its expansion of such technology, “China is a game-changer in solar PV manufacture, as its revenue share in the world market surged from an insignificant portion before 2005 to more than 50% in 2011 and 2012” (Chen, 2015). However, this trend is decreased since there is an anti-dumping investigations which have been adopted by foreign governments such as United States, European Union, Canada and other countries against Chinese solar products. Nevertheless, the export rate of Chinese solar PV is still continuing to grow and Japan is the largest importer. Furthermore, it is important to note that top Chinese firms such as Trina Solar and Yingli Green Energy, Jinko Solar etc. have reportedly entered as a latecomer since they have used this as the strategy in which they can dominate the market with the overall value chain, it has consequently decreased the dependence of foreign import of polysilicon production by the advanced market such as Europe, the United States and Japan. As mentioned, the solar PV manufacturing has been facing with antidumping duties and countervailing duties, therefore, there are current trade disputes cases in the WTO as the intermediary stage which shall be explained in later section (Mathews & Hao, 2015, pp.63-65).

Apparently, these two energy resources have a very high potential for China to utilize and gain economic advantage and further political dimension since it can leverage more negotiation power. It is therefore willing to transfer such technologies to other countries in a form of trade relations in order to have economic benefit. According to Lema and Lema, (2012), the development is separated into 2 phases which are

taking-off and catching up phase. In order to successfully transfer or diffuse the technology in each phases, the country needs to adopt different elements appropriately. In other words, conventional mechanism which includes trade (import), FDI/Joint ventures and technology licensing are significant in initial stage, taking-off phase. On the other hand, an unconventional mechanism remains crucial in catching up stage, “in-house R&D, local technology linkages, overseas R&D labs, and mergers and acquisitions have played increasingly important roles, although joint ventures, R&D collaboration and licensing have remained essential” (Zhang, 2011, p. 338). Furthermore, a research also suggests that China has taken “home-based” outside-in technology transfer and indigenous innovation model as stated which resulting the decreasing rate of dependency of foreign firms once it has successfully localized the technology (Zhang, 2011). This in turn drives China to be a potentially important exporter to other least developed and developing countries. Nevertheless, due to its noticeably ambition to sell their technology products, China has to face with IPRs issue, it has been accused of stealing of patents as complaints by the United States (Miles, 2018) and also, the trade disputes between Western countries such the US and Germany etc. which will be discussed in the following section.

China has been very active and essentially becoming the global leader regarding the development of green energy seemingly due to its substantial policy which was adopted in 11th Five-Year Plan in 2006-2010 (von Hippel, et al., 2015, p. 147). It has set out relative framework to reduce overall energy consumption as well as the strong support for renewable manufacturing industry especially wind power, “connection and ‘must-buy’ provisions related to utility additions of renewable capacity to their grids, including a provision for planned Mandatory Renewable Portfolio standards for utilities and the extension of grids to accommodate renewable supply sources” (von Hippel, et al., 2015, p. 148) It also includes other considerably crucial in development of its green energy such as water conservation, fuel efficiency standards for cars and vehicles and transportation etc. The plan seems to be successful as the growth rate of the wind and solar powers capacity have been increased during 2004-2009 and resulting them to be the major player in this particular field. Furthermore, it further continues to pursue the same and beyond direction of developing sustainable energy through the next 12th Five-Year Plan. Its goal is generally environmental

conservative and promoting the solution in which the world should be least affected by economic development, “to transform economic development patterns by building a resource-efficient and environment-friendly society” (von Hippel, et al., 2015, p. 154). It also include the attempt to substantially decreases fossil fuels energy and aims to increase non-fossil fuels by 15 percent in 2020 (Hippel et al. 2015 p.155). All in all, the most important aspect which China emphasizes is the technological development with the goal to overcome any obstacles that is preventing China from moving to green economy in China.

From these attempts that China has been trying to develop its own green energy technology, although the goal is to moving the country to another phase of energy consumption – renewable energy and; to combat climate change. It is inevitably argued that China also receives huge amount of economic gain, and further possibly translating to political power as viewed by Mearsheimer’s realist perspective as discussed in Chapter 2. This can be seen as an assertive move in the view of established hegemon like the United States. Below section will discuss on the action in which the US, as well as other major powers in the western worlds have responded to such development.

4.3 Obstacles and challenges towards green energy technology development

The main obstacles for China to catch-up can be separated into two categories, which are intertwined; Intellectual Property Rights (IPRs) and World Trade Organization (WTO) and; trade disputes. While both issues can be seen as an attempt by the United States and also major power like EU, to obstruct China in relation to realist perspective, it is necessary to understand the details, tools and strategies of which each actions have been taken which will be discussed as follow.

4.3.1 Intellectual property rights and World Trade Organization

China receives many criticisms from international communities particularly the United States regarding the issue of Intellectual Property Rights (IPRs). It should be noted that China is in fact attempts to improve its effectiveness on IPRs due to the government’s goal to create a more innovative Chinese society, “Chinese government's quest to make China an "innovation society" with its own technology and IP” (Paradise,

2013, p. 313) which, in turn, raises concerns and conflicts among foreign firms and businesses since the country seems to be discriminative and give special treatment towards its own domestic firms. Nonetheless, China does not ignore the voices which have been raised over the years, it then responds by creating an environment in which there is a stronger laws and regulations, encouraging the stricter and better enforcement as well as increasing social awareness of IPRs. This action arguably that WTO is one of the major factors which influence China to change its behavior and compliance to WTO's rules, in order to push its own domestic goods and services to be better well known in global arena, since the country joined WTO membership in 2001. For example, the case of which the United States complain against regarding IP issues, WTO ruled that, "part of China's Copyright Law did violate the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) and an inconsistency existed in the area of customs measures as well" (Paradise, 2013, p. 316) but China has adjusted its laws as a response in accordance with WTO recommendations.

The issue of IPRs can be argued that it is one of the most important issues during the trade disputes between China and the United States and therefore it is compulsory to discuss about the current trade war in which two countries have been fought for quite sometimes. It should be noted that China do not want to escalate the issue into physical war, although its response to the US seems to be aggressive to some extent. China in fact tries to use this issue to be one of the negotiations tools, Reuters reported that, "China had deleted its commitments to change laws to resolve core complaints that caused the United States to launch a trade war: theft of U.S. intellectual property and trade secrets; forced technology transfers; competition policy; access to financial services; and currency manipulation" (Lawder, Mason, & Martina, 2019). This can be seen that China pays much attention to the issue of IPRs and also technology transfer since, arguably, they realize that these two topics are essential for the country to expand its economic power, China will not easily giving up the table to negotiate such deal. Interestingly, the strategy in which China has been using is the effort that tries to portray itself as an unaggressive actor by using negotiation table, especially through WTO, in order to show that they respect laws and regulations adopted by the organization.

Moreover, it is necessary to note that one of the dispute cases of IPR issue which relates to green energy development, solar PV equipment, is through technology transfer. The US claimed that Chinese IPR enforcement in China has been problematic and even accuse of Intellectual Property (IP) stealing, “the latest U.S. trade losses due to counterfeiting and piracy in China remain unacceptably high” (Downey, 2012, p. 91), which seen to be an important obstacle for transferring technology to China. In 2009, the US Representative Mark Kirk also emphasized that “the Chinese essentially were seeking ‘the stealing of all intellectual property’ related to energy efficiency and climate change (Downey, 2012, p. 94). While China’s head of the Clean Development Mechanism program at the China Renewable Energy Industries Association explained that the protective IP of industrialized countries are too costly for the developing country like China since it would significantly increase the cost of production (Downey, 2012, p. 91). However, China, including India, has purchased PV technologies from international suppliers at an initial phase of catching up, “Pioneering Chinese firms entered the market by purchasing production equipment from Western providers” (World Intellectual Property Organization, 2017, p. 83). It is also notable that the internationalization rate by patent filings for China seen to be the least compared to other competitive markets such as the US, Japan and South Korea. In other words, Chinese applicants tend not to seek patent protection for PV technologies in other markets, which contrasts with Chinese company market share of around 80-90 percent (WIPO, 2017, p. 89).

Forbes also reported that the US president Donald Trump has announced that China has repeatedly steal American intellectual property after the US increased the tariffs for 25 percent on 50 billion dollars Chinese goods due to, “harm caused by China’s unreasonable technology transfer policies” (Volodzko, 2018). It has also reported that the Chinese wind turbine company called Sinovel was fined due to the bribery allegations, workers at American Superconductor (AMSC) were bribed by Sinovel’s employees since they stole the source code which caused the damage to AMSC lost 1.4 billion dollars in market value and had to cut 70 percent of its workers. China however responded that it is difficult for China to hold accountable since these technology transfers are based on mutual agreement (Volodzko, 2018). This can be seen as an action against the US that China has been negotiated and even fight back. It can

be argued that China's improvement of its IPRs system is in mature stage, however, it is quite contradictory that the problem of stealing IP from other countries are still persisted. One of the possible reasons is that Confucian society has been a strong thought embedded in the country in which copying and intimation are part of the education. The socialist idea has also influenced such thought, "it is impossible to separate the inventor's activity from the society of which the inventor is a part" (Paradise, 2013, p. 323).

4.3.2 Trade disputes and the World Trade Organization

The United States has been using World Trade Organization (WTO) as an intermediary to raise the complaints once the country lost economic advantage. China, on the other hand, does not remain indolent. It instead responds back in the same manner which resulting the current trade war between China and the US as stated. This event has been persisted since Donald Trump became the US President in 2016 and he has negatively criticized China for theft, "we can't continue to allow China to rape our country and that's what they're doing. It's the greatest theft in the history of the world" (Wong & Koty, 2019). Later, the US and China have been participated in various talks regarding the trade deals as well as negotiations setting up by both sides but essentially, the US adopted "global safeguard tariff" imposing a 30 percent tariff on all solar panel imports, except for those from Canada (Wong & Koty, 2019). This heavily raises concern by many economists and experts mentioning that the world could move into global recession if trade conflict is escalated (Franck, 2019). The economy of both sides have reportedly been impacted by each other's tariff which has imposed.

As stated, Western countries in particular the United States are skeptical and have perceived the threat by emergence like China as seen by realist perspective therefore it tries to prevent China from increasing its power through green technology catching-up. To illustrate, any solar cells that were made in China and desire to import in the United States were restricted due to its attempt to curb Chinese activities overseas and thus imposed trade sanctions – countervailing duties and antidumping duties (CV&ADs) since 2011 (Hughes & Meckling, 2017). The European Union (EU), on the other hand, has responded by even broader sanctions since it is not only tended to impose tariff on PV cells but also, for the whole modules and systems in a hope that it

could restraint the sales of Chinese made products (Mathews & Hao, 2015, p. 139). Nevertheless, the strategies imposed by the United States seems to be ineffective since the Chinese firms found the solutions to move their manufacturing base to the United States and internationalizing their production activities and later importing such product into the United States by non-mainland China such as Taiwan. China also responded the US by imposing tariff on PV components and materials, “the Chinese are perfectly able to impose counter-tariffs on US exports of high-value PV components and materials, including pure-grade silicon (where the United States currently runs a trade surplus with China)” (Mathews & Hao, 2015, p. 139).

Furthermore, China initiated the request for consultations through WTO as a response to tariff imposition by the United States, “US tariffs aimed at goods that Washington said were unfairly subsidized by Chinese state-owned enterprises and hurt American jobs and businesses” (Weinland, 2019). WTO has recently made the final decision to accept the argument however stated that it needs to accept Chinese pricing and, “not its own calculations on pricing — when calculating the tariffs” (Weinland, 2019) Later, the office of the US trade representative issued an announcement to complain and condemn the decision made by the WTO’s appellate body mentioning that the US proved that China uses State-Owned Enterprises (SOEs) which resulting subsidization and distortion on its economy and the report issued by WTO appellate body undermines WTO rules in which it makes them inefficient to oppose Chinese SOE subsidies (Weinland, 2019). Such realist power competition that China and the United States have been engaging might in fact, hinders the development of green technology, which is an unfortunate for global climate change adaptation as a whole.

The European market for solar PV system has taken different strategy in order to compete with China by expanding through consumer subsidies, feed-in tariffs which is anticipated that German manufacturing could supply the market. This can be seen as a successful strategy. However, Chinese firms have also received this benefits since there are no policies adopted to regulate other multinational companies and specify that only the German-owned and designed PV technologies are entitled (Mathews & Hao, 2015, p. 139). This antidumping and anti-subsidy measures imposed by EU however lasted for five years, the EU has essentially decided to end trade control over Chinese solar panels in 2018, “the commission said it was in the best interests of

the EU as a whole for the measures to lapse, given the bloc's aim of increasing its supply of renewable energy. The measures had also decreased over time, allowing import prices to align with world market prices" (Blenkinsop, 2018). The relationship between China and EU then seems to be improved. The different path in which EU has taken compared to the US can be viewed as the distinguishable capacity level that they possess. EU is although one of the major leading powers in the renewable energy development in the global stage, but its capabilities are, arguably, still unable to compete with China in terms of pricing. The US, on the other hand, remains in the race with China which creates tensions and trade conflicts to other kinds of goods.

Accordingly, the US also made relatively similar accusation regarding China's subsidy of solar PV manufacturing but this is the case for wind power and, it had requested China for the consultation through WTO. The US trade officials mentioned that, "Chinese manufacturers of wind turbines and related parts and components could have received several hundred million dollars in questionable government grants in 2008 under China's Special Fund for Wind Power Manufacturing" (Palmer, U.S. challenges China wind power aid at WTO, 2010). This issue is very concerned by the United States as the subsidization case in China has an impact to its overall economy since the cost of production is decreased and there is also requirement for Chinese manufacturers to use only Chinese-made parts and components. The US made products suddenly becomes less competitive. The US then made the case where such action violates WTO rules and regulations in 2010. Reuters reported the comment made by the U.S Trade Representative Ron Kirk which clearly explains the importance of such matter, "Import substitution subsidies are particularly harmful and inherently trade distorting, which is why they are expressly prohibited under WTO rules, these subsidies effectively operate as a barrier to U.S. exports to China" (Palmer, U.S. challenges China wind power aid at WTO, 2010). It is also notable that the EU requested to join the consultation one year later after the time in which US initiated the request. Later, in this case, China has agreed with the US to stop subsidy program which prohibited under WTO rules (Palmer & Walet, 2011).

4.3.3 Analysis on the conflict between China, the United States and the European Union through a realist perspective

In an analysis of realist perspective towards the US and EU actions, it is important to understand their motivations which obstructs the development of green energy technology by China. In fact, the above information has evidently explained that China's act is highly ambitious and therefore the great powers needs to block the emergence of other great powers as a rival states in order to maintain their own existing powers (Mearsheimer, 2001), according to realist idea. In relation to that, the case of solar PV manufacturing is one the examples in which it demonstrates clearly of such realist argument. The case was heated due to the clash of the three major powers, the US, the EU and China since the rise of solar PV manufacturing from China has provided negative impacts to those who have established markets which are the EU and the US, "Policy-makers in the EU and the US identified Chinese manufacturers as threats to US and EU solar firms" (Caprotti, 2015, p. 109). The research mentioned such apparent accusation of policymakers from both the US and EU as it appeared that the jobs in this particular sector in the US were significantly lost; "by the end of 2013, there were 69,658 workers employed in solar installation in the USA, compared to 29,851 employed in solar manufacturing" (Caprotti, 2015, p. 110). Consequently, the EU imposed import duties towards China in 2014. Thus, these cases support realist's explanation on the aspirations from both established powers seems to be rational in realist view as mentioned.

The issue of IPRs is another clear example of realist perspective towards the US action since IPRs somehow can be argued that it provides more benefits to those developed country rather than least-developed and developing countries as mentioned in the first chapter (Chang, 2001). This is an interesting point that helps explaining the attempt from the United States to utilize this strategy in order to slow down China's green energy technology growth as viewed by realist. For instance, it is argued that the developed countries have used the two-faced approach which the US had done, "the US putting pressure on other countries for the 'improvement' of their patent laws in the late nineteenth century in the build-up to the adoption of Paris Convention, while flatly refusing to protect foreign copyrights and the routine violation of British trademarks by German producers in the late nineteenth century when the country was putting pressure

on Switzerland to introduce a patent law” (Chang, 2001). It is worth noting that this is the effort in which the US has always been acted the same way since late nineteenth since the US understands that they can gain advantage from IPRs and slowing down other developing countries from further development of certain products. This, in turn, is something inevitable in which China has to face and thus it has adopted policy to improve its own IPRs system domestically. Nevertheless, it does not seem to be functioned very well, since the US still complains about the special treatments by Chinese central government towards their own Chinese firms and inadequately protecting foreign businesses. This can be seen that China has been using the strategies e.g. forced technology transfer or, even outright violation in order to gain latent power as argued by Mearshiemer.

In sum, the obstacles in which China has been facing during the development of green energy technology are mainly coming from trade conflicts and IPRs problem (solar PV and wind turbine manufacturing) between China and the United States as well as the European Union (EU). These perceivable that it is an attempt to block the emerging of great power. However, China is indeed has problems to some extent with a more favorable policy towards their own businesses but, it tries to cope with the issue which evidently seen by the compliance of laws and regulations adopting by WTO. Nevertheless, the US still, seems to be suspicious regarding China’s action therefore the current trade war is proceeding. China in turn responds to the US in the same manner which can be seen that China is very persistence in the global arena as a major power regarding green energy technology development. Therefore, these provided evidences have reflected and relevant to realist theoretical framework which was discussed in the previous chapter.

4.4 Conclusion

China’s energy consumption depends heavily on fossil fuels by burning coal. Due to its rapid economic growth and urbanization, the country has come to realize that it needs to find the solution to supply such high demand of energy and also, not harming environment as the conventional method of energy extraction has been done. Therefore, the country develops technology to utilize renewable energy which are hydropower, nuclear power, bioenergy, solar power and wind power. However,

solar and wind power seems to be well functioned, safer and they have a huge capacity to supply the whole nation's energy demand with low-cost production. The chapter then provides the details of how China develop and catch-up with technology in regards to solar and wind powers which was first developed by Western countries such as the US and EU. China inevitably had to receive technology from foreign firms through technology transfer. Later, it then reengineered and further localized such technologies until the dependence of foreign assistances are no longer required and, essentially receives economic gains since it has capacity to export the products to other countries with more competitive price. It is also important to note that the solar PV and wind turbines manufacturing have taken the different paths in the development phases. In other words, wind turbine was expanded mostly due to domestic market however solar PV was expanded by the export market and eventually being localized.

Moreover, the following section brings up the issue of current trade war between China and the United States. It is in fact a consequence of trade conflicts which some issues are relative to the development of green energy technology. To illustrate, the foreign firms cannot compete with the Chinese firms domestically and also, in international market since the exported products from China offers cheaper price due to the low-cost production but still, able to maintain the quality standard. This seems to be the big loss of US firms as some are found to be bankrupted and it essentially has an impact to the overall industry, this impact also includes EU market. The US and EU then responded by antidumping and countervailing polices and using WTO as an intermediary to raise the complaints and issues. There is certain case the US did not accept WTO's decision and further complains on how the appellate body. There has also been the issue of Intellectual Property Rights (IPRs) which essentially causing trade disputes between China and the US. Although, to some extent, China seems to have this problem existing in the country due to certain ideology and believes, they have been trying to solve the issue which shows the respect of international trade rules adopting by WTO. This is notable that China represent itself as a negotiator and not a very aggressive state. Nonetheless, it is unarguably that China will receive huge amount of economic gain if it wins the negotiations therefore the US is trying to prevent such case to occur.

The next chapter will discuss further relatively similar topics but focusing on India. The chapter will provide comprehensive overview of how India become the top ranking producers of solar and wind powers alongside with China, the development of its own green energy technology particularly, the catching up phases as well as certain obstacles, trade disputes which posing by the United States.



CHAPTER 5

GREEN ENERGY TECHNOLOGICAL CATCH-UP EFFORTS IN INDIA

After the discussion on China's green energy technology development in the previous chapter, this chapter shifts the focus to India since it is one of the countries that has huge capacities regarding the wind and solar powers manufacturing and, it can be seen as China's competitor. The chapter provides the similar structure with the Chapter 3 in order to illustrate differences and similarities in each topics between China and India. In other words, the chapter will be divided into three sections.

The first section will discuss about the overview of energy consumption in India between 1970 and 2014, describing the importance of wind and solar powers compared to other renewable resources and also, increasing interests in climate change as well as sustainable energy. The second section will discuss about the catching-up phases of wind turbine and solar PV manufacturing industry since the early stage of development. It is found that there had been pilot projects as well as the increasing support by the central government in various means, it also discusses about the government's aspiration to develop green energy technology, which was energy security initially and later, the motivation has shifted to be the concern of climate change mitigation due to the pressure from international community. The last section discusses about obstacles and challenges towards green energy technology development which is found to be relatively different from China, as the issue of IPRs does not seem to be a problem. However, the attempt to block emerging power by creating trade disputes of the US, as an established hegemonic power, still remains in which WTO plays significant intermediary role. Lastly, the analysis of conflicts occurred between these two countries through realist perspective will also be included. This is aligned with Mearsheimer's argument on latent power in which India would like to pursue and might be able to leverage its own military and political after achieving the goal. The US then needs to prevent such rising as hegemonic power.

5.1 Energy consumption in India between 1970 and 2014 and concerns about climate change

The beginning of energy consumption in India is similar to other countries globally, relying on conventional resources e.g. oil and gas, coal burning etc. During 1970s, there was a change when global energy crisis occurred and therefore Indian government had tried to adopt certain policy since all importing-oil countries are impacted by the crisis. The goal of various policies adopted were aiming to find the ways that reduce the demand on energy consumption however, it had not been succeeded (Mukhopadhyay & Chakraborty, 1999). In the following years, a number of institutions and working groups had been set up due to the support by the government. It adopted an outline for National Energy policy in 1976-1977 by addressing that the coal was the principal resources of country's energy in order to develop its economy but all actions such as exploration, exploitation and utilization should be programmed. It also addressed the support of indigenous production of oil and reduce the import rates and, importantly, the use of oil can be replaced whenever the technical and economic are ready. Later, Indian government adopted Electricity Act in 2003 in order to support the development of electricity industry, promote competition as well as protect the interest of customers (Kumar, 2017). This can be seen that the initial policy adoption by the government had come to realize that green energy was the way to sustainably develop its economy.

In 2008, the country has taken significant step which concerns climate change impact, the government adopted National Action Plan on Climate Change (NAPCC) in order to lay out principles, approaches, and institutional arrangement for eight national missions for managing climate change agenda; national solar mission, national mission for enhanced energy efficiency, national mission on sustainable habitat, national water mission, national mission for sustaining the Himalayan ecosystem, national mission for a green India, national mission for sustainable agriculture, national mission on strategic knowledge for climate change (Ahmad & Choi, 2000). This is deliberately substantial plans for India in addressing that the government pays much attention and takes this issue seriously. Furthermore, Indian government has been catching up with the trend as the research found that the demand

on electricity has exponentially increased over the years due to urbanization and, as mentioned, the conventional method of extracting resources such as coal burning causing damage to the world's climate in which the government is indeed realized that it is problematic. Consequently, India has modified energy policy in recent years in which it signaled that green energy has a huge capacity to substitute the possible shortage of energy's demand in the country. Thus, the government tends to develop energy resources differently in each regions due to geographic condition however, wind and solar powers remain the most capabilities alternative sources compared to others (Raghuwanshi & Arya, 2019). The following section will discuss in greater details of each energy resources which has potential to replace non-renewable energy that Indian government has been scrutinized.

5.1.1 Hydropower

Hydropower is a long established energy resource in India and it is partly contributed to the country's energy production for quite some times. It has now can be seen as a mature stage. In relation to that, the small hydro plants (SHP) have rapidly received popularities in recent years due to its size that solve the limitation that usually comes with the construction of reservoir. Its benefits is interesting particularly towards local communities since it is locally produced and consumed power, it also able to contributes to domestic and local financial system, a stable energy sources, almost has no effect on the environment as well as creating job opportunities. The project thus seems to be attractive for the stakeholders and investors. Nevertheless, it is notable that SHP also faces some challenges since the cost of production is high, there are complexity regarding administrative regulations which is time-consuming and the cost of maintenance is relatively high (Raghuwanshi & Arya, 2019, pp. 296-297).

5.1.2 Biomass energy

Biomass is one of the oldest sources in India and, unlike China, the country has great potential to produce such energy since it is agricultural-based. The research shows that agricultural waste has been greatly produced each year and that amount is comparable to 300 tons of coal which was then transformed to energy, "it contributes 4% of the total energy production and 11.88% of renewable energy sources. The potential is estimated to be about 30,000 MW in India" (Madan, Mallesham,

Sagadevan, & Veeramani, 2018). However, the problem occurs when the intervention of arable land by farmers in order to merely dedicating for cultivation of fuel crops which, in turn, might cause the conflict since the area of food crops tends to be reduced and therefore, “the productivity of marginal land is low and which is not suitable for current intensive agriculture” (Sinha, Subramanian, Singh, Tyagi, & Mishra, 2019). This should be noted that although India is agricultural-based country but due to the aforementioned problems, biomass energy cannot contributes its energy production as it was expected.

5.1.3 Geothermal energy and tidal wave energy

It is predictable that there could be the extraction of geothermal around the world in the next decade. India has potential areas for extracting this type of energy such as Himalayan region, Aravalli belt, NagaLushi, Andaman and Nicobar (A&N) arc, Surajkund, Hazaribagh in Jharkhand which estimated around 10,600 MW. However, it needs to be fully utilized. With reference to tidal wave energy, it is the technology which produces energy from the sea. It is believed that this type of energy could support local demands on energy in remote delta region. Thus, the government has permitted and agreed to implement India’s first 3.75 MW Durgaduani Mini Tidal Power Project (Raghuwanshi & Arya, 2019, pp. 298-299). Nevertheless, these resources still require more research and development which currently, incompetent comparing to wind and solar powers.

5.1.4 Wind power

Wind power is another one of the oldest resources that can be traced back to the early 1980s during the exploration of alternative resources period (Chaudhary, Krishna, & Sagar, 2015). It is, however, the fastest growing industry India which makes the country listed in the top five largest producers in the world, “The installed capacity of wind power in India was 28,700.44 MW as on January 2017. It was 9.12% of the total installed power generation capacity” (Madan et al., 2018, p. 4). It should be noted wind power extraction does not require much complexity and therefore the electrical production can be profitable. Furthermore, the area in which wind power can be generated is also important. In other words, the area where there is more density in the air, the more energy received by the turbine. Although, the country has low-speed-range

wind in general but there are some areas that have found to be the potential place to generate wind power especially coastal areas of Saurashtra, Western Rajasthan, and some other parts e.g. Tamil Nadu, Karnataka, Maharashtra, Gujarat, and Kashmir (Madan et al., 2018).

5.1.5 Solar power

Solar power sector has its own unique political-economic roots which provide strategic linkages to climate change mitigation as one of the most potential renewable energy resources. It is also relatively similar to the wind power in terms of the new energy industry resource although there was the relevant solar power policy dated back to 1980s but no meaningful implementation until the year 2009 (Chaudhary et al., 2015). The government has executed policy and programs for sustainable development of solar power and created Jawaharlal Nehru national solar mission (JNNSM) in which it plays important role developing such energy since 2000s resulting the increase in overall capacity from 10 MW to 3000 MW in 2014-2015. The government pays much attention to this particular power which has brought country to the top ten of the world's solar capabilities, "Solar grid has a cumulative capacity of 8626.8 MW as on September 2016. In the year 2015, the Indian Government significantly expanded its solar plans, targeting US\$100 billion of deal and 100 GW of solar capacity (including 40 GW directly from rooftop solar) by 2022" (Raghuwanshi & Arya, 2019, p.293). This may be considered as the ambitious target of Indian government to push forward this energy production in order to solving the problem of energy shortages as well as further exporting to other countries for economic gain.

5.2 Wind turbine and solar PV manufacturing industry catching up

Due to the importance of solar and wind powers stated in above section, the research then focuses on these two green energy resources which is similar to China. It can be noted that the development of wind power sector in India was initiated commercially in 1989 by the funding of World Bank and Asian Development Bank (ADB) due to the energy security reason as the high demand of energy consumption had been expected (Chaudhary et al., 2015). During nineteenth centuries, India faced with exponentially growth rate, "The growth in India has been phenomenal after the

entry of private entrepreneurs during 1992, the year which saw the ushering of an LPG (Liberalization, Privatization, and Globalization) era in India” (Singh, Bhatti, & Kothari, 2004, p. 812). The Ministry of Non-Conventional Energy Sources (MNES) played also an important role to promote wind power sector by working together with Ministry of Finance to suspend the federal tax for any related investments regarding renewable energy assets. MNES stepped up to reform the industry by adopting grid power policy in 1993-1994, which comes with the four important elements; feed-in tariffs, banking of energy, wheeling of power, third-party sale of power. Furthermore, there was another significant policy that helps encouraging private-participation as well as establishing wind power manufacturing base systems, in which it affiliates with macro-economic goal of liberalization and privatization. This policy apparently boosts up the local production by lower tax rate for component imports while increasing tax rate for turbine imports (Chaudhary et al., 2015). Such supportive and visionary by the government to strategize liberal ideas made this phase of development successful.

The later catching-up stage of wind power sector has seen to be another rapid expansion period as the previous phase seemingly the creating and establishing of fundamental goals and necessity instruments as motivated by energy security reason. MNES, renamed as the Ministry of New and Renewable Energy (MNRE) has still been playing significant role in order to working for improvement of government policies towards wind turbine manufacturing, it has set up various framework and regulations as well as adopted Electricity Act of 2003, which offers preferential tariffs for renewable energy as a goal to boost up investments (Chaudhary et al., 2015).

As the government policy focuses on the role private sector, it is worth noting that one of the largest India-owned producer as well as being ranked as the top five suppliers globally, Suzlon, has been playing the major role in development of wind power manufacturing. The company went public after 10 years of family ownership, since the major American investment, City Group and Chrystal Capital, funded the company which makes it has more capacity to keep manufacturing with the low labor costs due to its location. It also has overseas R&D centers since its subsidiaries are in Germany, Netherland and Australia which consequently, enable the company to have access to the most advanced technology innovation (Walz & Delgado, 2012). Additionally, climate change concerns have been addressed in the policy measurement

alongside with the energy security in this period of development (Chaudhary et al., 2015) which seems to be the significant step for India to pay attention on environmental issue in this period of the green energy technology development particularly wind power manufacturing.

The investment of wind power was at its peak between 2009 and until recent years due to the fact climate change has been widely discussed and become the global concerns. International community has come together finding the solution to mitigate the issue and essentially agreed to decrease greenhouse gas (GHG) emission rate in which India apparently has impacted by the EU's announcement to be committed to certain goal. It is also notable that growth in installed capacity of wind turbine resulting the government to strategically laying it out in the 11th National Five Year Plan (Chaudhary et al., 2015). Wind turbine industry is seen to be a good opportunities for India since it is potentially substitute the conventional resources in the time of country's growing economy and therefore an unexpected electricity demand. Interestingly, the central government has set an ambitious target to expand the wind power capacity, "the government's vision is for a sustainable clean energy future and it also set up a target of producing about 5000–6000 MW of power by 2022," (Prakash, 2018, p. 530). It is also important to note that India has been using both conventional mechanism – joint venture and licensing and, unconventional mechanism – joint R&D, foreign acquisition, oversea R&D (OFDI) as the means for technology transfer that essentially has been localized as it appeared to be the case for Suzlon and few other companies (Lema & Lema, 2012). This however seems to be mostly the strategic to support local demand of wind energy rather than selling to other countries, unlike solar power, which will be discussed below.

The beginning of solar power is seemingly similar to wind power. In other word, the various projects were although funded by central government but still, lack of serious implementation and the scale was small in rural areas. Importantly, the government's primary motivation was mainly due to energy security reason. In the mid of 2000s, the solar market was at its peak due to the increase of global demand as well as the belief in future domestic market. Thus, there were some private companies such as Moser Baer and Tata BP Solar have established the large plants of solar power PV manufacturing with their initial goal to export such solar power to international market

but later it essential materialized by domestic deployment. Moreover, it should be noted that there was no much emphasis on R&D in this period and these companies developed their knowledge by international linkages through joint ventures and acquisition (Chaudhary et al., 2015). It is also notable that the public expenditure during this period has increased significantly due to the government support in its education, technology and science, “During its 11th Five-year Plan (2007–2012), Indian central government has raised its expenditure on science, technology and environment by 194%, and local governments have raised such expenditure by 539% compared with the 10th Five-year Plan period (2002–2007)” (Zhang, 2011). This can be seen that there was attempt to substantially creating the clear path of development of green energy technology in particular, solar energy field.

Nevertheless, the solar power PV manufacturing has found to be slowing down due to the economic crisis in 2008, however, the government continued to push forward the industry. One of the most significant policy initiatives that has demonstrated such supportive role of the government was the Jawaharlal Nehru National Solar Mission (JNNSM) in 2009 (Chaudhary et al., 2015). The national mission or NAPCC regarding solar power has also played crucial role as it has set up the ambitious to improve its solar power capacity. This may be considered as the remarkable step of India to step up such development along with wind power development. Furthermore, the indigenous research, design and support has been the major contributions for renewable energy in India. It was essentially the result of 11th Five year plan which addressed the willingness to reduce foreign reliance by excessive importing products and services which can be produced domestically. Consequently, it seems to be similar to China in which the government inevitably adopting subsidy strategic in order to boost up the industry. There has noticeably been up to 100% subsidy given to the universities and public R&D institutions as well as to the industry at an initial stage of establishing, however, the support of R&D collaboration between foreign institutions still exists at the goal to achieve larger national interest area as Indian government has come to realize that R&D is critical for expanding green energy technology development (Zhang, 2011).

In fact, since 2009 until recently in fact, it can be considered as the taking off period of solar power manufacturing in India due to various supports and initiatives

at state-level as well as domestic research. It is important to note that it appears that the issue of climate change has been raised at the same period in which India has been developing wind energy. The pressure from international communities towards India as one of the top emitters in the world, has triggered the government to take step forward and essentially, pay much attention to solar power as the potential solution to mitigate climate change. One interesting speech from Indian prime minister, Jawaharlal Nehru, announcing that the importance of solar power development that, “Its success has the potential of transforming India’s energy prospects, and contributing also to national as well as global efforts to combat climate change” (Press Information Bureau, Government of India, 2010). However, the ministry of power (MoP) is not solely in charge of this matter, there have been other actors which were participated in agenda setting for mission policies such as international institution like World Bank, solar power manufacturers e.g. Moser Baer and Tata BP Solar and both international and domestic funded NGOs. This can be seen as an increased integration regarding climate mitigation by relevant parties comparing the previous phase with the goal to utilize solar power as mentioned (Chaudhary et al., 2015). This seems to be similar to wind power as it was one of the key renewable energy which has high potential to combat climate change and therefore Indian government has been focused on these powers.

These attempts are apparent that Indian government is ambitiously driving the country to another phase of energy consumption. The potential wind and solar capacities are well-functioned as the substitute for conventional resource such as coal, oil and gas etc. Although, these developments were motivated by energy security reason but the government has received some pressures from international community to mitigate climate change, and therefore focused on the development of green energy technology. It is however notable that India attempts to transfer the technology to other countries particularly solar sector through various means such as joint ventures, licensing etc. which benefits the country economically. Thus, this brings the conflict to other major powers as in the same case with China since the established hegemon such as the United States perceives such ambitious goals as a threat to its state, it then attempts to prevent it from happening. This will be discussed in greater details in the following section.

5.3 Obstacles and challenges towards green energy technology development

The main challenge that occurred between India and major powers such as the United States are seen to be relatively different with the case of China. In other words, the conflicts which have happened are not as severe as US-China Trade War. It is also notable that the disputes cases which were raised the complaint by using WTO as the intermediary are apparently less than that of Chinese's cases. Further, there has no accusation from the US towards India that the country engages in "theft" as it does with China (Wong & Koty, 2019) which means that the US has does not have any disputes with India regarding Intellectual Property Rights (IPRs) towards the field of green energy technology development. However, it is worth noting that the issue of IP still exists in terms of the cost of purchasing patent from western countries. This will be discussed in below sub-section. The trade disputes regarding solar PV manufacturing between India and the US are seen to be another conflict which is similar to China and both countries have been relying heavily on WTO by challenging each other in different period of time. Thus, this section will discuss the issue of IPRs as well as trade disputes in which the US has attempted to obstruct the rise of solar and wind powers manufacturing from India.

5.3.1 Intellectual property rights

Although there are no noticeable conflict regarding IPRs issue between the US and India, India has inevitably faced with the problem of patent costs that the country needs to pay while acquiring certain technology from other, specifically Western countries. This can be seen as one of the economic obstacles which not only India but also, developing countries have been facing. For solar power, it is notable its cost of production is relatively high compared to wind power since it requires a large scale capacity development however, this does not seem to be the case in the past decades as the price tends to decline due to the increase of PV technologies production. It is also even more favorable to India, as well as China, since they have a large installed capacity and therefore they do not seem to be effected much by such cost. In other words, India can overcome such issue easily. With regard to wind power, the obstacle is mainly relative to the new entrants which they might find themselves being restrained by existing industrial countries as they are not willing to share their own knowledge

and so on. This, again, does not seem have much effects on India and China since they can potentially build the wind farm in a large area without necessarily having to pay a high IP cost and, some of the Indian firms have now ranked at the top five in the global-level firm (Barton, 2007). Overall, this can be seen that India has been facing with IP issue since the technology transfer is needed for the country as initial stage of green energy development. However, an Indian company such as Suzlon, in turn, acquired other Western companies once it has fully developed in order to gain access to technology processes in western countries. Thus, there are solutions for this issue.

5.3.2 Trade disputes and World Trade Organization

It is interesting to note that not only China and India and the US which have been initiated the challenged through WTO in regard to renewable energy disputes, it also appears that there are other countries have been raising complaints with many various cases since 2008. For example, Australia, Argentina, Peru and the US have initiated the complaints on biodiesel etc. For India, it has initiated the complaint through WTO regarding solar panels in which China, Taiwan, Malaysia and the US were the respondent (Meyer, 2018). This was due to the fact that there were complaints from local Indian businesses mentioning that the cheap products which have been imported from the US and China are hurting the business since they are tax-free, while Indian have to pay duties for the production of similar goods. The United States later in 2013 responded by requesting for consultations with India regarding the measurement adopting on domestic content requirements under the Jawaharlal Nehru National Solar Mission (“NSM”) for solar cells and solar modules mentioning that solar power developers required to purchase and use solar cells and solar modules that only produced from domestic origin as agreed on the NSM. This can be seen as the violation of WTO regulations in which it requires both countries to provide equal opportunity to any companies including foreign firms accessing to a certain market (Rao, 2013).

It should be noted that the US attempts to initiate the dispute although the country had also been receiving benefits from tax-free importing goods as same as India. This clearly demonstrates hegemonic behavior of the US that tries to block the potential emergence power like India. In the following year, the United States filed another complaint regarding the domestic content while addressing that it was the phase

II of the Jawaharlal Nehru National Solar Mission program (NSM) (World Trade Organization, 2014). India then responded in a good manner by taking necessary actions in accordance with WTO's rulings. With this regards, India has submitted the report to WTO affirming that India has, "(a) taken all appropriate steps to bring its measures into compliance with the DSB recommendations and rulings; (b) no PPAs under the DCR measures have been entered into after December 2016; (c) some projects that were initially contemplated with the DCR measures, have been cancelled; and (d) India no longer enters into any PPAs involving the DCR measures" (WTO 2018b). However, India realized that it cannot avoid the future's action that might possibly has taken by the US therefore, it has filed the complaint challenging the US in the same allegation, "India requested consultations with the United States under the dispute settlement system regarding alleged domestic content requirements and subsidies provided by eight US states (Washington, California, Montana, Massachusetts, Connecticut, Michigan, Delaware and Minnesota) in the renewable energy sector" (WTO), 2016). Later, WTO has made the decision to uphold that those eight US states are indeed violate the WTO's rules by providing special treatments to local manufacturers and thus discriminating against Indian and other imported solar suppliers (Miles, 2019).

Nonetheless, this does not seem to make the US give up its effort to continuously working on the obstruction of India's rising solar power, since it claimed that such ruling by the WTO will have no impact for the US (Miles, 2019). Furthermore, the tit-for-tat strategy by these two countries have not come to an end since the United States has recently initiated another disputes against India duties on US imports, "the United States has requested WTO dispute consultations with India concerning additional duties applied by India on certain imports of US goods" (WTO, 2019). These disputes can be seen as significant development over the years since 2013 during ambitious goal setting up by Indian government. It can noticeably be seen that the US inevitably must respond to such determined effort according to realist perspective. Although, the recent dispute, which was initiated by the US, did not specifically targeting solar power but it concerns the increase of tariff for overall US importing goods to India, "India does not impose the additional duties measure on like products originating in the territory of any other WTO Member. India also appears to be applying

rates of duty to US imports greater than the rates of duty set out in India's schedule of concessions” (WTO, 2019) in which it potentially harms the US economy due to the inability to compete with local market producers.

As aforementioned dispute cases, it is worth noting that the US indeed concerns its own national interest although it is somehow relative to renewable energy sector, as the U.S. Trade Representative Michael Froman stated that “the Obama Administration is committed to strengthening the clean energy sector and the millions of jobs it supports here in America and all over the world. Trade enforcement is critical for ensuring that world-class U.S. clean energy goods and services can compete on an equal footing around the world,” (Meyer, 2018) This can be argued that the US perceives any states which seems to have high potential regarding such field, the US has responsibility for its own country to maintain the interest of relevant stakeholders inside the country. This speech portrays much of the realist idea on hegemonic power in which it could essentially find ways to prevent other rival states. Further analysis of the conflict will be discussed in following section.

5.3.3 Analysis on the conflict between India and the United States through a realist perspective

It is important to note that the actions which have been taken by India seems to be ambitious as it aims to take the leader role in global arena. The state’s motivation in developing green energy technology, which has been addressing by the central government, was initially due to energy security reason and, later, due to the pressure from international community regarding climate change mitigation. Thus, the country has implemented substantial projects in order to achieve the goal to mitigate climate change impact, specifically the development of solar PV and wind turbines manufacturing, which it has found to be one of the most successful countries in the world in these areas. As a result, the established hegemon like the United States must respond to emerging power as viewed by realist. It is, in fact, relative to the key idea of realist which is “balance of power” (Mearsheimer, 2001) in which it argues that hegemonic power will always find the way to block the emerging power regardless of where they are located. Furthermore, the trade conflicts which have presented above are mostly utilizing the intermediary player which is WTO in order to solve certain

disputes. However, in some cases, the United States does not seem to respect the decision made by WTO, which affirmed the argument proposed by realist that international institutions are in fact one of the instrumental tools by the powerful state in which it uses to portray its own power or even expanding power to some extent (Mearsheimer, 2001, p. 364). IPRs issue is another seemingly obstacle which might have insignificant impact to India however, it is worth noting that this is also one of the tools that provides more benefits to the developed countries than those of developing countries and therefore, it can be utilized by the US and other western major powers as a means to prevent India from rising.

Although, as mentioned, the conflicts between India and the United States have not escalated and therefore not as damaging as the conflict between US and China. However, this does not necessarily mean that the US would allow India to further developing solar PV as well as wind turbines manufacturing without any hostile reactions, even though the Indian government has addressed the willingness to mitigate climate change impact for benefits to international community. The Indian government arguably has come to realize this fact and thus responding to the United States trade disputes by initiating complaints towards the eight US states in the similar allegation as the US did with India. Nonetheless, the allegation of violation on WTO's rules, since both countries tend to provide preferential treatments for their local manufacturer, does seem reasonable from a realist perspective as each state needs to maintain its own national interest. This is best explained by one of the realist's basic concepts which is state's survival. In other words, state's first priority is its own national interest, the duty of state leader is to bring the most benefits to all citizen regardless of any means to be utilized. Both countries apparently followed this idea which consequently, causing trade disputes as they all concern their own national interest (Dunne & Schmidt, 2017, pp. 85-97).

In sum, the above evidence sufficiently explained the actions of both countries, the United States and India, in the view of realist perspective. The former attempts to block the rise of emerging power as well as concerning its own national interest. The latter has been ambitiously developing its own green energy technology development particularly solar power manufacturing which resulting in trade conflict with major power since its action seems suspicious and the US, as the established

hegemonic power, must inevitably act accordingly. India also demonstrates that the country concerns its own national interest as it responds to the US in the same manner e.g. initiating trade disputes with the similar allegation. This is, again, affirmed that realism still remain relevant in explaining the development of green energy technology circumstances.

5.4 Conclusion

It is notable that necessary information regarding India's catching-up on green energy technology development has been provided above. India can be seen as one of the high potential countries with regard to this particular field. The chapter provides a brief overview of energy consumption during 1970s to 2014 in order for the reader to understand the background of the issue. Energy consumption in India can be separated into six resources which are Hydropower, Biomass energy, Geothermal energy, Tidal wave energy, Wind power and Solar power. Each resources have various implications however, the government has emphasized on the development of wind and solar powers since they have highest capacity to substitute the conventional way of energy extraction e.g. coal burning and also, aligning with goal to reduce the dependence of fossil fuel in which currently, India is amongst the top polluted countries in the world. It is worth noting that the initial goal to shift its focus towards renewable energy for China and India are relatively similar as both countries came to realize that the excessive usage of conventional energy will not be lasting forever, therefore, it was the goal for China and India to find ways to sustainably support energy demand in which it has been increased over times. Later, as climate change has been widely discussed, international community has pressured on India and thus the country's aspiration to develop green energy technology has shifted towards climate change mitigation.

The following section discussed about the processes in which India has been catching-up with solar and wind powers manufacturing. It has found that the country in fact, has implemented certain pilot projects in order to explore the possibility for utilizing these powers but there has not much progress initially. However, due to the main support by central government in which it has set up various government departments, the investment that pours into research institutions as well as the education

budget for universities, since the country realized that it is crucial for developing technologies to utilize these powers at the maximum level. This period can be seen as the technological progress which supports the country's development on green energy. Furthermore, it should be noted that the private sector has been playing significant role. There have been the process of technology transfer in which the local manufacturers were benefitting from foreign investment by joint ventures, acquisition etc. This, again, cannot be successful without the government substantive policies which was adopted in order to facilitate the flow of investment and encouraging domestic manufacturers. This, in turn, creates allegedly conflict between major power like the US since the country accused of providing preferential treatment to local businesses and therefore, resulting the inability of foreign firms to compete in local market due to the subsidy by the government.

Accordingly, the last section discussed about the obstacles and challenges in which India has been facing. This happens to be the case which is different from what China does. In other word, the issue of Intellectual Property Rights (IPRs) seems to have small impact for India since it has capacity to overcome relatively low cost of patent purchasing particularly solar PV and there are no other conflicts with the US. Thus, the US then puts much effort to create trade disputes regarding solar power PV as Indian government ambitiously setting target to expand installation capacity in the near future. In response, India also fight back by initiating the complaints through WTO by using the same allegation which is, the special treatment towards local manufacturers. This further explain later in the section on analysis of realist perspective towards this conflicts that the action can be explained by the core basic ideas which are, national interest as well as the behavior of hegemonic country. This chapter can as well emphasizes the relevant of realist's argument towards the action taken by India and the US although the obstacle in which India has been facing seemingly less severity than that of China.

After providing sufficient information on China and India green energy technology development, the next chapter will provide evaluation on similarities and differences of these two countries as the case studies, including lesson in which it could be learnt from them. Lastly, the chapter will discuss whether realist perspective still appropriate in analyzing this particular circumstances.

CHAPTER 6

AN EVALUATION OF THE CASE STUDIES AND CONCLUSION

The case studies of China and India catching-up effort on green energy technological development, have been presented in Chapter 3 and Chapter 4. This chapter will provide a comparative evaluation for the two countries. The chapter demonstrates differences and similarities in which the two countries have gone through in the process of green energy technology development, solar and wind powers in particular and providing conclusion of the research.

The first section will discuss domestic energy security and climate change concerns as the motivation to develop solar and wind technologies for both China and India. The second section will discuss the different processes of catching-up in China and India. This includes the reason why these two countries emphasize on the development of solar and wind powers, and also an evaluation of their relative success. The third section will discuss about trade disputes and IPRs issue among China, India and the United States as the hegemonic power which seems to create these obstacles to prevent the rise of green energy technology by China and India. The fourth section will discuss whether realism is still appropriate in analyzing current circumstances of this whole particular event by presenting the evidences which is relevant to the key concept of realist. It will also include the evaluation of whether the competition between these countries have positive impact towards climate mitigation, or only demonstrating national interest, which does not essentially lead to global gains. The last section will discuss the summary of research, policy recommendations and lesson learnt for Thailand and future research areas.

In summary, the goals for China and India to develop green energy technology seem to be the mixture of the concerns on climate change impact as well as the desire to expand and gain more economic power, arguably translating into political and military powers. The future prospect of conflicts of both countries between the US will still remain as long as it holds hegemonic power. However, this might be opportunity for the world to witness substantial action since climate change mitigation has been tackled by major powers.

6.1 State motivations in the promotion of solar and wind powers

There have been concerns among international communities with regard to climate change that more and more people will receive significant impact if there has yet to be substantial plan to tackle with the issue. This also expects that the developing countries will mostly impacted by climate change due to socio-economic reason, in which they lack of the potential to respond with such threat. China and India are amongst developing countries where they seemingly come to realize this fact and thus have been searching for ways to mitigating climate change impacts. One of the reasons is due to the increase of domestic's energy demand as well as the excessive utilization of current energy resources. As a result, green energy development is one of the most sustainable and effective ways to tackle the problem in which both countries have been developed. Nevertheless, realist might argue that the two countries will be able to receive a huge economic advantage and might further translating into political and military powers by doing so. Therefore, they have put much efforts by setting ambitious goals to maintain the global leadership status and expanding their own capacities. This, arguably, partly seems to be the case as both countries do not only aiming for economic expansion but also the attempt to mitigating climate change as stated. In other words, their aspirations to develop green technology development are likely to be the mixture of climate change concerns as well as economic advantage and, they do not share their technologies to other developing countries, which insist self-interest motivation.

As mentioned, energy security is the result of the consumption circumstances India and China. They have begun to realize that the countries cannot only rely on conventional resources e.g. fossil fuels, oil and gas etc. around the same time. China has adopted the "open door" policy in 1970 which made significant changes regarding the technology investment from foreign countries and the shifting focus from conventional to 'unconventional' resources although, the country had received the criticisms that it still remained protectionist. While India effected by global event, energy crisis in 1970s, which resulting in the adoption of various policies by the government as well as other working groups since the country came to realize that it cannot rely on such energy. This is also due to the increasing demand of energy consumption which happened to be the case for both China and India as the emerging

of urbanization and rapid growth of country's economy. Therefore, it should be noted that the primary motivation of both countries to shift their focus from the dependence on fossil fuel and coal burning were regarded as energy security reason. Nevertheless, China faced with unprecedented impact from excessive utilization of coal burning which resulting greenhouse gas (GHG) and essentially effected its citizen health problems. India, on the other hand, receives international pressure to tackle with climate change issue since the country is amongst the top emitters in the world. Both countries then began to put much effort on the development of green energy technology as a goal to help mitigate climate change impact which has been happening.

Later, these two countries have become one of the major countries that possesses high potential of renewable energy. It is important to note that China and India have similarly, developed renewable resources which are hydropower, biomass energy, wind power and solar power. However, there is relatively different renewable resources in India which are geothermal energy and tidal wave energy. Apparently, these renewable energies have various advantages and each one has certain benefits for specific area which includes the conditions of indigenous people but, the negative dimension determines whether the government should push forward certain type of energy. For example, hydropower requires a huge amount of investment and the massive areas which may results in the conflict between government and indigenous people who will be displaced with such project. With this regards, solar and wind power are amongst those renewable which has the highest potential compared to other resources as well as the lower cost of operation that attracts the government to support these types of green energy.

6.2 Wind and solar power catching-up development of China and India

There are noticeably differences between China and India regarding the catching-up process of wind and solar powers. For China, it can be seen that the country has pushed forward for both energy resources as one of the export products. Although, the catching-up phases of solar and wind powers might initiated in different path, wind energy sector has expanded itself from domestic development while solar energy sector developed in international market and it essentially, localized. The goal of the country however is to reduce the reliance of foreign firms as much as possible and able to export

these two energy to international countries such as United States, Australia, Ethiopia and Turkey. In this regards, it is important to note that technology transfer is crucial for local manufacturers in China for the initial stage of development of wind and solar powers since they can intimate and further reengineered certain technologies as well as facilitating the exporting products. This process involves FDI/Joint ventures and technology licensing, in-house and overseas R&D. China also taken “home-based” outside-in technology transfer in order to reduce the reliance of foreign companies. This, in turns, creates suspicion for the United States as a hegemonic power which resulting in the trade conflicts and issue Intellectual Property Rights (IPRs) in which it was accused of being a theft by the US President Donald Trump.

In contrast, India seemingly push much effort on expansion of solar power to international market rather than wind power. The research found that the government supports the development of these two energy powers due to energy security at the initial stage. However, after India received international pressure, noticeably the European Union (EU), to substantially mitigate climate change as it is one of the counties that are producing greenhouse gas (GHG) at the highest level. The country then focused on wind power as the development reached the successful period in 2009 and has an equivalent capacity to substitute conventional resources e.g. fossil fuels which had been generated the energy consumption for the domestic demand. Although, solar power was slowing down due to global economic in 2008 but it has driven by government various policies and tools such as joint ventures etc. and consequently increased government’s expenditure regarding the investment on education, technology and science. Indian government also set an ambitious target to expand its solar power capacity in NAPCC as well as notably supports private sectors to be able to compete with international market by providing up to 100% subsidiary to newly established companies, while most of the companies in China are state-owned but still, receiving subsidiary from the government. This incident is similar to China as the US seems suspicious about such development, therefore, there has been trade disputes between them but, it does not include IPRs issue as the situation as not as severe as China.

6.3 Trade conflicts and IPRs amongst China, India and the United States

The main difference of conflicts between China and the US and India and the US, is that IPRs is seen to have small impact between India and the US, while it still remains one of the obstacles since India has to purchase the technology's patent while developing its own solar PV and wind turbines at initial stage. Surprisingly, the trade disputes and issue of IPRs between China and the US have escalated into trade war which is now has impacted to the whole world. Thus, China may be considered as the more active rival state of the US compared to India. Further, it is important to note that the US uses WTO as an intermediary to solve certain issues that it has with China and India. This can be seen as the portrayal of hegemonic power through international organization. It should also be noted that there is evidence that the solar and wind manufacturing in the US has received a huge negative impact from the Chinese's manufacturers since they are able to offer the lower price, the companies in the US have then found to be bankrupted and therefore employees forced to leave their jobs. The trade disputes and IPRs cases that have brought into WTO for China are including both solar and wind powers, in which China does not ignore the disputes and willing to solve the any problems notably by compliance of WTO's rules and regulations. On the other hand, the US disregarded the decision ruled by WTO.

With regards to India, the trade disputes which have occurred over times mainly targeted on solar power sector, not wind power and IPRs as mentioned. One of the reasons is that the Indian has provided heavily support for this particular field of energy. Similar to China, the US has utilized WTO as an intermediary global stage to solve the disputes. However, it is important to note that not only the US complaints and requested for consultations, India, including China, do not remain inaction. They constantly responded back to the US by requesting the consultations in some cases. Indian government support on solar power also has an impact to the US local manufacturing since the government has been using the same practice, providing subsidiary to their own businesses, as China in which it causes the US solar panel became uncompetitive to the local market and, it was accused by the US that the country violates core provisions of international market adopted by WTO. Nonetheless, this should be noted that it is not only China and India that have implemented this practice.

The US has been acting in the same manner. Essentially, this issue can be seen as fundamentally about national interests as states would gain by dominating the market. For the US, its intention seems to be that of blocking the emerged rival states.

6.4 The analysis of realism towards green energy technology development and lessons learnt

Realist concepts of John J. Mearsheimer indeed provides valid points in explaining this even; the behavior of great powers, the idea of national interest, states always seek power in anarchic world, the ill-functioning of international organization and the concept of ‘latent power’ – socio-economic power. Firstly, the United States has apparently acted the way that the world’s hegemony should act. In other words, it does not allow the emergence of other great powers in international arena due to its own stability by trying adopting any possible ways e.g. creating of trade disputes, to prevent it from happening, in this case, China and India as the world’s top wind and solar powers producers. Secondly, the case studies in Chapter 3 and 4 provides sufficient evidence that not only the United States but also, China and India are concerned about their own national interests. They have tried to support their own local manufacturers in any means with the goal to reduce foreign reliance, which eventually unable to compete with Chinese and Indian companies. Thirdly, China and India are also acting according to the realist key idea that states always seek power in anarchic world. Since there is no global authority to control each states, state needs to seek as much as power in order to survive, both countries are pursuing this by developing green energy technology, as they can increase their latest power by gaining economic power, which can essentially translates into political power. Lastly, the case studies have shown that the US does not respect and not comply with WTO’s decision for certain cases, and instead, condemned the appellate body. This clearly explains the ineffective of international institution since it has seen as the major power’s instrumental tool to portray its power.

Most importantly, it should be noted that socio-economic power or ‘latent power’ which was described in Chapter 2 is appropriate in this event. Either the US, China and India have been attempting to gain this sort of power as much as they can, since they understand that it is the main driving force for military capabilities. India and

China, in particular, aim to achieve this goal through the development of green energy technology in order to compete with hegemonic power like the US. Accordingly, economic and political power remains the most crucial tools in order to drive certain action and make changes to the world. All countries seems to be realize this key idea of how to survive in international stage, therefore, political power remains an ultimate goal for every states. However, as the world has been changing over the past decades, the increase of transactional and mobilization of goods and services, economy has become important to leverage its own political power. The pursuit of economic development has turned to be another crucial step for a country to gain more power. With this regard, the competition amongst China, India and the United States on the development of green energy technology particularly solar and wind technologies, might also be beneficial to climate change mitigation as it helps reduce technology costs and leads to more innovation. Although, it might not be the only primary goal for them, their motivations can be mixed with the expected economic power. This does not necessarily mean good or bad but, as long as the climate change is tackled by major powers, there is hope that there might be substantive results for the future world.

6.5 Lesson learnt for Thailand and future research areas

It should be noted that the current attempts to halt climate change has not progressed much but there is noticeably interesting demonstration led by Greta Thunberg, the youngest activist who passionate about the climate change issue (Weir, 2019). She and others around the world have participated in the protest asking the government to take the real action as the issue has neglected for quite some times and it is arguably that the impact of climate change might not happen in the near future rather, the young generation will likely be the ones who deal with the issue as long as there has no concrete action taken to mitigate the issue. The interesting thing is that she always refers to IPCC, as presented in introduction of this research, to prove that climate change is real and is required urgent plan to tackle it. With this regards, it can be seen that climate change is a global issue in which it requires collective cooperation. As mentioned, developing countries are far more vulnerable to impact of climate due to socio-economic factor. Thailand are amongst developing countries where there have

been recurrence disasters, although some are not directly caused by climate change but the country should be well prepared once it happens.

The policy recommendation to the government is that they should reduce the utilization rate of fossil fuels as much as possible. Since the case studies presented have shown that coal burning indeed has severe impact to environment, the government needs to prioritize this issue by delegating relative departments and setting out substantial goals in order to tackle with this particular issue. With this regard, Thailand should definitely adopt green energy technology from either the US, China or India. The competition amongst them provide choices for Thailand to receive the most efficient products with a more reasonable price. Thailand does not necessarily become the green energy exporter instead, fully utilize and promote such energy e.g. solar and wind powers. Once the scale is big enough, the country can make use of green energy for tourism sector which potentially benefit the country in terms of economic gain.

For future research area, it is very interesting to see more social scientist views towards this particular issue. In fact, there are many dimensions that one can discuss about as it is relative to socioeconomic. Thus, it should be worth reading if there will be some sort of a follow up research on climate change investigating some of the changes over the past years, whether or not the problem has been tackled, and has it been successful? It is always plausible to bring up other countries as a case study since each country do not necessarily has similar method of combatting with climate change. Furthermore, the research focusing on other actors in international relations that have driven this particular issue and to what extent have they achieved their goals, the necessity of states as the major role? Importantly, the research that looks at climate change issue through other IR theoretical frameworks such as Liberalism, Constructivism and Marxism would be fascinating to explore.

REFERENCES

- Ahmad, S., & Choi, M. (2000). Urban India and climate change: Mitigation strategies towards inclusive growth. *Theoretical and Empirical Researches in Urban Management*, 5(6), 60-73.
- Barton, J. H. (2007). *Intellectual property and access to clean energy technologies in developing countries: An analysis of solar photovoltaic, biofuel and wind technologies*. Issue Paper no. 2. ICTSD Programme on Trade and Environment. Retrieved from https://www.ictsd.org/sites/default/files/research/2008/11/intellectual-property-and-access-to-clean-energy-technologies-in-developing-countries_barton_ictsd-2007.pdf
- Beeson, M., & Bisley, N. (2010). *Issues in 21st century world politics*. Palgrave Macmillan.
- Beinhart, L. (2018, August 23). Why China, and not the US, is the leader in solar power. *Aljazeera*. Retrieved from <https://www.aljazeera.com/indepth/opinion/china-leader-solar-power-180822102606141.html>
- Blenkinsop, P. (2018, August 31). *EU ends trade controls on Chinese solar panels*. *Reuters*. Retrieved from <https://www.reuters.com/article/us-eu-china-trade/eu-ends-trade-controls-on-chinese-solar-panels-idUSKCN1LG1QM>
- Caprotti, F. (2015). Golden sun, green economy: Market security and the US/EU-China 'solar trade war'. *Asian Geographer*, 32(2), 99-115.
- Chandrayaan-2: India aims for soft landing on Moon's south pole. (2019, September 6). *BBC*. Retrieved from <https://www.bbc.com/news/world-asia-india-49575480>
- Chang, H. (2001). Intellectual property rights and economic development: Historical lessons and emerging issues. *Journal of Human Development*, 2(2), 287-309.
- Chaudhary, A., Krishna, C., & Sagar, A. (2015). Policy making for renewable energy in India: Lessons from wind and solar power sectors. *Climate Policy*, 15(1), 58-87. doi:10.1080/14693062.2014.941318

- Chen, G. (2015). From mercantile strategy to domestic demand stimulation: Changes in China's solar PV subsidies. *Asia Pacific Business Review*, 96-112.
- Cleugh, H., Smith, M. S., Battaglia, M., & Graham, P. (Eds.). (2011). *Climate change: Science and solution for Australia*. CSIRO.
- Climate Technology Centre & Network. (2018). *2018 CTCN progress report*. CTCN publications.
- Deb, J. C., Phinn, S., Butt, N., & McAlpine, C. A. (2018). Climate change impacts on tropical forests: Identifying risks for tropical Asia. *Journal of Tropical Forest Science*, 30(2), 182-194. doi:10.26525/jtfs2018.30.2.182194
- Dent, C. M. (2011). Asia and Europe: Meeting future energy security challenges. In S. Bersick, & P. van der Velde (Eds.), *The Asia-Europe meeting: Contributing to a new global governance architecture* (pp. 127-142). Amsterdam University Press.
- Downey, K. (2012). Intellectual property rights and renewable energy technology transfer in China. *South Carolina Journal of International Law and Business*, 9(1), 90-130.
- Dunne, T., & Schmidt, B. C. (2017). Realism. In J. Baylis, S. Smith, & P. Owens (Eds.), *The globalization of world politics: An introduction of international relations*, 7th ed. (pp. 85-97). Oxford University Press.
- Eckstein, D., Künzel, V., & Schäfer, L. (2017). *Global climate risk index 2018: Who suffers most from extreme weather events? Weather-related loss events in 2016 and 1997 to 2016*. Germanwatch e.V. Retrieved from <https://germanwatch.org/sites/germanwatch.org/files/publication/20432.pdf>
- Franck, T. (2019, August 26). Wall Street sees elevated recession risk, market woes after US and China stoke trade fears. *CNBC*. Retrieved from <https://www.cnbc.com/2019/08/26/wall-street-sees-elevated-recession-risk-amid-us-china-trade-fight.html>
- Fu, X., & Zhang, J. (2011). Technology transfer, indigenous innovation and leapfrogging in green technology: The solar-PV industry in China and India. *Journal of Chinese Economic and Business Studies*, 9(4), 329-347. doi:10.1080/14765284.2011.618590

- Gardner, T. (2017, March 1). U.S. military marches forward on green energy, despite Trump. *Reuters*. Retrieved from <https://www.reuters.com/article/us-usa-military-green-energy-insight/u-s-military-marches-forward-on-green-energy-despite-trump-idUSKBN1683BL>
- Hall, B. H., & Helmers, C. (2010). The role of patent protection in (clean / green) technology transfer. *Santa Clara High Technology Law Journal*, 26, 487-532. doi:10.3386/w16323
- Hoegh-Guldberg, O., Jacob, D., Taylor, M., Bindi, M., Brown, S., Camilloni, I., . . . Zhou, G. (2018). Impact of 1.5°C global warming on natural and human systems. In V. Masson-Delmotte, P. Zhai, H. Pörtner, D. Roberts, J. Skea, P. Shukla, . . . T. Waterfield, *Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change* (pp. 177-284). World Meteorological Organization Technical Document.
- Hopkins, A., McKellar, R., Worboys, G. L., & Good, R. (2015). Climate change and protected areas. In G. L. Worboys, M. Lockwood, A. Kothari, S. Feary, & I. Pulsford (Eds.), *Protected area governance and management* (pp. 495-530). ANU Press. Retrieved from <http://press-files.anu.edu.au/downloads/press/p312491/pdf/CHAPTER17.pdf>
- Hughes, L., & Meckling, J. (2017). The politics of renewable energy trade: The US-China solar dispute. *Energy Policy*, 105, 256-262. doi:10.1016/j.enpol.2017.02.044
- Intergovernmental Panel on Climate Change (IPCC). (2011). Summary for policymakers. In O. Edenhofer, R. Pichs-Madruga, Y. Sakona, K. Seyboth, P. Matschoss, S. Kadner, . . . C. von Stechow (Eds.), *IPCC special report on renewable energy sources and climate change mitigation*. Cambridge University Press.
- Intergovernmental Panel on Climate Change (IPCC). (2018). *Summary for policymakers*. Retrieved from https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf

- International Energy Agency (IEA). (2017). *Market report series: Renewables 2017: Analysis and forecasts for 2022*. IEA.
- Jaswal, P. S., & Jolly, S. (2013). Climate refugees: Challenges and opportunities for international law. *Journal of the Indian Law Institute*, 45-58. Retrieved from <https://www.jstor.org/stable/43953626?seq=1>
- Jayawardhan, S. (2017). Vulnerability and climate change induced human displacement. *Consilience*, 103-142.
- Jiang, K. (2017). Technological progress in developing renewable energies. In L. Song, R. Garnaut, C. Fang, & L. Johnston (Eds.), *China's new sources of economic growth: Vol. 2 human capital, innovation and technological change* (pp. 315-341). ANU Press. doi:10.22459/CNSEG.07.2017
- Kim, H.-E. (2011). *The role of the patent system in stimulating innovation and technology transfer for climate change: Including aspects of licensing and competition law*. Nomos Verlagsgesellschaft mbH. doi:10.5771/9783845234472
- Kumar, G. S. (2017). Anatomy of Indian energy policy: A critical review. *Energy Sources, Part B: Economics, Planning, and Policy*, 12(11), 976-985. doi:10.1080/15567249.2017.1336814
- Lall, S. (2003). Indicators of the relative importance of IPRs in developing countries. *Research Policy*, 32(9), 1657-1680.
- Lawder, D., Mason, J., & Martina, M. (2019, May 8). Exclusive: China backtracked on almost all aspects of U.S. trade deal - sources. *Reuters*. Retrieved from <https://www.reuters.com/article/us-usa-trade-china-backtracking-exclusiv/exclusive-china-backtracked-on-nearly-all-aspects-of-u-s-trade-deal-sources-idUSKCN1SE0WJ>
- Lema, R., & Lema, A. (2012). Technology transfer? The rise of China and India in green technology sectors. *Innovation and Development*, 2(1). doi:10.2139/ssrn.2003367
- Lindström, L. (2018, April 18). *Swedish-Indian collaboration to support energy innovation and entrepreneurship*. Retrieved from <https://www.energimyndigheten.se/en/news/2018/swedish-indian-collaboration-to-support-energy-innovation-and-entrepreneurship>

- Liu, M., Liu, X., & Yang, Z. (2016). An integrated indicator on regional ecological civilization construction in China. *International Journal of Sustainable Development and World Ecology*, 23(1), 53-60.
doi:10.1080/13504509.2015.1057774
- Madan, D., Malleshham, P., Sagadevan, S., & Veeramani, C. (2018). Renewable energy scenario in Telangana. *International Journal of Ambient Energy*.
doi:10.1080/01430750.2018.1501737
- Mark, D. (2010). China's climate change policy process: Improved but still weak and fragmented. *Journal of Contemporary China*, 19(67), 971-986.
- Mark, D. (2011). Climate change and Thailand: Impact and response. *Contemporary Southeast Asia: A Journal of International and Strategic Affairs*, 229-258.
Retrieved from <https://muse.jhu.edu/article/450064>
- Mathews, J. A., & Hao, T. (2015). *China's renewable energy revolution*. Palgrave Macmillan.
- Mearsheimer, J. (2001). *The tragedy of great power politics*. University of Chicago Press.
- Meyer, T. (2018). Free trade, fair trade, and selective enforcement. *Columbia Law Review*, 118(2). Retrieved from <https://columbialawreview.org/content/free-trade-fair-trade-and-selective-enforcement/>
- Midilli, A., Dincer, I., & Rosen, M. A. (2007). The role and future benefits of green energy. *International Journal of Green Energy*, 4(1), 65-87.
doi:10.1080/15435070601015494
- Milczek, E. M., & Kosjek, B. (2015). Biocatalytic solutions for green chemistry. In T. P. Umile, *Catalysis for sustainability: Goals, challenges, and impacts* (pp. 113-35). Routledge.
- Miles, T. (2017, December 20). U.S. takes India back to WTO in solar power dispute. *Reuters*. Retrieved from <https://www.reuters.com/article/us-usa-india-wto/u-s-takes-india-back-to-wto-in-solar-power-dispute-idUSKBN1EE1BK>
- Miles, T. (2018, March 23). U.S. accuses China of stealing patents in WTO complaint. *Reuters*. Retrieved from <https://www.reuters.com/article/us->

usa-china-trade-wto/u-s-accuses-china-of-stealing-patents-in-wto-complaint-idUSKBN1GZ1BV

- Miles, T. (2019, June 27). India wins U.S. solar case at WTO but impact disputed. *Reuters*. Retrieved from <https://www.reuters.com/article/us-usa-trade-india-wto/india-wins-us-solar-case-at-wto-but-impact-disputed-idUSKCN1TS2B0>
- Morgenthau, H. J. (1948). *Politics among nations: The struggle for power and peace*. Alfred A. Knopf.
- Mukhopadhyay, K., & Chakraborty, D. (1999). India's energy consumption changes during 1973/74 to 1991/92. *Economic Systems Research*, 11(4), 423-438.
- Never, B. (2013). Power in global climate governance. In O. C. Ruppel, C. Roschmann, & K. Ruppel-Schilchting (Eds.), *Climate change: International law and global governance: Volume II: Policy, diplomacy and governance in a changing environment* (pp. 215-234). Nomos Publisher.
- Nussbaumer, P., Caltagirone, M., Duwyn, J., Leuenberger, H., Low, V., & Ould-Dada, Z. (2015). Stakeholder's perspective on opportunities and challenges for climate technology facilitation in developing countries: Informing the operation of the climate technology centre and network. *Climate and Development*, 8(2), 197-201.
doi:10.1080/17565529.2015.1040366
- Palmer, D. (2010, December 23). U.S. challenges China wind power aid at WTO. *Reuters*. Retrieved from <https://www.reuters.com/article/us-usa-china-windpower/u-s-challenges-china-wind-power-aid-at-wto-idUSTRE6BL3EU20101222>
- Palmer, D., & Walet, L. (2011, June 7). China agrees to halt subsidies to wind power firms. *Reuters*. Retrieved from <https://www.reuters.com/article/us-china-windpower/china-agrees-to-halt-subsidies-to-wind-power-firms-idUSTRE7561B920110607>
- Paradise, J. F. (2013). The new intellectual property rights environment in China: Impact of WTO membership and China's 'innovation society' makeover. *Asian Journal of Social Science*, 41(3-4), 312-332.

- Peng, S., & Sun, X. (2015). Research on challenges and strategies for China's green economy development. *Chinesne Journal of Population Resources and Environoment*, 13(2), 127-131. doi:10.1080/10042857.2015.1005342
- Pickering, J., McGee, J. S., Stephens, T., & Karlsson-Vinkhuyzen, S. I. (2018). The impact of the US retreat from the Paris Agreement: Kyoto revisited? *Climate Policy*, 18(7), 818-827.
- Powell, R. (1991). Absolute and relative gains in international relations theory. *The American Political Science Review*, 85(4), 1303-1320.
- Prakash, O. (2018). Wind energy potential, development and current trends in India: A review. *International Journal of Ambient Energy*, 39(5), 521-532. doi:10.1080/01430750.2017.1303636
- Press Information Bureau, Government of India. (2010, January 11). PM launches Jawaharlal Nehru national solar mission - solar India [Press release]. Retrieved from <https://pib.gov.in/newsite/erelease.aspx?relid=56780>
- Qian, Z. X. (1994). Energy system and its future in China. *International Journal of Solar Energy*, 14(2), 75-87.
- Raghuwanshi, S. S., & Arya, R. (2019). Renewable energy potential in India and future agenda of research. *International Journal of Sustainable Engineering*, 12(5), 291-302. doi:10.1080/19397038.2019.1602174
- Rao, K. (2013, April 23). India's grand solar plans threatened by ugly US trade spat. *The Guardian*. Retrieved from <https://www.theguardian.com/environment/terra-india/2013/apr/23/india-solar-plans-us-trade-spat>
- Schüller, D. (2012). Techonolgy transfer mechanisms and international cooperation to combat climate change. *Climate and Development*, 4(2), 78-87. doi:10.1080/17565529.2012.727358
- Seekins, D. (2009). State, society and natural disaster: Cyclone nargis in Myanmar (Burma). *Asian Journal of Social Science*, 717-737. doi:10.1163/156848409X12474536440500
- Singh, S., Bhatti, T. S., & Kothari, D. P. (2004). Indian scenario of wind energy. *Energy Sources*, 811-819.
- Sinha, S. K., Subramanian, K. A., Singh, H. M., Tyagi, V. V., & MIshra, A. (2019). Progressive trends in bio-fuel policies in Indai: Targets and

- implementation strategy. *Biofuels*, 10(1), 155-166.
doi:10.1080/17597269.2018.1522483
- Stern, N. (2008). The economic of climate change. *American Economic Review*, 1-37.
- Stiglitz, J. E., & Charlton, A. (2007). *Fair trade for all: How trade can promote development*. Oxford University Press.
- Suetsugu, K., & Kambara, T. (1998). Geopolitics and energy development in Northeast. *Cambridge Review of International Affairs*, 12(1), 114-130.
- Sun, X., & Huang, D. (2014). An explosive growth of wind power in China. *International Journal of Green Energy*, 11(8), 849-860.
doi:10.1080/15435075.2013.830261
- Trade wars, Trump tariffs and protectionism explained. (2019, May 10). *BBC*.
Retrieved from <https://www.bbc.com/news/world-43512098>
- United Nations Environment Programme. (n.d.). Climate change initiatives and partnership. Retrieved from <https://www.unenvironment.org/explore-topics/climate-change/about-climate-change/climate-change-initiatives-and-partnerships>
- United Nations Framework Convention on Climate Change (UNFCCC). (2015). *Technology mechanism: Enhancing climate technology development and transfer*. UNFCCC. Retrieved from https://unfccc.int/ttclear/misc/_/StaticFiles/gnwoerk_static/TEM/0e7cc25f3f9843ccb98399df4d47e219/174ad939936746b6bfad76e30a324e78.pdf
- United Nations Framework Convention on Climate Change (UNFCCC). (2017, April 21). China and India lead global renewable energy transition. Retrieved from <https://unfccc.int/news/china-and-india-lead-global-renewable-energy-transition>
- United Nations Framework Convention on Climate Change (UNFCCC). (n.d.). The Paris Agreement. Retrieved from <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>
- Volodzko, D. (2018, November 11). The trade war with China and the problem with intellectual property rights. *Forbes*. Retrieved from <https://www.forbes.com/sites/davidvolodzko/2018/11/11/the-trade-war->

with-china-and-the-problem-with-intellectual-property-rights/#2ac97c08728e

- von Hippel, D., Takase, K., Iida, T., Cho, M., Wang, Y., & Yun, S.-j. (2015). Energy security and the role of green economies in East Asia. In P. Hayes, & K. Yi (Eds.), *Complexity, security and civil society in East Asia: Foreign policies and the Korean peninsula* (pp. 85-222). Open Book.
- Walz, R., & Delgado, J. N. (2012). Different routes to technology acquisition and innovation system building? China's and India's wind turbine industries. *Innovation and Development*, 2(1), 87-109.
- Wearable, solar soldier power nears the battlefield. (2013, December 31). *Forbes*. Retrieved from <https://www.forbes.com/sites/pikerresearch/2013/12/31/wearable-solar-soldier-power-nears-the-battlefield/#fd92e2020704>
- Weinland, D. (2019, July 16). WTO rules against US in tariff dispute with China. *Financial Times*. Retrieved from <https://www.ft.com/content/131a55ea-a84a-11e9-984c-fac8325aaa04>
- Weir, B. (2019, 20 September). Greta Thunberg: The teenage old soul of the climate crisis. *CNN*. Retrieved from <https://edition.cnn.com/2019/09/20/us/greta-thunberg-profile-weir/index.html>
- Wong, D., & Koty, A. C. (2019, August 20). The US-China trade war: A timeline. *China Briefing*. Retrieved from <https://www.china-briefing.com/news/the-us-china-trade-war-a-timeline/>
- World Intellectual Property Organization (WIPO). (2017). *World intellectual property report 2017 - intangible capital in global value chains*. WIPO.
- World Trade Organization (WTO). (2014, February 11). US files dispute against India over measures relating to solar cells and solar modules. Retrieved from https://www.wto.org/english/news_e/news14_e/ds475rfc_11feb14_e.htm
- World Trade Organization (WTO). (2016, September 9). India files new dispute challenging domestic content requirements, subsidies in US states. Retrieved from https://www.wto.org/english/news_e/news16_e/ds510rfc_12sep16_e.htm
- World Trade Organization (WTO). (2018a, August 16). China initiates dispute complaints against US solar cell duties, renewable energy measures.

Retrieved from https://www.wto.org/english/news_e/news18_e/ds562_563rfc_16aug18_e.htm

- World Trade Organization (WTO). (2018b). *India – certain measures relating to solar cells and solar modules*. WT/DS456/20.
- World Trade Organization (WTO). (2019, July 4). United States initiates WTO dispute against Indian duties on US import. Retrieved from https://www.wto.org/english/news_e/news19_e/ds585rfc_04jul19_e.htm
- Wroughton, L., & Brunnstrom, D. (2019, March 14). U.S. and India commit to build six nuclear power plants. *Reuters*. Retrieved from <https://www.reuters.com/article/us-usa-india-nuclearnuclearpower/us-and-india-commit-to-building-six-nuclear-power-plants-idUSKCN1QU2UJ>
- Zailani, S., Iranmanesh, M., Nikbin, D., & Jumadi, H. B. (2014). Determinants and environmental outcome of green technology innovation adoption in the transportation industry in Malaysia. *Asian Journal of Technology Innovation*, 22(2), 286-301. doi:10.1080/19761597.2014.973167
- Zhang, J. (2011). Technology transfer, indigenous innovation and leapfrogging in green technology: The solar-PV industry in China and India AU. *Journal of Chinese Economic and Business Studies*, 9(4), 329-347. doi:10.1080/14765284.2011.618590
- Zhang, L. (2017). Legal framework and practice for environment protection and application of green energy in China. *International Journal of Ambient Energy*, 38(5), 489-496.