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Intellectual Property Rights and Climate Change
A Differentiated Patent Regime for Environmentally Sound Technologies

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I hereby declare that this thesis is the results of my own investigations, except where otherwise stated. All other sources are acknowledged by bibliographic references. This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree unless, as agreed by the University, for approved dual awards.

Yr wyf drwy hyn yn datgan mai canlyniad fy ymchwil fy hun yw'r thesis hwn, ac eithrio lle nodir yn wahanol. Caiff ffynonellau eraill eu cydnabod gan droednodiadau yn rhoi cyfeiriadau eglur. Nid yw sylwedd y gwaith hwn wedi cael ei dderbyn o'r blaen ar gyfer unrhyw radd, ac nid yw'n cael ei gyflwyno ar yr un pryd mewn ymgeisiaeth am unrhyw radd oni bai ei fod, fel y cytunwyd gan y Brifysgol, am gymwysterau deuol cymeradwy.

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Intellectual Property Rights and Climate Change: A Differentiated Patent Regime for ESTs (Environmentally Sound Technologies)

Abstract

Climate change is a major reason why fresh thinking is required in order to promote the application and diffusion of ESTs. Intellectual property rights (IPRs), particularly the patent regime discussed in this thesis, carry a high degree of influence over the development of ESTs. There have been many studies on the relationship between ESTs, patents and climate change; the role of patents in stimulating the innovation of ESTs by providing some preferential treatment; and global and regional EST-related patent activities and trends. However, little light has been shed on how to use patent systems to increase access to ESTs, or to consider how to establish a special patent system based on the particularity of ESTs. This thesis explores whether a differentiated patent regime for ESTs is feasible, in the context of climate change, with the goal of enhancing access to ESTs. It argues that the inherent disadvantage of the current patent system, which centers on the strengthening of exclusive rights, is counterproductive to wider diffusion of ESTs.

By analyzing the existing coordination arrangements around patents and climate change, this thesis finds that solutions under the United Nations Framework Convention on Climate Change (UNFCCC) are a flawed vision and the flexible terms in the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) are not as adaptable to changes as expected, so a more eclectic approach is required to manage the EST-related IP issues. This means that IPRs need be re-examined in the context of climate change, to examine a solution which will both avoid the prevailing over-emphasis on the inviolability of private rights in the world trading system, while simultaneously seeking a solution which will overcome the shortcomings of being

devoid of legally binding arrangements under the climate regime.

Departing from previous research which fails to examine in a systematic way the discord between the structure of patent rights and access to ESTs, this thesis examines the structure model of patent rights specially designed for ESTs, and its role in addressing climate change as its research object. Several lessons drawn from the comparison between pharmaceuticals and ESTs indicate that efforts on the development of an appropriate patent protection in line with ESTs' own characteristics are worthwhile. With the objective of enhancing access to ESTs, the proposed patent regime in this thesis is constructed under a quadrilateral platform, with WIPO as core coordinator, which is conducive to harmonizing patent protection in the context of climate change.

The study contributes to the dispute on the question of what should be the appropriate legal approach to deal with IP issues in climate talks. For a specific type of technology with particular functions, a refined and differentiated legal system is necessary. This is demonstrated in two senses: a system that discourages non-environmentally sound technologies and a system providing value-based protection for different types of ESTs. The proposal put forward in this thesis turns a reward system, into a system that aims to green the innovation environment and is suitable for technology diffusion, by using multiple variables of a patent system.

The study explores from the perspective of law and economics an appropriate structure model of patent protection specially designed for ESTs, which consists of patent intensity (patentability), length (duration), and breadth (width). Different levels of the three dimensions have different incentive effects on the innovation and accessibility of technologies. Based on the quasi-public nature and characteristics of ESTs, an optimal combination of the three dimensions is put forward, which suggests that the level of the grant standards be raised; the length be extended; the breadth be narrowed, for the sake of public welfare. Accordingly, differentiated protection with value-based judgment at its core, is proposed for different types of ESTs, giving priority to the innovation of basic and core ESTs and accessibility of improved and

combined ESTs.

Located in China, as one of the largest emitters of green house gases (GHGs) with a great potential for emission reduction, the discussion regarding how to flexibly apply this differentiated patent regime in different jurisdictions is based upon China's biased development of ESTs and actual demand for ESTs, against the background that the implementation of patent protection must work with characteristics of EST-related industries at a national level. This study finds that differentiated patent protection is desirable for China in two main aspects, namely, the actual working and local innovation, and therefore could have a very positive impact on the building of China's green innovation environment, as well as enhancing effective competition for ESTs around the world.

Throughout, the study made full use of patent systems to increase access to some necessary ESTs for emission reduction in key concerned industries. What is more, the far-reaching significance of establishing a special regime under WIPO lies, not in the attempt to provide an alternative system for national laws, but in the demonstration of the flexibility and inclusiveness of the IP system under WIPO, in response to new potential challenges, which will enhance coordination between IPRs and other fields.

Abbreviations

CCS - Carbon Capture and Storage

CDM - Clean Development Mechanism

COP - Conference of the Parties

CTCN - Climate Technology Centre and Network

CTFs - Clean Technology Funds

DSM - Dispute Settlement Mechanism

EGTT - Expert Group on Technology Transfer

EPO - European Patent Office

ESTs - environmentally sound technologies

ETV - Environmental Technology Verification

EU – European Union

FGD - Flue Gas Desulfurization

GDP - Gross Domestic Product

GEF- Global Environmental Facility

GHGs - green house gases

ICC- International Chamber of Commerce

ICTSD - International Centre for Trade and Sustainable Development

IEA - International Energy Agency

IET - International Emissions Trading

IFCC - Ignited Fuel Combined Cycle

IGCC - Integrated Gasification Combined Cycle

IP - intellectual property

IPC - International Patent Classification

IPCC- Intergovernmental Panel on Climate Change

IPRs - intellectual property rights

JI - Joint Implementation

JPO - Japan Patent Office

KIPO - Korean Intellectual Property Office

LDCs - Least developed countries

NGOs - Non-Governmental Organizations

OECD - Organization of Economic Cooperation and Development

PCT - Patent Cooperation Treaty

SBSTA - Subsidiary Body for Scientific and Technological Advice

SC- super-critical power unit

SIPO - State Intellectual Property Office of P. R. China

SPV- solar photo-voltaic

TEC - Technology Executive Committee

TRIPS - The Agreement on Trade-Related Aspects of Intellectual Property Rights

UKIPO - the United Kingdom Intellectual Property Office

UN - United Nations

UNCTAD - United Nations Conference on Trade and Development

UNDESA - United Nations Department of Economic and Social Affairs

UNEP - United Nations Environment Programme

UNFCCC - United Nations Framework Convention on Climate Change

USA – United States of America

USC - ultra-supercritical power unit

USPC - United States Patent Classification

USPTO - United States Patent and Trademark Office

WHO - World Health Organization

WIPO - World Intellectual Property Organization

WTO - World Trade Organization

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Chapter 1 Introduction

1.1 Research Questions and Preliminary Assumption of the Research

1.1.1 Research Questions and Research Gap

Addressing climate change requires the wide application and diffusion of ESTs. IPRs, particularly patent rights discussed in this thesis, carry a high degree of influence over access to ESTs. This thesis seeks to answer the main research question: Is it feasible to design a differentiated patent regime to facilitate access to ESTs in the context of climate change? In order to answer the main research question, the following related sub-questions need to be considered: Is it justifiable to create a differentiated patent regime for ESTs? Why is it not possible to improve access to ESTs through the existing legal rules? What could be learnt from the heated debate on IPRs and public health? What form would the differentiated patent system take? How can the preliminary assumption of this research be proven workable?

Climate change has imposed great challenges on the world. All countries, whether rich or poor, are subject to its effects. Although this effect is spread across the world, there are still major differences in the timing, magnitude and regional distribution which enhance the difficulty and uncertainty of climate change prediction.[1] The innovation and wide use of ESTs has been confirmed as an effective way to control GHGs, thus substantially improving the environmental protection standard.[2] In an

[1] The United Nations Framework Convention on Climate Change, May 9, 1992, 1771 U.N.T.S. 107 (entered into force Mar. 21, 1994)<http://unfccc.int/key_documents/the_convention/items/2853.php> accessed on 11 October 2011. (It points out that there are many uncertainties in predictions of climate change, particularly with regard to the timing, magnitude and regional patterns thereof in the foreword of the United Nations Framework Convention on Climate Change.)

[2] Bali Road Map 2007 Decision 3/CP.13 Development and transfer of technologies under the Subsidiary Body for Scientific and Technological Advice FCCC/CP/2007/6/Add.1 <http://unfccc.int/resource/docs/2007/cop13/eng/06a01.pdf#page=12> accessed on 11 October 2011. (In this Decision, the Conference of all Parties, '*Recognizing* that there is a crucial need to accelerate innovation in the development, deployment, adoption, diffusion and transfer of environmentally sound

effort to find a way to resolve issues related to ESTs, the focus of attention has fallen on the role and impact of IPRs.[3] This is because IPRs constitute a critical factor in the innovation process and in decisions to invest in R&D activities and, at the same time, they have implications on the rate of technological diffusion and the cost of technology acquisition given the high transaction costs of obtaining information as well as negotiating and acquiring proprietary technologies.[4] Therefore, it is essential to study how to address EST-related IP problems appropriately in the global climate negotiations.

This study discusses the accessibility of ESTs with the ultimate goal of bringing about sustainable development from the perspective of patent protection.[5] Considering solutions from the perspective of the structure of EST patent rights is essential to solve external problems of the environment and resources in an internalized economic way.[6] This means that the rules about the conferral of patents, the protection and application of patent rights could play a profound role in addressing climate change. Throughout the history of patent systems, adequate

technologies among all Parties, and particularly from developed to developing countries, for both mitigation and adaptation.')

[3] Meir Perez Pugatch, 'Mitigating Climate Change through the Promotion of Technology Transfer and the Use of Environmentally Sound Technologies: The Role of Intellectual Property Rights' (2010) 4 European Journal of Risk Regulation 408, 409. (A new project aiming at studying the role of IPRs in relation to the transfer, access and application of ESTs was jointly conducted by the United Nations Environment Programme, the European Patent Office, and the International Center for Trade and Sustainable Development through the survey of EST licensing by leading companies and organizations.)

[4] Frederick M. Abbott, 'Innovation and Technology Transfer to Address Climate Change: Lessons from the Global Debate on Intellectual Property and Public Health' (2009) ICTSD's Programme on IPRs and Sustainable Development, Issue Paper No. 24, June 2009. (It is emphasized by the author that IPRs is a decisive element to attract private and public investment in research and development of ESTs and a prerequisite for the acquisition of the high cost of technology development. Therefore, the cost of negotiations and access to ESTs, most of which are privately held, is naturally produced.)

[5] Henning Grosse Ruse-Khan, 'Sustainable Development in International Intellectual Property Law – New Approaches from EU Economic Partnership Agreements?' (2010) 29 ICTSD Programme on IPRs and Sustainable Development 1.(With an ambiguous meaning and several distinct connotations, the concept of sustainable development shows up in many international formal and informal documents including IP-related agreements by integrating and reconciling economic, social and environmental aspects as a core function.)

[6] Joshua D. Sarnoff, 'The Patent System and Climate Change' (2011) 16 (02) Virginal Journal of Law and Technology 302, 336. (According to Lemley, only in the area of IP is the internalization method permitted to solve the issue of social benefits, including environmental benefits.)

attention has been paid to the role of patents in stimulating innovation and economic growth. There is no doubt that the economy-oriented value embodied in patent systems has made a great contribution to the improvement of scientific and technological progress and human wellbeing.

However, as problems arise, such as global warming, resource depletion, ecological deterioration and environmental pollution, the development model that pursues fast but unhealthy unilateral economic growth has been perceived as having a negative influence on society as a whole. Despite efforts to improve national patent laws and draft international patent conventions, there has been no real changes to guidance on creative activities and protection of innovation under the current patent system, which apparently fails to take into account environmental externality thereof.[7]

ESTs are grabbing attention because of their potential as weapons against environmental pollution and excessive resource consumption. From the legal perspective, it is patent systems that have the largest effect on technological innovation. As all the problems brought by technological development need to be solved by technological solutions, the design of any patent system undoubtedly plays a substantial role in handling environmental problems with the main characteristic as climate change.[8] Given the constantly increasing value of EST patents, the relationship between ESTs, patents and climate change; the role of patents in stimulating innovation and transfer of ESTs; and global and regional EST-related patent activities and trends; they have become the focus of recent research. This

[7] Daniel K.N. Johnson and Kristina M. Lybecker, 'Challenges to Technology Transfer: A Literature Review of the Constraints on Environmental Technology Dissemination' (2009) 07 Colorado College Working Paper in the Project Supported by the National Peace Foundation and the United States Chamber of Commerce 1, 13. (According to David Popp, environmental externality is one of the two market failures that need to be addressed in the field of green technologies, or there would be no additional incentives to adopt new technologies. The measures to deal with this issue are supposed to generate satisfactory results in terms of both atmospheric temperature and economic welfare.)

[8] Ujjwal Kacker, 'Technology Transfer and Financing: Issues for Long Term Climate Policy in Developing Countries' (2009) 3 Carbon & Climate Law Review 292, 293 < http://heinonline.org/HOL/Page?handle=hein.journals/cclr3&div=51&g_sent=1&collection=journals#310> accessed on 8 January 2014. ('Technological solutions are imperative in meeting the challenges of climate change. A critical factor in greenhouse gas emissions, technology is also fundamental to enhancing existing abilities and lowering the costs of reducing these emissions.')

research is important for understanding the role of patents in the global response to climate change, technological development in energy industries, and the relationship between EST patent protection and collective actions against the challenges of climate change.

However, little light has been shed on how to use patent systems to increase access to ESTs, or to consider how to establish a special patent system based on the particularity of ESTs. Existing practice focuses on the reform and adjustment of the patent review process to support the development of ESTs. As the review process is only a part of the patent protection system, the limitation of this method is that it does not present all the advantages of how patent systems can promote access to ESTs, and fails to examine in a systematic way the potential discord between the structure of patent rights and access to ESTs.

The broad transfer and use of ESTs is the most effective solution to addressing climate change. Given its limited role in encouraging technology diffusion, the general patent system cannot meet the special needs for ESTs, even though its positive effect on innovation is significant. In order to fill the research gap and realize the value of patent systems, this study proposes that the establishment of a special patent system for ESTs be supported as deep concern about climate change, which requires necessary reform of the international patent system so as to play its due role in dealing with global threats and challenges.[9]

Compared with other technologies, the ability of ESTs to relieve man-made pollution suggests their tight link to environmental problems with climate change as the main feature. EST patents have always been controversial in climate negotiations, indicating that ESTs have their own traits which separate them from other emerging

[9] Nandini Kotthapally, 'From World Intellectual Property Organization (WIPO) to World Innovation Promotion Organization (WIPO)? Whither WIPO?' (2011) 2011 WIPO Journal 1. (Global threats and challenges spur increasing demand of reform in IP systems, seen from '[a]t the international level, this post-TRIPS developmental consciousness in IP was primarily crystallized and manifested in the Doha Declaration on Public Health in 2001 and followed up by the WIPO Development Agenda in 2007 and at the national level, it is evidenced in ongoing IP reforms both in the developed and developing worlds and the chorus of public interest voices even within the developed countries for re-balancing the IP system to ensure that stronger IP regimes do not constrain access to technology, knowledge and ultimately human welfare.')

industries, such as biotechnology, information and communication industries.[10] More critically, ESTs are not defined as a kind of industry or as a way of offering services to a particular type of customer, but instead are scattered widely and meet the needs of different kinds of customers.[11] The internal properties of ESTs examined from the user-friendly perspective are not fixed or abstract entities based on hypotheses, but rather entities with substantive and productive characteristics with a clear dual attribute as public and private products.[12] It is because of these characteristics that ESTs have unusual value and should be distinguished from the other technologies and given special treatment in patent protection.

Worsening climate change impresses people with the urgent demand for ESTs, which need special legal treatment. In response, some proposals have been put forward to promote the diffusion of ESTs.[13] These can be divided into two main categories: the mechanism of EST transfer under the UNFCCC and the full use of flexibilities in TRIPS, for example, a Doha-type solution under WTO, to deal with conflicts between exclusive rights of patent holders and access to ESTs. Unfortunately, insurmountable institutional barriers, deep-rooted trade rules and IP protection have

[10] Michael A. Gollin, 'Using Intellectual Property to Improve Environmental Protection' (1991) 4 Harvard Journal of Law & Technology 193, 197. (In this article, the scope of ESTs is listed in six categories, including industrial processes with minimum of resource consumption and waste production, products of environmentally soundness throughout their life cycle, recycling systems, waste management systems, pollution control systems, pollution disposal products and methods, all of which together form 'a discrete industrial sector of legal, technical, and commercial characteristics of its own'. Interestingly, a phenomenon shared by ESTs and other areas such as biotechnology and computer science is witnessed that all relevant aspects are brought together in a technique-specific context.)

[11] Eric L. Lane, 'Building the Global Green Patent Highway: A Proposal for International Harmonization of Green Technology Fast Track Programs' (2012) 27 Berkeley Technology Law Journal 1119.

[12] James B. Ang, 'CO_2 Emissions, Research and Technology Transfer in China' (2009) 68 Ecological Economics 2658. (The pollution control and prevention function of ESTs could create a higher productivity growth, which in return can promote environmental protection because a more productive country can use resources in a more efficient way.)

[13] Ahmed Abdel Latif, 'Change and Continuity in the International Intellectual Property System: A Turbulent Decade in Perspective' (2011) 3 (1) WIPO Journal 36, 39. (Proposals for the issue of ESTs range from 'the exclusion of climate-friendly technologies from patentability in developing countries and LDCs to full and expanded use of existing TRIPS flexibilities, including compulsory licenses, through a 'Doha-type' solution.')

stood in the way of these two proposals.[14] These reflect the attitude of market-based mechanisms towards transfer of ESTs.[15]

Despite the lack of will to dismantle regulative safeguards in the hope that the markets instead will solve all problems, the idea that EST transfer can only be solved through market adjustment mechanisms keeps its key status in international rule-makings.[16] Under current trading system, it is hard for a group of individuals who lack moral self-discipline to take the initiative to coordinate economic benefits and other interests in an optimal manner in response to global goals such as climate adaptation and mitigation.[17]

Therefore, the traditional mode of market incentives is not a particularly reliable way to increase access to ESTs. Instead, specially-designed patent rules for ESTs should be adopted to coordinate patent rights and public interests. The protection of private interests of IP owners through a legal monopoly for a certain period of time is just an approach to maximize public welfare, leading to the same destination as the implementation of public welfare in other areas.[18]

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[14] Bronwyn H. Hall and Christian Helmers, 'The Role of Patent Protection in (Clean/Green) Technology Transfer' (2010) No.16323 National Bureau of Economic Research Working Paper 1, 26. (Based on case study of three clean energies conducted by Barton, it is observed that the prevailing oligopolistic market structure arising from proprietary technologies that account for a sizeable share of that market will increase the risk of collusion and prevent entry of new small companies, which do harm the market competition and future innovation.)

[15] UNEP, EPO and ICTSD, 'Patents and Clean Energy: Bridging the Gap between Evidence and Policy: Final Report' (2010) < http://www.ictsd.org/themes/innovation-and-ip/research/patents-and-clean-energy-bridging-the-gap-between-evidence-and-policy>accessed on 20 September 2014. (The market-based mechanisms such as IPRs are viewed, mainly by developing countries, as barriers against the fulfillment of EST-related commitments.)

[16] John H. Jackson, 'International Economic Law in Times that Are Interesting' (2000) 3 (1) Journal of International Economic Law 3, 24. ('Human rights law offers WTO rules moral, constitutional, and democratic legitimacy far beyond the traditional economic and utilitarian justifications. This legitimacy will be crucial for the democratic support of future WTO negotiations and agreements.' However, it argues that economic freedom and property rights of individuals to the greatest extent also serve 'as a barrier to the power of governments to restrict private freedom and interfere in the rule of law'.)

[17] Amartya K. Sen, 'Rational Fools' in *Philosophy and Economic Theory* edited by Frank Hahn and Martin Holls (Oxford University Press 1979) 87-109. (It is believed that each individual engaged in economic activities acts out of selfish motives and tries to obtain the biggest benefits at a minimum cost.)

[18] The Agreement on Trade-Related Aspects of Intellectual Property Rights, Apr. 15, 1994, signed as Annex 1C of Marrakesh Agreement Establishing the World Trade Organization, 1869 U.N.T.S. 229, 33 I.L.M 1197 (1994), coming into force on January 1,1995.

1.1.2 The Preliminary Assumption of this Thesis

Different from previous research, most of which puts much emphasis on the discussion about whether IPRs promote or impede the international transfer of ESTs to developing countries, the proposed system accepts the classic role of patent protection in stimulating innovation of ESTs, and that the real discord is between IPRs and access to ESTs. Analysis of the coordination between the international patent system and the climate regime reveals that the international patent system, which centers on the strengthening of exclusive rights, could be counterproductive to the global efforts to address climate change. This reflects the inherent disadvantage of the traditional patent system.[19] This thesis attempts to explore a new regime to harmonize the two domains.

In order to establish a new international regime, a new perspective based on the dual nature of ESTs is proposed in this thesis. This is different from the perspectives that separate the private and public characteristics of ESTs when dealing with the relationship between patent rights and access to ESTs. In previous research, there mainly exist two diametrically opposed perspectives: one perspective stands for no compromise in terms of IP protection and enforcement by laying stress on the inviolability of patent rights, while the other advocates absolute restrictions on patent rights of protected ESTs due to their nature as public goods, with the objective of promoting the application of ESTs.[20] This study prefers the perspective which falls

<http://www.wto.org/english/docs_e/legal_e/27-trips_01_e.htm.> accessed on 11 December 2011.

[19] Jonathan S. Masur, 'Regulating Patents' (2010) 2010 (7) Supreme Court Review 275, 279. (It is argued by Masur that 'patent questions should be decided with respect to moral or deontological considerations, not economic ones' that are foremost, if not the only one, in the modern patent system.)

[20] Sarnoff (n 6) 339. (The other approach which means expanding the exceptions of exclusive rights to ESTs is considered more problematic than excluding patents on science, nature and ideas that may be contrary to the public order or morality without regard to the interpretation of the term 'invention'. Even if climate change is presumably recognized as 'a sufficiently serious problem that excluding patentability for environmental sound technologies that make significant contributions to climate change would help to avoid serious prejudice to the environment within the meaning of Article 27.2, the Article 27.2 may contemplate only the prohibition of patents on inventions that also must be banned from the marketplace, due to their exacerbation of environmental problems, rather than their ability to

somewhere in the middle, which places the dual nature of private and public characteristics in the same object, that is, the imperfect or quasi-public goods from the economic point of view, in order to achieve EST-related IP protection and rational use through two layers of coordination and cooperation.[21]

The preliminary result of this study indicates that to establish a special patent regime that could be conducive to proper circulation of ESTs among countries and lead to positive results in response to climate change requires joint efforts, mainly by the United Nations (UN), the World Intellectual Property Organization (WIPO), the World Trade Organization (WTO) and the World Health Organization (WHO). At the same time, it is certainly necessary to take the coordination of different national intellectual property systems into account. In short, this could take the form of a legal regime which harmonizes patent protection and access to ESTs with a wide range of participation of world society under the WIPO.[22]

The proposed regime is clear and practical, and can be presented at two distinct levels. At a macro level, it focuses on the cooperation within the international climate regime and IP system, including the justification of the establishment of such a patent regime, the objective of the regime, the principles that the regime follows, and the consideration of public interests. At a micro level, the study explores from the legal and economic perspective an appropriate structure model of patent protection specially designed for ESTs, which consists of intensity (patentability), length (duration), and width (breadth).[23] Different levels of the three dimensions have

mitigate such problems.' These arguments mean that it remains uncertain whether ESTs are falling in the scope that could be excluded from patentability under TRIPS.)

[21] Anastasia Lewandoski, 'Intellectual Property Rights to Enhance International Clean Tech Transfers' (2008) 9 Sustainable Development Law & Policy 51. (It is believed by the author that although the positive human right to public health and access to scientific advancement is seemingly at odds with IPRs, a middle ground can be reached by reconciling the two in 'a system that recognizes patent protection for a limited time'.)

[22] UNEP, EPO and ICTSD, 'Patents and Clean Energy: Bridging the Gap between Evidence and Policy: Final Report' (n 15) 20. (Based on the case study of the wind power industry in India, China and Spain, it finds that there exist primary, second- and even third-tier markets for the needs of countries or regions of different developmental levels. Therefore, in this thesis it believes that the solutions to harmonize the patent protection and access to ESTs among countries or regions in which contradictions are concentrated help to solve the similar issue of access to ESTs in other markets.)

[23] Here intensity is used to explain the issue about patentability of ESTs, including one of the targets of

different incentive effects on the innovation and accessibility of technologies. Based on the quasi-public nature and major components of ESTs, an optimal structure of patent rights is put forward to improve social welfare, suggesting that the threshold of patentability be raised; the length be extended; the breadth be narrowed. Accordingly, differentiated protection with value-based judgment at its core, is proposed for different types of ESTs, giving priority to the innovation of some ESTs and accessibility of other ESTs. Furthermore, for the purpose of task allocation of sectors on emission reduction, a new key sector-based classification of ESTs could assist in framing the EST patent system and assessing technology needs to guide the application of ESTs.[24]

As such, the proposed regime in this study is a refined and differentiated legal system, which is demonstrated in two senses: a system that discourages non-environmentally sound technologies and a system providing value-based protection for different types of ESTs. The proposal put forward in this thesis turns a reward mechanism, into a system that aims to green the innovation environment and is suitable for technology diffusion, by using multiple variables of patent system.

Located in China, as one of the largest emitters of GHGs with a great potential for emission reduction, the discussion regarding how to flexibly apply this differentiated patent regime in different jurisdictions is based upon China's biased development of ESTs and actual demand for ESTs, against the background that the implementation of patent protection must work with characteristics of EST-related industries at a national level. This study finds that differentiated patent protection is

this specially-designed patent system that is to clarify the vague definition of ESTs and the level of grant standards.

[24] Peter Drahos, 'Bargaining over the Climate: Lessons from Intellectual Property Negotiations' (2011) 2 Climate Law 1, 9. (Sectoral approaches in handling emission reduction are highly advocated by both large companies and governments. Large companies in high emission industries such as aluminum, cement, and steel 'will probably face increasing incentives to negotiate a sectoral approach to emissions reduction. For example, the South Korean steel producer POSCO will have an emissions-reduction target under Korea's Target Management System for greenhouse gas reduction, and may well face a tougher target under the Korean cap-and- trade scheme being discussed by policymakers in Korea'. As for governments, sector-specific agreements to reduce emission could be achieved among big emitters and the membership of these agreements is likely to increase by means of bilateral trade agreements.)

desirable for China in two main aspects, namely, the actual working and local innovation, and therefore could have a very positive impact on the building of China's green innovation environment, as well as enhancing effective competition for ESTs around the world.

1.2 Scope and Context of the Research

1.2.1 Scope of the Research

Given the complexity of this study, involving as it does many disciplines, this thesis is not intended to focus on solving problems about international relations, public policy or international trades initiated by this topic. It rather explores the optimal rules regarding patent protection in the context of facilitating access to ESTs, and thereby to understand how to use these legal rules to respond to challenges of climate change. The international IP issues may be considered as one of thorniest matters in climate negotiations, but it is necessary to clarify that their solution is extremely important for the transfer and application of ESTs, and surely any doubt about it could be swept away only by convincing arguments. Besides, in this thesis, the focus is placed on invention patents, which are arguably of massive significance above all for ESTs. In the context of climate change, the continuous efforts in crafting a legal institutional architecture could be helpful to provide a promising landscape and a realistic solution to break the impasse in the global battle against climate change.[25]

International harmonization of IPRs in the context of climate change is a dynamic process of development which involves major stakeholders in international

[25] Frederic M. Abbott, 'Distributed Governance at the WTO-WIPO: an Evolving Model for Open-Architecture Integrated Governance' (2000) 3 Journal of International Economic Law 63. (It is believed that 'the inter-institutional relationship that has evolved between the WTO and the World Intellectual Property Organization (WIPO) since the conclusion of the Uruguay Round evidences a number of characteristics that might usefully form the basis for relations between the WTO and other inter-national organizations.' The specially-designed patent system in this thesis is viewed as an institutional innovation, which involves a wide range participation of world society in IP rule making and is composed of an agreement and a series of legal obligations.)

negotiations, i.e. sovereign states, IP holders and users.[26] It is worth mentioning that its central aim is not to examine conflicts between each single country and all other countries in this area of ESTs one by one, because obviously this is not going to work. Rather, the focus is placed on major concerns that have significant impact on the future development of the whole of human society.[27] Admittedly, due to the fact that there is necessarily an economic gap between nations, it is impossible to completely balance the interests of all parties. Accordingly, however, the conclusion cannot be drawn that the harmonized system or the IP system will result in the gap between the rich and the poor.

Since it began, IP protection has been used to encourage the innovation and dissemination of knowledge, but there are always limitations in the advancing process of history where expansion of social systems is often beyond a reasonable range, which is an extremely important reason why social systems continue to be corrected and improved.[28] The Agreement on Trade-Related Aspects of Intellectual Property Rights[29] (TRIPS) is undoubtedly viewed as the most significant adjustment in the

[26] Keith E. Maskus and Jerome. H. Reichman, 'The Globalization of Private Knowledge Goods and the Privatization of Global Public Goods' (2004) 7 (2) Journal of International Economic Law 279, 300. (The stakeholders would not quietly fade away even if they were excluded from the process of normal setting in the field of IPRs, and, conversely, they 'have worked through numerous NGOs to defend global public goods against further encroachment in parallel or alternative forums', which is called the strategy of regime-shifting.); see also Henrike Peichert, Nils Meyer-ohlendorf, 'G8 Impact on International Climate Change Negotiations - Good or Bad' (2007) the report made in the 2007 Annual Conference of the British International Studies Association.(A wide range of stakeholders of high interests are invited to attend the G8 plus 5 Climate Change Dialogue, including senior legislators from sovereign states, international business leaders, civil society representatives, and opinion leaders to discuss about a new paradigm for international cooperation, which is of great reference value for the reconciliation of IPRs and efforts against climate change.)

[27] Elizabeth Burleson and Winslow Burleson, 'Innovation Cooperation: Energy Bioscience and Law' (2011) 2011 (2) University of Illinois Law Review 101, 121. ('Building international consensus is an arduous task across many sectors, yet momentum is building to try to resolve key areas of international concern—including transfer of environmentally sound technologies to least developed countries.')

[28] Edward Kwakwa, 'Reflection on "Development", "Developing Countries" and the "Progressive Development" of International Trade and Intellectual Property Law' (2012) 40 Denver Journal of International Law and Policy 221, 232. (Given the limitation of international trade and IP system on the development issues, a group of countries known as 'Development Agenda Group' take an active part in IP and related issues debated under WIPO, believing that in the context of national public policies and development goals exceptions, exclusions and limitations to IPRs can bring 'much needed balance between private interests and larger public interests'.)

[29] The Agreement on Trade-Related Aspects of Intellectual Property Rights, Apr. 15, 1994, signed as Annex 1C of Marrakesh Agreement Establishing the World Trade Organization, 1869 U.N.T.S. 229, 33

recent history of IP protection, accompanied by the reform in the coverage and scope of patents in new technologies such as computer software, business methods, genetically modified plants and animals as well as gene sequences in a number of countries.[30]

It often happens that the evolution of existing legal systems lags behind that of new technologies, which fosters the reform of the former directly or indirectly.[31] The question is how flexible should be the global IP regime be to meet the demand of ESTs required by addressing climate change? Some critics of the global IP regime under TRIPS have suggested that spotting the risks caused by the strengthening of IPRs in all countries in all technologies needs to be done urgently.[32] In accordance with TRIPS, a minimum standard of IP protection is compulsory for all signatory countries, which are not allowed to favor domestic innovative industries.[33] As a matter of fact, this is not equally advantageous to all states, especially those that are not prosperous enough to afford expensive technologies and those that cannot create satisfactory conditions to attract FDI.[34]

This anxiety resulted from the unbalanced geographic distribution of cutting-edge

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I.L.M 1197 (n 18).

[30] P Weiss, *Patent Policy：Legal-economic Effects in a National and International Framework* (Routledge 2010) 22. (Weiss stated that it is urgent for the patent system to adapt and make the necessary change to meet the challenges posed by the new development in science, technology and society. However, the question is how to choose the reasonable alternations after the shortcomings of the current system are identified.)

[31] Johnson and Lybecker, 'Challenges to Technology Transfer: A Literature Review of the Constraints on Environmental Technology Dissemination' (n 7) 3. (One of the main findings of the authors' study is that the evolution of the legal system related to IPRs is extremely important because the implementation of IP laws plays a decisive role in measuring the effectiveness of IPRs and predicting benefits for innovative companies in the legal realm.)

[32] K. Ravi Srinivas, 'Climate Change, Technology Transfer and Intellectual Property Rights' (2009) 153 Research and Information System for Developing Countries Discussion Paper, 40. (The reference used by Srinivas is from Maskus and Reichmann's book *International Public Goods and Transfer of Technology under a Globalized Intellectual Property Regime* (Cambridge University Press 2005), in Page 15 of which it is believed that the proactive action should be taken by governments in developing countries in order to make easier access to technologies possible and to adopt these new technologies as soon as possible. Another question that how to enhance the ability to access technologies of developing countries raised by the strengthening IP protection should be carefully treated.)

[33] Cameron Hutchison, 'Does TRIPS Facilitate or Impede Climate Change Technology Transfer into Developing Countries?' (2006) 3 (2) UOLTJ 517, 530.

[34] Ibid.

technologies, which is not only reflected by the fact that the latest and most cutting-edge ESTs are generated in western countries but also by the uneven allocation of interests behind this fact in the process of globalization.[35] Globalization not only allows developing countries enjoy the benefits brought by integration, but also makes them more keenly aware of the urgency and anxiety of the self-development. Therefore, in view of the reality of painful experience and survival anxiety in developing and least-developed countries (LDCs), international harmonization of IPRs in the context of climate change should considers facilitation of technology transfer to these countries and use of IPRs and technologies for development of Member States.[36]

The role of ESTs has been well documented in the multilateral instruments on climate changes. The UNFCCC (Article 4.1 (c)) and the Kyoto Protocol (Article 10 (c)) specifically mention development, application and diffusion of ESTs relevant to climate change, including the know-how, practices and processes.[37] It is worth noting that consumers have an unclear environment-friendly concept in their minds, which is often not conducive to and even hinder the spread and pricing of ESTs.[38] ESTs, also known as environmentally sustainable technologies, green technologies or clean technologies, are the beneficial application of environmental science in order to protect the natural ecology and resources and ensure environmental sustainability by

[35] Antoine Dechezleprêtre, Matthieu Glachant, Ivan Hascic, Nick Johnstone, Yann Ménière, 'Invention and Transfer of Climate Change Mitigation Technologies on a Global Scale: A Study Drawing on Patent Data' (prepare for the Review of Environmental Economics and Policy)<http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1414227 > accessed 5 February 2012. (Statistics shows that the distribution of innovations is uneven because sixty percent of aggregate innovations are highly concentrated in Japan, Germany and the USA. It is surprising that the innovation performance of China and South Korea, as the representatives of emerging economies, is far from being negligible with 15% of total inventions together. However, the export market of their innovations is not optimistic as quite as that of innovations generated by industrialized countries due to the relatively low value. Additionally, it is reported that most of patentable low-carbon technologies are held by western countries, who have gained excess monopoly profits from their advantages in this aspect.)

[36] Srinivas, 'Climate Change, Technology Transfer and Intellectual Property Rights' (n 32).

[37] The United Nations Framework Convention on Climate Change (n 1); the Kyoto Protocol to the United Nations Framework Convention on Climate Change, Conference of the Parties, 3d Sess. U.N. Doc. FCCC/CP/1997/L.7/Add.1 (Dec. 11, 1997).

[38] Johnson and Lybecker, 'Challenges to Technology Transfer: A Literature Review of the Constraints on Environmental Technology Dissemination' (n 7).

eliminating the negative effects caused by human activities.[39] In this thesis, all technologies under discussion in the context of climate change are referred to as ESTs, which are those that can bring about the reduction of GHG emissions and those that can increase energy efficiency.[40]

In an effort to explore an appropriate patent regime for ESTs, it is essential to examine existing arrangements around patents and access to ESTs. At present, the international coordination of discord between protecting patents and access to ESTs may be achieved by the use of flexibilities in TRIPS, mainly the criteria for obtaining patents, exemptions, interpretation of claims, the use of compulsory licensing measures on behalf of public interests and anti-competitive practices.[41] The use of compulsory licenses is regarded as being reserved for the pharmaceutical industry, while other forms of these flexibilities can be used to promote the transfer of ESTs.[42] According to Bollyky, this is not the case, because 'TRIPS imposes conditions and procedural requirements, but not subject matter restrictions, on the issuance of compulsory licenses'.[43] However, the deterrent effect of compulsory licenses in this

[39] Emma Barraclough, 'EPO Leads Debate on Patents and Climate Change' (2010) No.196 Managing Intellectual Property 32. (In the subsection 'the Green name game' of Patent Survey: Introduction, if the innovation or invention complies with the green or environmentally friendly technologies standard, it will be allowed by the UK IP Office to entered Green Channel; EU also make the promise to give the financial support to the eco-innovation projects which are centered on the technologies defined as any form with the significant success in achieving the sustainable development by reducing the impact on environment or improving the efficiency and reasonable application of natural resources).

[40] Srinivas, 'Climate Change, Technology Transfer and Intellectual Property Rights' (n 32). (In the introduction of the discussion paper, the author considers that climate friendly technologies are a part of environmentally sound technologies.)

[41] Jerome H. Reichman, 'From Free Riders to Fair Followers: Global Competition under the TRIPS Agreement' (1997) 29 (1-2) New York University Journal of International Law and Politics 25. (It is suggested in this article that developing countries should create a sound competitive atmosphere in their domestic markets as a faithful way to implement the international minimum standard of intellectual property protection provided by TRIPS. At the same time, they will certainly take full use of flexibilities within international conventions, which leave much room for wide and crucial issues to the vagaries of WTO Member States' domestic laws.)

[42] Robert Percival and Alan Miller, 'Resolving Conflicts between Green Technology Transfer and Intellectual Property Law' (2011) 27 University of Maryland School of Law 18< http://ssrn.com/abstract=1861340> accessed on 16 June 2012.

[43] Thomas J. Bollyky, 'Intellectual Property Rights and Climate Change: Principles for Innovation and Access to Low-Carbon Technology' (2009) 1557196 Center for Global Development Note 1, 5. (The author explained that

> 'TRIPS imposes conditions and procedural requirements, but not subject matter restrictions, on the issuance of compulsory licenses. In other words, the use of compulsory licensing is not limited

aspect has been challenged by some scholars.[44] Options provided in TRIPS for harmonization of IPRs and other fields are restricted for countries that have to resort to compulsory licensing and competition policies.[45] Additionally, the scope of the use of compulsory licenses may be not so favorable in respect to ESTs.[46]

This research never disregards the deficiencies and obstacles of the current climate regime and IP system in coordinating IPRs and climate protection. As concrete methods for getting access to ESTs were not embraced in the climate regime, the provisions with respect to technology transfer may be interpreted in various ways, and it is difficult to evaluate whether countries comply with Article 4.5 of UNFCCC or not.[47] The Kyoto Protocol puts more emphasis on creating a favorable environment for private sector bodies and requires the commitment of developed countries on technology transfer in general terms, not in specific details.[48] The study

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to treatments for diseases such as HIV/AIDS, malaria, or tuberculosis; a member state may issue a compulsory license on any patent, including patents for clean technologies, provided that member state satisfies the conditions and procedural requirements of the TRIPS Agreement'.)

[44] Keith E. Maskus and Ruth L. Okediji, 'Intellectual Property Rights and International Technology Transfer to Address Climate Change: Risks, Opportunities and Policy Options' (2010) 32 ICTSD's Programme on IPRs and Sustainable Development Issue Paper 1, 47. (Maskus and Okediji hold the view that a non-voluntary mechanism is likely to reduce the effectiveness of technologies, especially those that are indispensable to the use or adaptation.)

[45] Ken Shadlen, 'Policy Space for Development in the WTO and Beyond: The Case of Intellectual Property Rights' (2005) Tufts University Global Development and Environment Institute Working Paper No. 05-06, 10-11<http://ase.tufts.edu/gdae> accessed on 31 May 2012. (The general objective of TRIPS is to safeguard the interests of IP holders, despite some flexibilities provided. Thus it can be predicted that policy options available to countries to balance the interests of public users and IP right holders and to encourage competition are restricted.)

[46] Bollyky (n 43) 4. (The author holds the view that 'compulsory licenses may only be issued by national governments and are national in scope and may deter private investment and innovation'.)

[47] Hutchison (n 33) 527. (Referring to the Intergovernmental Panel on Climate Change special report on climate change *Methodological and Technological Issues in Technology Transfer*, Hutchison pointed out that the provisions under the climate change conventions are ambiguous and the interpretation of the provisions is different, so the performance in compliance sense is hard to measure.)

[48] The Kyoto Protocol UN Doc FCCC/CP/1997/7/Add.1, 37 I.L.M.22, an important international agreement to the United Nations Framework Convention on Climate Change, was adopted on 10 December 1997, and entered into force on 16 February 2005 http://unfccc.int/essential_background/kyoto_protocol/items/6034.php. (It is stated as the Article10 (c)

'Cooperate in the promotion of effective modalities for the development, application and diffusion of, and take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies, know-how, practices and processes pertinent to climate change, in particular to developing countries, including the formulation of policies and programmes for the effective transfer of environmentally sound technologies that are publicly

finds that technology transfer under the UNFCCC and Kyoto Protocol does not appear to be given a significant position as it is supposed to and is insufficient to meet the needs of developing countries.[49] The TRIPS Agreement does not provide effective international compulsory licensing remedies, once patent holders in developed countries refuse to transfer or license patents to developing countries so as to circumvent competition.[50] Thus, 'there is no conflict on the face between the climate change regime and TRIPS.'[51] Under these circumstances, the expectation of fruitful results in the greater transfer of ESTs produced by TRIPS alone is not encouraging.[52]

As far as the current proposed amendment to the international regulations concerning IPRs under the UNFCCC is concerned, this thesis considers it is unlikely to work because developed countries have made a large amount of investment in the IP arena.[53] For example, total IP assets accounted for a large proportion of U.S. commercial assets and IP is closely related to domestic employment.[54] Although there have been waves of criticism and denunciation of over-stressed IPRs from the international community, some studies have argued that IPRs are not as great an obstacle as claimed because there are a variety of alternative emission reduction

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owned or in the public domain and the creation of an enabling environment for the private sector, to promote and enhance the transfer of, and access to, environmentally sound technologies'.)

[49] Srinivas, 'Climate Change, Technology Transfer and Intellectual Property Rights' (n 32) 1.

[50] Hutchison (n 33) 533. (Referring to the book *The TRIPS Regime of Patent Rights* (The Hague: Kluwer Law International, 2005) written by Carvalho, Nuno Pires de, the author held the following opinion. 'There is no basis under TRIPS, according to this view, to compulsorily license technologies which companies refuse to deal because 'there is no sounder business practice than refusing to engage in commercial deals with competitors'.)

[51] Ibid. (The author points out that there are shortcomings in both TRIPS and UNFCCC, meaning that the two regimes are not contradictory to each other in terms of transfer of ESTs.)

[52] Srinivas, 'Climate Change, Technology Transfer and Intellectual Property Rights' (n 32).

[53] Bollyky (n 43) 4. (It is analyzed by the author that many proposals on IPRs have been put forward to make reform in the negotiations of climate change. However,

> '[t]he merits of these particular proposals aside, it would be difficult to maintain that such changes to the international regulation of IP, once made, should not be extended to address concerns regarding developing countries' access to patented medicines and other patented technologies relevant for development. It is highly unlikely that developed countries would agree to any such changes given their heavy investment in IP'.)

[54] David Kappos, 'Securing America's Innovation Future: Challenges and Progress for Intellectual Property System' (2010) Speech as prepared for the conference in the Columbia University on December 14, 2010 <http://www.uspto.gov/news/speeches/2010/Kappos_Columbia_Speech.jsp> accessed on May 20, 2012.

technologies.[55] With the rapid development and increasing emission amounts, many developing countries are able to meet economic and political obligations for emission reduction. As for the LDCs that are still in the transition period in accordance with TRIPS, the role of IP may become obvious at the end of that period.[56] In other words, the role of IP seems to be exaggerated currently, and IP will play a greater role in the future development and dissemination of ESTs under some specific conditions.[57]

The difficulties encountered in the WTO and UNFCCC indicate that institutional obstacles may be a big challenge for international harmonization of IPRs in the context of climate change by establishing a differentiated patent regime for ESTs. Choosing an appropriate platform to form a resultant force against uncertainty in institutional and economic exchange is a puzzled but inevitable legal issue for the formulation and implementation of such an international regime.[58]

The lessons drawn from the heated debates on IP and public health need to be analyzed in a comprehensive and comparative way, so that a differentiated patent regime could be created based on the characteristics of ESTs. In fact, it is quite significant to find similarities and differences between ESTs and drugs before any lesson to be learnt from negotiations on IPRs and public health, because these differences cannot be overlooked and may directly lead to different consequences with the introduction of IPRs into the two domains. Through comparison of the different roles of patents in the pharmaceutical industry and the field of ESTs, the argument that patent rights hinder the transfer of ESTs may be reinforced or denied by

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[55] Johnson and Lybecker, 'Challenges to Technology Transfer: A Literature Review of the Constraints on Environmental Technology Dissemination' (n 7).

[56] TRIPS Agreement, Art.66.1. The extension of transitional period is set especially for least developed countries which are defined by the UN. http://www.wto.org/english/tratop_e/trips_e/t_agm7_e.htm.

[57] Bollyky (n 43) 1-2. (After discussion of the role of IPRs under UNFCCC negotiations, it is concluded that 'the role of IP rights in addressing climate change is more nuanced than the polarized negotiations would suggest'.)

[58] Thomas Cottier and Marina Foltea, 'Global Governance in Intellectual Property Protection: Does the Decision-making Forum Matter?' (2012) 3 (2) The WIPO Journal 139, 140. (By comparing the impacts of the IP rule-making forums at different levels on the achievement of keeping a balance between rights and obligations of stakeholders involved, it finds that 'the balance is better preserved in a multilateral norm-setting', so it is suggested in this article that 'IP rule-making in these fora is encouraged while taking proper account of the current political constraints under which they operate'.)

government officials and other stakeholders explicitly or implicitly.[59]

Undoubtedly, ensuring a good ecological environment or dealing with disasters caused by environmental problems lies in the scope of public interest, but it is not to be taken for granted that the exclusive position of patentees should be excluded by the existence of public interest.[60] Provided that public interest could be satisfied by other similar methods, non-voluntary licensing cannot be authorized in the name of public interest.[61] It is worth noting that the substitutability of ESTs is higher than that of drugs in the domain of public health, so particular care should be applied when taking advantage of compulsory licensing and other exceptional measures. Based on the analysis and examination on the similarities and differences, the study of lessons from the international debate on IPRs and public health does not mean that it can naturally provide a completely successful model for negotiations on climate change and IPRs, and a rational treatment is surely needed when talking about lessons including benefits and drawbacks.[62]

Appropriate patent protection for ESTs must be considered from the perspective of improving social welfare.[63] In this respect, the law and economics analysis justifies that different levels of the three dimensions of patent rights that includes intensity, length and breadth jointly affects social welfare. Accordingly, an optimal

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[59] Abbott, 'Innovation and Technology Transfer to Address Climate Change: Lessons from the Global Debate on Intellectual Property and Public Health' (n 4). (The author attaches great significance to the parallel made in view of the different roles of IPRs in pharmaceutical sector and renewable energy sector in the forward of this article.)

[60] Percival and Miller (n 42) 18. (As it is argued,

> 'The green technology transfer debate has centered on the possibility of relaxing intellectual property rights (IPRs) to facilitate the transfer of technologies from developed to developing countries that would not otherwise be able to afford them. Arguments in favor of relaxing IPRs generally stress that the ability of national governments to use strategies such as compulsory licensing is justified by a compelling public 'health' or 'emergency' interest.')

[61] Robert Fair, 'Does Climate Change Justify Compulsory Licensing of Green Technology' (2009) 6 International Law & Management Review 21, 25. (The author said that 'there are more effective methods of transferring energy-efficient technology to developing states, such as removing tariff and non-tariff trade barriers'.)

[62] Abbott, 'Innovation and Technology Transfer to Address Climate Change: Lessons from the Global Debate on Intellectual Property and Public Health' (n 4).

[63] Masur (n 19) 287. (As claimed by critics of expansive patent rights, patent protection needs to adjust if 'patents diminish innovation and social welfare in some fields more than they increase it'. The social welfare is a part of economic consideration embedded within the doctrine of patent law.)

combination of the three dimensions, involving definitional problems and the grant standards of ESTs; the length or duration of patents; the breadth of patent validity, can be suggested.

The discussion regarding how to prove the proposed patent regime is workable must be set in a specific context, against the background that the implementation of EST patent protection must work with characteristics of EST-related industries at a national level.[64] As the biggest emerging country and so one that clearly faces the dual pressure of economic transition and emission reduction, China could be selected as a particular focus to explore the domestic application of this special patent system. As one of the largest emitters of GHGs with a great potential for emission mitigation, China must make its due contribution to tackling climate change, by promoting innovation of and access to ESTs based on the development bias of ESTs in its key sectors.[65]

International harmonization of IPRs in the context of climate change means patent protection does not restrict itself to the stimulus of innovation and dissemination of ESTs, but extends its concerns over its effect on climate protection. This study aims to make full use of patent systems to facilitate access to necessary ESTs for emission reduction in key concerned industries. What is more, the far-reaching significance of establishing a special regime lies, not in the attempt to provide an alternative system for national laws, but in the demonstration of the

[64] David Ockwell, Jim Watson, Alexandra Mallett, Ruediger Haum, Gordon MacKerron, Anne-Marie Verbeken, 'Enhancing Developing Country Access to Eco-Innovation: The Case of Technology Transfer and Climate Change in a Post-2012 Policy Framework' (2010) No. 12 OECD Environment Working Papers 2010 < http://dx.doi.org/10.1787/5kmfplm8xxf5-en> accessed on 2 November 2014. (The context-specific technological development which varies inter- and intra- nationally requires an international mechanism with a capability to deal with IP issues in specific instances.)

[65] Aaditya Mattoo, Arvind Subramanian, 'A 'Green-print' for International Cooperation on Climate Change' (2013) Policy Research Working Paper No. 6440 by Trade and Integration Team of The World Bank Development Research Group 1, 12-14. (As number 1 of large emitters in emission rankings, China is 'are now significant players in the world economic system and will have a significant say in the design of any international agreement'. In the context of climate change, it argues that without the significant emission reduction from China, India and other developing-country emitters, 'global targets cannot be met by actions by industrial countries alone'. However, given the significant emission costs and massive demand for energy, the current dissemination and generation of environmental technologies cannot satisfy the reconciliation between economic growth and climate change goals in these developing countries.)

flexibility and inclusiveness of the IP system under WIPO, in response to new potential challenges, which will enhance coordination between IPRs and other fields.[66]

1.2.2 The Context of the Research

To truly implement the goals of the international climate cooperation and to effectively stabilize GHG concentrations, it is essential to accelerate the development of advanced ESTs and promote their wide use on a global basis. The great challenge now is that it seems quite difficult to form a positive interaction of risk distribution and benefit sharing between the international IP protection and human struggle with the climate crisis.[67]

Theoretically, the solution to the climate crisis is fundamentally dependent on innovation and large-scale use of ESTs and provides external incentives for the transfer of advanced ESTs between different countries in different regions, especially the transfer to developing countries. Technology innovation and transfer, with which the form of patents are classically associated with, guarantees commercial benefits which are the inherent driving force to attract private and public investment. In other words, IP is a prerequisite for the development and transfer of ESTs in order to address climate change, which could in return facilitate the updating and dissemination of technologies.[68] So far, however, the international community has not

[66] Thomas Cottier, Marina Foltea, 'Global Governance in Intellectual Property Protection: Does the Decision-making Forum Matter?' (2012) 3 (2) The WIPO Journal 139, 164. ('WIPO has shown a host of interesting initiatives in treaty-making during the past 15 years, which have further developed IP protection in a globalized economy in a properly balanced manner.' However, developing countries express their concerns that 'the overall regime has remained the same and that additional instruments developed in WIPO run the risk of eventually being incorporated into WTO law'.)

[67] Deborah Behles, 'The New Race: Speeding up Climate Change Innovation' (2009) 11 (1) North Carolina Journal of Law & Technology 1, 16. (It argues that the combination of IP rules and environmental policies is necessary to encourage the development and spread of ESTs, however, the current intellectual property law is insufficient to meet the requirement which is already clarified crucially in environment regulations.)

[68] Elizabeth Burleson, 'Dynamic Governance Innovation' (2013) 24 The Georgetown International Environmental Law Review 477, 526. (It is pointed out by Burleson that there is another prerequisite that 'the degree to which fossil fuel is deeply embedded in the economy and the degree to which

yet worked out a concrete and effective mechanism to enhance access to ESTs. Moreover, coordination between the existing international climate framework and the IP system is far from the positive theoretical interaction mentioned above.

The constantly deteriorating environmental situation has encouraged countries to attempt to establish a cooperation mechanism which also has the benefit of overcoming the weakness of individual countries. The increasing interdependence of countries for resolving global environmental issues has resulted in that the two traditional theories in the field of relations between countries, idealism[69] and realism[70], becoming interdependent and not mutually exclusive. All countries pursue their own interests and try to resolve public challenges through cooperation as well - sharing both risks and benefits. The contradiction between the irrationality of individual profit-driven actions and mutual compromise required by collective actions encourages continuous development of international cooperation to solve this global problem.

International cooperation in climate negotiations needs to move towards a global governance structure of broader sustainable development.[71] Since the 1990s, climate negotiations have involved in a difficult and arduous negotiating process. In

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putting a price on carbon' to encourage substantial private sector investment in innovation and participation in diffusion.)

[69] Hans J. Morgenthau, 'Six Principles of Political Realism' in Phil Williams, Donald M. Goldstein, Jay M. Shafritz (eds), *The Classical Reading on the International Relations* (Peking University press 2003）43. (Hans J. Morgenthau, the representative of the realism on the international relations, once pointed out that the realism with the interests defined by the power as its key concepts is universally valid and objective, but it does not mean that a great effort can be made to accomplish something once and for all to save future conflicts between all countries; realistic holders are aware of the moral significance of political action, but refuse to recognize that the moral pursuit of any state can be equivalent to the moral law that dominates the universe).

[70] Ibid. (Contrary to realism theory, the mainstream of international relations theory in the West, even in the world over the long term, the idealism school advocated the core of international relations is the 'right' and 'justice' defined by 'power'. The 18th century Swiss jurist Vattel (Emmerich de Vattel), a representative of idealism in the field of national relations theory, once said 'justice is the foundation of society as a whole and a reliable link for all exchanges'. He even believes that justice between states is more necessary than that between individuals, because it is likely to lead to more terrible results when injustice occurs to state relations.)

[71] The UNFCCC (n 1). (It has been stated in UNFCCC '*Acknowledging* that the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions'.)

reviewing this dynamic process, several important watershed events have occurred which are far from negligible. In 1992, the UNFCCC was adopted at the UN Conference on Environment and Development to set a long-term goal of stabilizing atmospheric concentrations of GHGs, and several important principles, including fair and common but differentiated responsibility and sustainable development to address climate change, were put forward.[72] The UNFCCC can be regarded as the most far-reaching foundation document in the international climate regime. So far, the UNFCCC has not yet promoted successful transfer of ESTs, but it has established a clearing house mechanism and engaged in activities which are helpful to assess technology needs.[73]

Another important document is the Kyoto Protocol which was approved at the Kyoto Conference held in Japan in 1997.[74] This provides quantitative reduction commitments for developed countries and countries with economies in transition for the first time. At the same time, three market-based flexible mechanisms were introduced at this conference: International Emissions Trading (IET), Joint Implementation (JI) and Clean Development Mechanism (CDM).[75] The meeting in Bali, Indonesia in 2007 which had global attention and broad participation focused on issues surrounding how to build a more equitable and effective international climate regime after 2012.[76] The Bali Action Plan affirmed ESTs as central to action. In spite of no consensus, the drafts did embrace many proposals from developing countries that put forward new and practical actions and mechanisms for the development and

[72] Ibid. (The objective and principles are stated clearly in Article 2 and Article 3 of the Convention.)

[73] Krishna Ravi Srinivas, 'Technology Transfer and Intellectual Property Rights' (2010) 606 India Seminar 23 <www.india-seminar.com> accessed on 10 February 2012. (The author holds the view that 'although the UNFCCC has so far not been successful in actualizing technology transfer, it has established a clearing house mechanism and helped conduct several assessments on technology needs over the years'.)

[74] The Kyoto Protocol (n 48). (The Kyoto Protocol is an important international agreement to the United Nations Framework Convention on Climate Change, was adopted on 10 December 1997, and entered into force on 16 February 2005. The detailed rules for the implementation of the Protocol were adopted at COP 7 in Marrakesh in 2001, and are called the 'Marrakesh Accords'.)

[75] Ibid.

[76] The Bali Road Map (n 2). (The Bali Road Map, as the most important result of the 2007 Bali Climate Change Conference, includes the Bali Action Plan and many other forward-looking decisions and resolutions as well to safeguard a secure climate future.)

dissemination of ESTs, rather than simply rhetoric on IPRs[77], 'including technology needs assessment, joint R&D programs, a healthy technology transfer environment, and licenses'[78].

Although some significant conferences have been held one after the other, from the Copenhagen Conference[79] to the climate conference in Cancun[80], and then to the Durban Conference[81], there continue to be profound differences between developed and developing countries on the allocation of responsibilities in addressing climate change and how to engage in mutual cooperation. The positive significance of Copenhagen Conference lies in the fact that the discussion on the role of IP and the issue of technology development and transfer was placed on the agenda of future climate negotiations[82], although the technology development and transfer and

[77] Srinivas, 'Technology Transfer and Intellectual Property Rights' (n 73) 23-26. (The draft texts of the Bali Action went through a long-term negotiation and what is praiseworthy is that the negotiating process was open to listen carefully to the voice of developing countries).

[78] Michael Hasper, 'Green Technology in Developing Countries: Creating Accessibility through a Global Exchange Forum' (2009) Duke Law & Technology Review 1.

[79] The 15th session of the Conference of the Parties to the UNFCCC and the 5th session of the Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol took place in Copenhagen, Denmark from 7-18 December 2009. (The Copenhagen Climate Change Conference has been regarded as the highest political level to find the appropriate policy to tackle climate change with the largest gathering of about 115 world leaders ever outside UN headquarters in New York. Despite the high level of convergence of the opinions of governments on the long-term goal of constraining the maximum global average temperature increase, an acceptable outcome about how to realize the goal was not gained.) http://unfccc.int/meetings/copenhagen_dec_2009/meeting/6295.php.

[80] As the next session of the Conference of the Parties to the UNFCCC after Copenhagen Conference, the meeting in Cancun, Mexico laid down the foundation for the most comprehensive and profound international effort to address climate crisis in history to reduce carbon emission and establish an overall system that encouraged all countries to work together and made them accountable to each other for the reductions. http://unfccc.int/meetings/cancun_nov_2010/meeting/6266.php.

[81] The United Nations Climate Change Conference, Durban 2011, made a breakthrough on the international community's response to climate change to strengthen the implementation of the outcomes of the previous important conferences including the Convention and the Kyoto Protocol, the Bali Action, and the Cancun Agreements in a more balanced way. It is the decision that was made at this conference to adopt a universal legal agreement on climate change as soon as possible, and no later than 2015. http://unfccc.int/meetings/durban_nov_2011/meeting/6245.php.

[82] A great deal of literature can been found to discuss the technology development and transfer and related issues, including intellectual property rights. For example, Hutchison (n 33); 'Climate Change: Technology Development and Technology Transfer for Beijing High-Level Conference'(2008) United Nations Department of Economic and Social Affairs (UNDESA) Background Paper, 2008 DESA, New York, UN; K.Ravi Srinivas, 'Climate Change,Technology Transfer and Intellectual Property Rights' （2009）153 Research and Information System for Developing Countries Discussion Paper; Bollyky (n 43).

management of the Green Climate Fund remained unsolved.[83] On 12 December 2015, a landmark agreement, the Paris Agreement, was built upon the Convention and 'charts a new course in the global climate effort' on the basis of the best available scientific knowledge.[84]

The role and impact of IPRs on access to ESTs are not clear under climate negotiations, though the development of ESTs has received much attention from the international community in the process of crafting the Paris Agreement. The current discussions under the UNFCCC on whether IP impedes the international transfer of ESTs or whether it is a necessary condition for the development and effective use of ESTs are subject to the marked North-South divergence.[85]

With hundreds of thousands of corporations as members in over one-hundred thirty countries, the International Chamber of Commerce (ICC) put forward in a research report stating that the IP system is a proven, effective international mechanism for the promotion of technological innovation so it is necessary and reasonable for the existing level of IP protection to remain unchanged rather than reduce the level of protection in the name of climate change.[86] Nevertheless, clear evidence is still needed to prove whether the strong IP protection exerts a positive or

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[83] The Cancun Agreement was reached on December 11 in Cancun, Mexico, at the 2010 United Nations Climate Change Conference. In order to gradually increase long-term financial support to developing countries, the Cancun conference participants decided to set up a green climate fund used to support actions and programs taken by the developing countries to address climate change. http://unfccc.int/meetings/cancun_nov_2010/items/6005.php.

[84] The Paris Agreement, adopted at the COP 21 in Paris on 12 December 2015 <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement> accessed on 20 December 2018.

[85] Bollyky (n 43) 1. (Bollyky points out that

> '[v]iews in the UNFCCC process largely along north-south lines over whether IP rights are a significant potential barrier to the international transfer of clean technology or necessary to induce its development and effective deployment have led to a standoff, depressingly familiar to those who follow international IP issues, in which developing countries, led by China and India, have argued that IP rights increase the cost of clean technologies and hinder their transfer to developing countries, while developed countries, such as the United States and Australia, have maintained that stronger protection for IP rights is necessary to induce the development of clean technologies and enable their diffusion and transfer to developing countries.')

[86] 'International Chamber of Commerce Optimistic Progress Can Be Made at the Copenhagen Climate Summit' (2009) Articles made by International Chamber of Commerce on 04 December 2009 <http://www.iccwbo.org/News/Articles/2009/ICC-optimistic-progress-can-be-made-at-Copenhagen-climate-summit/> accessed on 12 January 2012.

negative effect on the transfer of ESTs into developing countries.[87] It is worth mentioning that 'creation of an enabling environment for the private sector' specified in Article 10 (c) of the Kyoto Protocol has been interpreted as the protection of IPRs.[88] Even if this is the case, a strong IP protection system is not entirely the same as highlighting the importance of protecting IPRs.[89]

The extreme divergence of opinions on the role of IP in the transfer of ESTs has created a deadlock in international multilateral negotiations on climate change. The major industrial countries and companies in these countries[90] insist that the so-called balanced system of IP protection by use of flexible terms is nothing but a large campaign against IPRs with the aim of corroding the competitive advantages of western countries.[91] As such, the strategy that these countries employ is to avoid any mention of IP issues in the international multilateral discussion on green technologies or climate change.[92] The temporary interruption from considering the IP issue in climate negotiations is irrational because the problem is always there. Unless a constructive and balanced approach is selected to deal with IP issues, there is little

[87] Hutchison (n 33). (Hutchison listed several reasons to draw the conclusion that the overall effect of strong patent protection on the flowing of ESTs into developing countries is yet to be verified. First reason is that although strong patent protection may be helpful for the GDP growth of developing countries, the benefits are far less than the cost of importing ESTs due to limited innovative capability of those developing countries. Second reason is that it is undoubted that strong patent provide legal security for transfer and licensing to occur, but the question arises that to what extent the patent protection is appropriate to make the companies in developing countries can afford expensive patented ESTs. The third reason is that strong patent protection is conducive to foreign direct investment into developing countries but not the least developed countries.)

[88] Ibid 518, 524. (The obligations of countries in the transfer of ESTs have been defined by the 'push' obligations and 'pull' obligations. The latter place much emphasis on the duty of recipient countries to create a sound and healthy environment as much as possible to convince foreign private sectors to transfer ESTs willingly. One of the methods advocated by developed countries is to enhance the level of IP protection.)

[89] Ibid 524.

[90] Ahmed Abdel Latif, 'Intellectual Property Rights and Green Technologies from Rio to Rio: An Impossible Dialogue?' (2012) 14 International Center for Trade and Sustainable Development Programme on Innovation, Technology and Intellectual Property July 2012 Policy Brief 1, 4 <http: //ictsd.org/i/publications/138067/.> accessed on 14 April 2013. (According to the author, the major countries are mainly six members of the Organization for Economic Co-operation and Development (OECD) including US, Japan, Germany, the Republic of Korea, the United Kingdom and France, representing 80% of patents filed in clean energy technologies.)

[91] Ibid 5.

[92] Ibid. (The President of IP Owners Association in US wrote a letter to the US officials on the eve of Rio+20 conference asking them to reject the discussion of IP issue in upcoming negotiations.)

hope to achieve sustainable and real success in addressing climate change.[93]

In this regard, the Doha Declaration has offered a good example of the flexible application of national IP systems beyond the provisions of the TRIPS Agreement that may be useful for access to ESTs.[94] The Waiver Decision of 30 August 2003 and Article 31bis Protocol of Amendment in the Doha Declaration provide more policy space for the supply of newer pharmaceutical products, which is certainly unwanted by drug patent holders.[95] Although there are some flexibilities and exceptions to counter impediments to the transfer of ESTs, a declaration comparable to the Doha Declaration regarding IP protection and climate change may promote the development of international law which would help to balance the interests between IP holders and the public.[96]

In addition to the solution from the international IP system, some attempts such as a cooperation mechanism on the innovation and sharing of ESTs, a new structural mechanism for innovation in form of public-private partnerships, and a supportive financial mechanism are worthwhile.[97] The Montreal Protocol[98] provides a meaningful reference for international cooperation in phasing out the consumption of

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[93] Ahmed Abdel Latif, Keith Maskus, Ruth Okediji, Jerome Reichman, Pedro Roffe, 'Overcoming the Impasse on Intellectual Property and Climate Change at the UNFCCC: A Way Forward' (2011) 11 ICTSD Programme on Innovation, Technology and Intellectual Property November 2011 Policy Brief 1. <http: //ictsd.org/i/publications/120254.> accessed on 12 May 2013.

[94] The Doha Declaration on the TRIPS Agreement and Public Health (hereinafter referred to as Doha Declaration) adopted by the WTO Ministerial Conference of 2001 in Doha on November 14, 2001 WT/MIN(01)/DEC/2. http://www.wto.org/english/thewto_e/minist_e/min01_e/mindecl_trips_e.htm. (It reaffirmed flexibility of Member States under TRIPS in circumventing patent rights for better access to essential medicines.)

[95] Jerome H. Reichman and Frederick M. Abbott, 'The Doha Round's Public Health Legacy: Strategies for the Production and Diffusion of Patented Medicines under the Amended TRIPS Provisions' (2007) 10 (4) Journal of International Economic Law 921.

[96] Abbott, 'Innovation and Technology Transfer to Address Climate Change: Lessons from the Global Debate on Intellectual Property and Public Health' (n 4).

[97] Moustapha Kamal Gueye, 'Technologies for Climate Change and Intellectual Property: Issues for Small Developing Countries' (2009) ICTSD Information Note 12 2009, 7-8 < http://ictsd.org/i/publications/57611/> accessed on 8 January 2014. (Institutional arrangements for open or collaborative innovation and public-private partnership, and financial mechanisms are hot topics that are being discussed under UNFCCC negotiations.)

[98] The Montreal Protocol on Substances that Deplete the Ozone Layer as either adjusted and/or amended in London 1990, Copenhagen 1992, Vienna 1995, Montreal 1997, Beijing 1999 and published in 2000 by Secretariat for the Vienna Convention for the Protection of the Ozone Layer &The Montreal Protocol on Substances that Deplete the Ozone Layer.

ozone-depleting substances, through sharing ESTs and creating multilateral financing mechanisms for controlling climate change, including the Global Environmental Facility (GEF) and the World Bank Clean Technology Funds (CTFs).[99] In the case of climate change, however, the proposed level of funding by the Protocol is far from able to meet the challenges.[100] Moreover, the investment direction and management of such funds are still controversial.[101] It is also criticized by some experts that the Montreal Multilateral Fund[102] does not have an overall framework for the effective management of IP, which is supposed to play an important role in the successful operation of the multilateral or intergovernmental co-operation fund.[103]

The establishment of a technology mechanism was proposed in Cancun, which embraces a technology executive Committee (TEC) and a Climate Technology Centre and Network (CTCN).[104] The transfer and innovation of ESTs supported by IP is sought by developing countries but will be damaging to industrialized countries, so the importance of IP for achieving the goals of the climate convention currently remains outside the technology mechanism generated in Cancun.[105]

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[99] Stephen O. Andersen, K. Madhava Sarma, Kristen. N. Taddonio, *Technology Transfer for the Ozone Layer: Lessons for Climate Change* (Earthscan 2007) 29.

[100] Srinivas, 'Technology Transfer and Intellectual Property Rights' (n 32) 23-26.

[101] Bollyky (n 43) 7. (The author explores that

> '[t]he treatment of IP in the international multilateral fund is polarized. The G77 proposed a Multilateral Climate Fund, requiring significant changes in the international regulation of IP and liberal use of compulsory licensing. Other Parties have proposed multilateral investment in clean technology must lead to any resulting IP being dedicated to the public domain'.)

[102] Article 10 under the Montreal Protocol on Substances that Deplete the Ozone Layer, Published 2000 by Secretariat for The Vienna Convention for the Protection of the Ozone Layer & The Montreal Protocol on Substances that Deplete the Ozone Layer. http://www.unep.org/ozone.

[103] Charles K. Ebinger and Govinda V. Avasarala, 'Transferring Environmentally Sound Technologies in an Intellectual Property Friendly Framework' (2009) Energy Security Initiative Policy Brief 09-08 by Brookings Institution.

[104] The new Technology Mechanism proposed at Cancun Conference is expected to facilitate enhanced action on technology development and transfer to support action on mitigation and adaptation. The Mechanism consists of two key components: a Technology Executive Committee and a Climate Technology Centre and Network.

[105] Percival and Miller (n 42) 18; see also Manuel A.J. Teehankee, Ingrid Jegou, Rafael Jacques Rodrigues, 'Multilateral Negotiations at the Intersection of Trade and Climate Change --An overview of Developing Countries' Priorities in UNCSD,UNFCCC and WTO Processes' (2012) 2 ICTSD Programme on Global Economic Policy and Institution May 2012, 24. (The technology mechanism is believed to have potential to move a static technology transfer to a dynamic one that is achieved by fostering public-private partnership, promoting innovation and joint research, and taking full use of technology centers at different levels. The IP issue is not mentioned in this mechanism.)

The UN climate change negotiation is more likely to focus on how to provide an economic impetus to create a favorable environment for innovation, dissemination and application of ESTs through market mechanisms.[106] From the standpoint of developing countries, Abbott drew a conclusion from the negotiation of public health that zero-sum bargaining does not produce positive results nor is it enough to bring about compromises and concessions based on equity.[107] Instead, it will be more practical to achieve this through the establishment of an economic activity framework that is conducive to encouraging innovation and transfer of ESTs to address climate change. Maskus and Okediji proposed a combination of financial incentives and a more streamlined system of licensing.[108] It seems that some countries are gradually leaning towards making subtle but meaningful adjustments to patent legal procedures, including accelerated examination, reduction or waiver fees, removal of ESTs from deferred examination, earlier publication and stronger protection at the infringement stage to make sure ESTs can flow more smoothly.[109] While developed countries hold a dominant position technically, joint development and technology transfer among developing countries in certain areas could encourage more innovation and technology sharing.[110]

International harmonization of IPRs in the context of climate change by

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[106] Bollyky (n 43) 6. (In addition, the author suggests that '[e]nabling policies are needed, including carbon pricing, effective emissions standards, and initiatives to improve the governance and absorptive capacity of developing countries. Financing mechanisms supporting the particular technology and adaptation needs of most poor and vulnerable countries are essential.')

[107] Abbott, 'Innovation and Technology Transfer to Address Climate Change: Lessons from the Global Debate on Intellectual Property and Public Health' (n 4).

[108] Maskus and Okediji (n 44).

[109] Estelle Derclaye, 'Not Only Innovation but also Collaboration, Funding, Goodwill and Commitment: Which Role for Patent Laws in Post-Copenhagen Climate Change Action' (2010) 9 J. Marshall Rev. Intellectual Property L. (Special Issue) 657. ('Some countries' mainly refer to US (Green Technology Pilot Program), UK (Green Channel), Australia and South Korea.)

[110] Srinivas, 'Technology Transfer and Intellectual Property Rights' (n 73) 25. (For example, countries like India and Brazil have distinct advantages in bio-fuels, and some of the major producers in solar energy and wind energy are located in India and China. Therefore,

> '[e]xpertise in specific fields can be shared and mutually beneficial trading arrangements can be worked out. They can also acquire patents for specific technologies or for critical processes and develop them further. Though difficult for an individual company, it is easier for countries to come together, buy out patents and license them to companies, to ensure a rapid diffusion of technologies'.)

constructing a differentiated patent regime for ESTs is a process full of contradictions, in which several pairs of relations are principally involved. The relations between globalization and locality, IPRs and their limitations, patents on ESTs and sustainable development, all of which definitely have influence on the establishment and the effectiveness of such a regime.

Two aspects of globalization and locality are discussed here first. In the first place, global liquidity of ESTs in the form of capital conflicts with regional differences in IP protection systems. As intangible assets follow the trends of the time, ESTs are borderless by their very nature and circulate freely within the global market.[111] In view of regional differences in IP systems, some countries, especially those which are in a dominant position in terms of technological innovation, have taken the initiative to implement a unified IP protection system across the world.[112] This initiative is now partly achieved by the minimum standard of IP protection, which coordinates different levels of IP protection based upon domestic, political and cultural preferences.[113] On the other hand, global warming caused by climate change is global but its influences on the environment of countries are evident with geographical differences.[114] There is a view that since 'environmental issues are usually local or regional, local knowledge and solutions to these issues are needed. Further, many ESTs are highly ecology-specific and while appropriate in one setting may be difficult to employ in

[111] T. Mandeville, 'An Information Economics Perspective on Innovation' (1998) Journal of Social Economics 25 360. (The author notes that 'since excludability is difficult and indeed dangerous for innovation, it may be good for both scientific and cultural industries to share innovation as widely as possible'.)

[112] John F. Duffy, 'Harmony and Diversity in Global Patent Law' (2002) 17 Berkeley Technology Law Journal 685, 686-687. (Given that the uniformity of law has an undeniable intellectual appeal, a broad movement to harmonize patent law throughout the world arose in the second half of the twentieth century. At the annual Fordham Conference on International IP Law and policy, Todd Dickinson, the former head of the USPTO, made a speech as the representative about the need for a uniform patent system on a global scale by listing the possible benefits of such a system for inventors and assignees.)

[113] Robert C. Bird, Subhash C. Jain, 'The Continuing Challenge of Global Intellectual Property Rights' in Robert C. Bird, Subhash C. Jain (eds), *The Global Challenge of Intellectual Property Rights* (Edward Elgar Publishing Limited 2008).

[114] Hall and Helmers, 'The Role of Patent Protection in (Clean/Green) Technology Transfer' (n 14) 3. (The authors conclude that developing countries, esp. those developing countries in coastal areas, take more risks of natural disasters and other social problems caused by climate change according to the IPCC 2007 report.)

another.'[115] In order to enter the market of developing countries and reduce the information asymmetries and transaction cost, local technical needs must be fully taken into account.[116]

As private rights, the exercise of patent rights shall certainly be limited to prevent abusive activities. The market power conferred by patents might be in conflict with objectives of other public policies, so it is reasonable that the duration and scope of patents are subject to legal restrictions, which include some specific exceptions to exclusive rights, in order to ensure the balance of interests between rights holders and users.[117] On many international occasions, a major topic of concern has been that 'the technology source country' might abuse or improperly use patents in 'the technology recipient country'.[118] Accordingly, how to limit such behavior has become the focus of relevant international and domestic legislations.

For example, in order to prevent the abusive exercise of conferred exclusive rights, such as refusal to implement, it is provided in Article 5 of the Paris Convention that the Parties have a right to take legislative measures in the granting of compulsory licenses, and in case that it is insufficient to prevent the abuse of rights by granting a compulsory license, the Member State may also publicize the invalidity of a patent.[119]

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[115] Johnson and Lybecker, 'Challenges to Technology Transfer: A Literature Review of the Constraints on Environmental Technology Dissemination' (n 7) 4.

[116] Hasper (n 78) 10.

[117] Jayashree Watal, *Intellectual Property Rights in the WTO and Developing Countries* (Kluwer Law International 2001) 291-292. (Some categories of IPRs, such as patents, copyright related rights, industrial designs and layout designs that are directly reflect the objective of encouraging creative and or inventive activity, are 'meant to confer market power through legal exclusivity, albeit limited in time and scope'. They are subject to stricter exceptions to protection than those primarily intended to prevent information asymmetries and consumer deception, such as trademarks and geographical indications, because it is acknowledged that public interests and welfare might suffer from this limited market power. A study by Watal can be supportive in this regard that estimates welfare losses for India with the introduction of product patents and the declining effects of some policy options.)

[118] Thomas L. Brewer, 'International Technology Diffusion in a Sustainable Energy Trade Agreement (SETA): Issues and Options for Institutional Architectures' (2012) International Centre for Trade and Sustainable Development, Geneva, Switzerland. (In the view of the author, it is worth noting that developing and developed countries can be both sources and recipients in the international technology transfer. An empirical study is necessary to decide to what extent an individual country can be called as a source or recipient. It is argued that the highly relevant to this issue is 'the scope of a country's capabilities as a technology exporter and the level of its current and prospective capabilities'.)

[119] The Paris Convention for the Protection of Industrial Property signed on March 20, 1883, as revised at Brussels on December 14, 1900, at Washington on June 2, 1911, at The Hague on November 6, 1925,

The Decision on the Implementation of Paragraph 6 of the Doha Declaration on TRIPS and Public Health, adopted by WTO General Council on 30 August 2003, has been regarded as a significant step at the international legal system level, because concrete implementation by attaching restrictions to IPRs in the field of public health is a good start to avoid absolute and abuse of rights in the areas that are related to human public interests.[120]

The relation between patents on ESTs and sustainable development offers a valuable indicator for a better understanding of the motivation of harmonizing IPRs in the context of climate change.[121] Moreover, the positive interaction between the two is also one of the goals pursued by this regime. Since climate change is the biggest sustainable development challenge the international community has had to tackle to date,[122] a special patent regime that could effectively promote innovation and access to ESTs as widely as possible forms a substantial contribution to global sustainable development.

1.3 Literature Review

The debate on IPRs and climate change has aroused considerable enthusiasm for research, due to the possible conflict between the ever-pressing threat posed by

at London on June 2, 1934, at Lisbon on October 31, 1958, and at Stockholm on July 14, 1967, and as amended on September 28, 1979. <http://www.wipo.int/treaties/en/ip/paris/trtdocs_wo020.html>

[120] Daniel Gevrais, *The TRIPS Agreement: Drafting History and Analysis* (Sweet & Maxwell 4th edn, 2012) 63. (There is a comment from J. T. Gathii on the Decision that 'thereby laying down a framework for a more fair determination of the conflicting interests in the TRIPS Agreement'. The author suggests that 'TRIPS should be interpreted in light of the Doha Declaration and the Decision', which recognize that Members have flexibilities to address emergencies in the area of public health.)

[121] World Commission on Environment and Development 'Our Common Future, Chapter 2: Towards Sustainable Development' Un-documents.net. <http://www.un-documents.net/ocf-02.htm.> accessed on 28 December 2011. (The most widely recognized definition of sustainable development is

> '…that meets the needs of the present without compromising the ability of future generations to meet their own needs, which contains within it two key concepts: the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.')

[122] World Trade Organization Trade and Environment, The Introduction of Multilateral Trading System and Climate Change <http://www.wto.org/english/tratop_e/envir_e/climate_intro_e.htm.> accessed on 12 January 2012.

climate change and the characteristics of IPRs. The interpretation and discussion about this seemingly contradictory couple provide a relatively clear picture of the trend of the international protection of IPRs.

The Research Handbook on Intellectual Property and Climate Change, edited by Joshua D. Sarnoff, is described as 'an essential practical guide for current and future generations of consumers, academics, practitioners and policy makers'.[123] With a collection of articles from scholarly journals that covers a wide range of issues related to IP and climate change, including climate science and international environmental law, underlying philosophical perspectives, technology transfer, specific IP laws with regard to ESTs, and economic sectors most affected by climate change, this Handbook focuses on the increasing intersection of IP and climate change, stating that 'the ability of society to mitigate and adapt to climate change will be affected in numerous ways by intellectual property rights'.[124]

Another book *Intellectual Property Rights and Climate Change: Interpreting the TRIPS Agreement for Environmentally Sound Technologies* by Wei Zhuang provides 'an excellent, comprehensive, and thought-provoking contribution to the discussion of IP and climate change'.[125] In her book, Zhuang tackles the role of IPRs can and should play in the process of innovation and technology diffusion and recommends that 'clarifying the scope and enhancing the remedial measures available through enforcement of competition law and pursuing a Doha Declaration-analog for IPRs and climate change' can be used to overcome obstacles to technology diffusion.[126] In addition, she believes that the UN may be a better forum for such a Declaration.

An empirical data analysis from the microeconomic perspective about the trajectory followed by ESTs is carried out by Durán-Romero and Urraca-Ruiz who find that efforts in these kinds of technologies are mainly concentrated in corrective

[123] Laetitia Lagarde, 'IP and Climate Change: An Essential Practical Guide for Current and Future Generations' (2017) 12 (4) Journal of Intellectual Property Law & Practice 351.
[124] Joshua D. Sarnoff, 'Introduction' in Joshua D. Sarnoff (ed), *Research Handbook on Intellectual Property and Climate Change* (Edward Elgar 2016) 1.
[125] Frederick M. Abbott, 'Book Review' (2018) 21 Journal of International Economic Law 233.
[126] Wei Zhuang, *Intellectual Property Rights and Climate Change: Interpreting the TRIPS Agreement for Environmentally Sound Technologies* (Cambridge University Press 2017).

technologies rather than preventive ones.[127] This article suggests that pushing public policies toward abatement and collaboration between the promotion of ESTs and industry is both essential to meet the real needs in specific sectors which take primary responsibility of addressing climate change.

The study made by Derclaye is closely related to the theme in my thesis. Derclaye principally focuses on the role of patent law in preventing environmental deterioration and reducing GHG emission in particular, and finds that there is 'no adversarial relationship' between patent and environment law.[128] She further advocates that a mixed system which combines negative and positive elements, that is, 'prohibiting polluting technologies and encouraging the invention and use of clean technologies', is the best way to implement the role of patent law.[129] Located in Europe, Derclaye reaffirms the function and justification of patent law as a way of protecting environment and suggests that 'European patent laws be modified to strengthen the prohibition of polluting inventions and grant favored treatment to green technologies, especially those reducing greenhouses gases in the earth's atmosphere'.[130] However, there is still dearth of intensive research regarding how to play the role of patent law in environment protection, and the discord between the structure of patent rights and access to ESTs has been paid little attention by Derclaye. Derclaye also recognizes that it is not enough to fight against climate change by relying on patent law because 'patent law is a small part of the solution to address climate change, which requires more than intellectual property-related solution'.[131]

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[127] Gemma Durán-Romero, Ana Urraca-Ruiz, 'Climate change and Eco-innovation: a Patent Data Assessment of Environmentally Sound Technologies' (2015) 17 (1) Innovation 115.

[128] Estelle Derclaye, 'Should Patent Law Help Cool the Planet? An Inquiry from the Point of View of Environmental Law: Part 1' (2009) 31 (4) European Intellectual Property Review 168.

[129] Estelle Derclaye, 'Should Patent Law Help Cool the Planet? An Inquiry from the Point of View of Environmental Law: Part 2' (2009) 31 (5) European Intellectual Property Review 227.

[130] Estelle Derclaye, 'Patent Law's Role in the Protection of the Environment: Re-assessing Patent Law and its Justification in the 21st Century' (2009) 40 (3) International Review of Intellectual Property and Competition Law 249.

[131] Derclaye, 'Not Only Innovation but also Collaboration, Funding, Goodwill and Commitment: Which Role for Patent Laws in Post-Copenhagen Climate Change Action' (n 109). (The author believes that addressing climate change is a systematic project and fighting alone is most undesirable. Here, other solutions besides IP refer to 'using technology already in the public domain, collaborating rather than competing, funding especially for developing and least developed countries (to build renewable

Maskus takes as his primary subject the scope for beneficial differentiation in patent rights, including 'extension patent terms', 'expedited patents examinations', 'investment in patent transparency and landscaping efforts', 'facilitation of voluntary patent pools'.[132] It is believed by Maskus that such changes are unlikely to yield significant gains in innovation and transfer of ESTs without the support of 'broader policy approaches, including publicly financed fiscal supports for local technology needs and adaptation, means to raise the global cost of using carbon-based energy resources, and improving the environment for investment in poor countries'.[133] In view of 'the ongoing failure even among the industrialized economies to make progress on a WIPO Substantive Patent Law Treaty', he was disillusioned with a global or sub-global agreement on harmonization of patent rules across countries for ESTs.[134] With that in mind, Maskus recommends that since the risks from relaxation of IP protection to safeguard access to ESTs are higher than the benefits thereof, it might be a compromise to provide differentiated IP protection by the use of flexibilities in TRIPS and other supplementary means.[135] While it seems like a good idea, Maskus remain unconvinced on its effect on stimulating innovation and access to ESTs. The preferential treatment proposed by Maskus is rather mild and conservative, and the result of his study is different from that of this thesis.

Bollyky points out that it is imperative to establish an effective intellectual property framework to harmonize the extreme North-South divergence on IP issues under the UNFCCC. He insists that the objective of adjusting the existing intellectual

energy plants, reforest the earth), goodwill (accept to license technology to developed countries at cheap prices to developing and least developed countries for a while) and above all both individual and collective commitment'.)

[132] Keith Maskus, 'Differentiated Intellectual Property Regimes for Environmental and Climate Technologies' (2010) Environment Working Paper of Organization for Economic Cooperation and Development No.17 <http://dx.doi.org/10.1787/5kmfwjvc83vk-en> accessed on 12 June 2013.

[133] Ibid.

[134] Ibid.

[135] Ibid. (Maskus examines whether particular changes in patent rules would be effective in inducing innovation and diffusion of ESTs. Respectively from the standpoint of term extension, grant standards and qualifications, wild-card patents, compulsory licensing and other supplementary means such as competition policies, public financial support, border taxation and cancellation for trade controls, Maskus proposes a differentiated protection for ESTs. While it seems like a good idea, the author remain unconvinced on the utility of these measures.)

property system under the UNFCCC must be clear, and in order to achieve the objective several realities must be taken into consideration.[136] Bollyky considers that a Doha-type Declaration should be the last resort, and the more important issue is how to identify and clarify the legal relationship between such a declaration as part of the UNFCCC negotiations and TRIPS. The principle to resolve the IP issues advocated by Bollyky is a global access principle, which not only provides a strategic framework of IP management for the private and public partners but also creates flexibility and space for private investors, so that they can receive benefits in a profit-driven market environment. The study by Bollyky makes valuable contribution to harmonization of IPRs and climate change, but the study may be more reasonable if a clear proposal is considered from the perspective of practical benefits. Besides, the real difficulties faced by developing countries and LDCs were not given their due attention in his study.

Given the background to IP and technology transfer, Ebinger and Avasarala believe that IPRs are not the most important issue that hinders technology transfer. Nevertheless, the conflict between IPRs and climate change is undeniable. After a discussion on the weakness of existing multilateral environmental agreements vis-a-vis IP, the authors propose a new IP framework which is, however, not elaborated in their paper. It is advocated by the authors that it is necessary to reach a realistic agreement which places much emphasis on joint efforts made by major emitters.[137]

A series of studies by the International Centre for Trade and Sustainable Development Programme on intellectual property and sustainable development have made a significant contribution to the heated debate on IPRs and climate change. For instance, from a legal and economic perspective, Maskus and Okediji provide a

[136] Bollyky (n 43) 3-5. (The realities facing the adjustment of IP system include: 'the structure or pathway for technology innovation and diffusion that will satisfy all parties in climate negotiation does not exist; the commitment on international technology transfer should be concrete and detailed; the requirement of the change in the international rules or regulations of IP will not receive the positive response; an agreement on compulsory licensing are unnecessary.')

[137] Ebinger and Avasarala (n 103).

comprehensive approach beyond the previous all-or-nothing approach to balance the conflicts between IPRs and EST transfer.[138] They seek to provide a wider range of driving force for the development and dissemination of ESTs, by taking tailored government measures and IPRs into account. The most important finding of their study is that the effectiveness of IPRs on the development and application of ESTs relies on innovation policies of developed countries and capabilities of developing countries to absorb advanced ESTs.[139]

The study carried out by Latif, Maskus, Okediji, Reichman and Roffe attempts to uncover the issues behind the impasse on IP and climate change and also the reasons for these issues.[140] The principles and recommendations are proposed for IP negotiations under the UNFCCC in this study, which should advance in two stages.[141] The conclusion of the study comes to that it is meaningful to find a middle way to break the impasse under the UNFCCC rather than under the aegis of the WTO. A similar study conducted by Latif intends to find the common ground on IP issues among countries by examining the history of global negotiations on IPRs and green technologies from 1992 to 2012, so that suggestions about how to further promote a more constructive dialogue could be provided.[142]

In accordance with the patent statistics and classification of the main ESTs, Ravi Srinivas holds the view that there is no necessary causal link between stronger protection of IP and technology transfer. He points out the shortcomings of technology transfer under the UNFCCC, the Kyoto Protocol and TRIPS.[143] The

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[138] Maskus and Okediji (n 44).

[139] Ibid. (Maskus and Okediji believe that it is crucial to maintain a perfect join between originating and recipient countries, while making a balance in domestic and international IP system.)

[140] Latif, Maskus, Okediji, Reichman, Roffe (n 93) 2-3. (The study uncovers the reasons for the impasse. The first reason is that IP issue is regarded as a bargaining chip in negotiations of agreements and commitments. The second reason is that the negotiation on IP is improperly limited within the frame where the two diametrically opposite views have always been dominant.)

[141] Ibid 6-8. (The two stages refer to how to restart the negotiation and how to find the workable options in the negotiation.)

[142] Latif, 'Intellectual Property Rights and Green Technologies from Rio to Rio: An Impossible Dialogue?' (n 90).

[143] Srinivas, 'Climate Change, Technology Transfer and Intellectual Property Rights' (n 32). (Srinivas states that the technology transfer under UNFCCC and Kyoto Protocol is at such a low level that is unable to meet the demands of the developing countries. Due to the limited use of compulsory license

author suggests that IP issues should not become what is holding back the transition process of developing countries. Climate challenge calls for thinking outside of the box to find positive answers that change the existing situation. The IP issue related to ESTs can be resolved only if incentive measures, appropriate policies and the IPR reform under TRIPS work together.[144] The study is a good example of theoretical research based on empirical evidence. The trend of ESTs and patents on ESTs needs further study because the relevant data updates are always faster than academic research.

Ravi Srinivas also conducts an analysis on the positive results of UN climate negotiations, unsolved issues regarding technology transfer, and the fund's management.[145] He suggests that lessons should be learnt from the Montreal Protocol and other modes, such as open innovation and decentralized innovation. His case study puts forward alternative innovative modes for developing countries, and then a conclusion is drawn that South-South cooperation is of significance and effective.

Cannady also makes a critical evaluation on proposals available to promote EST transfer to developing countries, such as compulsory license, patent pools, patent databases and voluntary licensing mechanism. The author notes that these proposals are not ideal for solving problems, because most of the proposals are based on the outdated sponsorship or patronage relationship between technology holders and passive recipients.[146] Accordingly, the study proposes 'a two-pronged approach' for developing countries, in order to reach a win-win situation which concentrates on the capacity building of innovation and its absorption in developing countries.[147]

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and competition policy under TRIPS, in some sense, TRIPS does not promote transfer of ESTs, especially the transfer to LDCs.)

[144] Ibid.

[145] Srinivas, 'Technology Transfer and Intellectual Property Rights' (n 73) 23-26.

[146] Cynthia Cannady, 'Access to Climate Change Technology by Developing Countries: A Practical Strategy' (2009) ICTSD's Programme on IPRs and Sustainable Development, Issue Paper No. 25, International Centre for Trade and Sustainable Development, Geneva. (Cannady insists that the outdated sponsorship or patronage relationship between technology holders and passive recipients is unequal from the beginning and won't last for long.)

[147] Ibid. (Cynthia Cannady puts forward 'a two-pronged approach' which includes innovation strategy and mutually-beneficial contracts. The innovation strategy aims at address the funds and infrastructure necessary for the R&D and commercialization of technologies. The success of mutually-beneficial

From the perspective of international harmonization, the study on the relationship between IP and climate change in recent years is often related to TRIPS, focusing in particular on its principles, goals, compulsory licensing, restrictive practices and the transfer of ESTs to developing countries in the forms of FDI, joint venture and technical service and consultation. For example, under the international legal regimes which refer to the climate change regime and TRIPS Agreement, Hutchison explains the obligations of technology transfer as 'push' and 'pull' factors.[148] Hutchison points out the drawbacks of the two regimes: The TRIPS Agreement almost entirely stresses the 'pull' factors, which means the obligations of technology recipients[149]; The UNFCCC lacks a sufficient financial mechanism as a specific way of supporting technology transfer. An adjustment to TRIPS is recommended by Hutchison.[150]

Another example of international harmonization which has an underlying significance for the establishment of an EST-related patent system under WIPO is the international negotiation on drafting a substantive patent law treaty. Reichman and Dryfuss argue that to finalize a substantive patent law treaty is premature under WIPO, according to their analysis of the adverse effect of the substantive patent law treaty on developed and developing countries.[151] Their study notes that under TRIPS, at least, for developing countries, there are some compromises and concessions to offset high

contracts can be achieved only if the innovation strategy is implemented smoothly.)

[148] Hutchison (n 33) 521. ('Push' means to encourage technology transfer from developed countries, while 'pull' means to encourage private sector trade and investment into developing countries. Both of the two factors emphasize the active roles of developed and developing countries' governments, which include the active transfer by governments of developed countries and the creation of favorable conditions in developing countries to attract technologies through trade and investment.)

[149] Ibid. (Hutchison focuses on the discussion whether TRIPS facilitates or impedes the technology transfer through international trade and foreign directive investment and arrives at the conclusion that 'TRIPS might an obstacle to technology transfer to developing countries, especially those that cannot afford to license new technologies or those that are not attracting the FDI that stronger patent laws promise'.

[150] Ibid 537. (It is suggested by Hutchison that 'developing countries should take full use of the flexible language in TRIPs. The regulations in TRIPs which conflict with obligations in addressing climate change and the export prohibition on compulsory licensing should therefore be abandoned'.)

[151] Jerome H. Reichman and Rochelle Cooper Dryfuss, 'Harmonization without Consensus: Critical Reflections on Drafting a Substantive Patent Law Treaty' (2007) New York University School of Law. Law & Economics Research Paper Series Paper No. 07-43; Duke University School of Law Legal Studies Research Paper Series Paper No.178; Duke Science, Technology and Innovation Research Paper Series Paper No.22.

social costs of protecting intellectual products, but the new independent substantive patent treaty may greatly reduce the effect of flexibilities in TRIPS with no additional compensation obtained by other means for developing countries. The assumption in this article that harmonization would be in favor of those countries that have a longer history of superiority in terms of quality of innovation, is not built up on a neutral stance for coordination of national interests.

Percival and Miller examine the view that IP law which is designed to encourage innovation may in fact hinder it and the transfer of green energy technologies to developing countries.[152] Although their study does not find a good example to prove that the transfer of green energy technologies is subject to existing intellectual property protection, the strategies to address these issues in the future, such as compulsory licensing measures, are discussed. The conclusion of their study is that IP should not be an obstacle to the global transfer of green energy infrastructure, which can be helpful not only to promote economic development but also to enhance the level of international cooperation.[153]

Some scholars have conducted studies on how to balance the discord between IPRs and climate change from perspectives of specific sectors such as energy, transportation, insurance, and taxes. Burleson focuses on how to strengthen multilateral cooperation in ESTs within a reasonable time frame.[154] She considers ways of transitioning to a sound policy and the context in which insurance companies and other sectors of the economy have an impact on energy policy. She believes that the insurance industry has more opportunities than other sectors to stimulate the reform of energy policy in response to climate change. Furthermore, she advocates enhancing the community's resilient ability to respond to emergent disasters through

[152] Percival and Miller (n 42).

[153] Ibid 21. (Without finding significant examples that the diffusion of ESTs has been hindered by existing IP protection, the authors instead give some suggestions about how to respond such problems if they occurs in the future.)

[154] Elizabeth Burleson, 'Energy Policy, Intellectual Property and Technology Transfer to Address Climate Change' (2009) Climate Change and Human Rights Symposium 18 University of Iowa Transnational Law and Contemporary Problems, 69.

energy revolution.[155] In order to clarify implications of IP for developing countries' goal of accessing ESTs, Barton conducted a study on three sectors: solar photo-voltaic, bio-mass for fuel and wind energy technologies.[156]

In view of lessons to be drawn from the global negotiation on IPRs and public health to balance R&D and access to medicine, Abbott conducted a study on the form IPRs could take to promote and protect innovation, and how they exert influence on alternative energy resources and ESTs. Through critical analysis on the different roles of IPRs in pharmaceutical and renewable sectors, it is believed that, from the standpoint of developing countries, zero-sum bargaining does not make sense. The key to devising a way out is to create a mutually beneficial economic cooperation framework between developed and developing countries.[157] In a similar comparative study, Fair argues that the increasing use of compulsory licensing may lead to a series of strong reactions, because the differences between the energy industry and the pharmaceutical industry make the use of compulsory licensing in the former not as appropriate as in the latter.[158] Fair suggests some alternative methods for effectively distributing green technologies, such as tiered-pricing schemes and relaxation of trade barriers between states.

The discussion regarding the role of the patent system in innovation and the transfer of ESTs can also be supported by empirical data analysis. Following a general overview of the role of patent in promoting innovation and international technology

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[155] Elizabeth Burleson, 'Energy Revolution and Disaster Response in the Face of Climate Change' (2011) 22 (169) Villanova Environmental Law Journal 101. (The ESTs transfer mechanism and its feasibility is explained and the role of governments in the balance of IPRs and technology dissemination is stressed in this paper. It is called for by Burleson that only by establishing collective standards on the basis of fairness and efficiency with individual country implementation, the resolution to climate change could be encouraging.)

[156] John H. Barton, 'Intellectual Property and Access to Clean Energy Technologies in Developing Countries: An Analysis of Solar PV, Bio-fuel and Wind Technologies' (2007) ICTSD trade and sustainable energy series, Issue Paper No.2.

[157] Abbott, 'Innovation and Technology Transfer to Address Climate Change: Lessons from the Global Debate on Intellectual Property and Public Health' (n 4). (It is suggested by Abbott that Doha-type Declaration will be helpful to promote the development of international law.)

[158] Robert Fair, 'Does Climate Change Justify Compulsory Licensing of Green Technology' (2009) 6 International Law & Management Review 21, 41. (It is concluded by comparison that despite of the opinion that the use of compulsory licensing may help to address climate change, some drawbacks show that compulsory licensing is not the best choice for effective technology transfer.)

transfer, through the use of empirical evidence Hall and Helmers believe that patent protection of host countries is conducive to encouraging technology transfer to their nations, but the impact on local innovation and national economic and social development is ambiguous.[159] The final finding of their study is that the double externality of the environment and knowledge shows that patents may not be the most appropriate tool to encourage local innovation, especially taking into account the application of green technologies and local demand.[160]

Dechezleprêtre, Glachant, Hascic, Johnstone and Ménière jointly conducted the first study to use patent data to quantitatively describe the geographical and temporal trend of innovation and diffusion of climate change mitigation technologies at a global level.[161] The authors regard patents as indicators of technology innovation through recent dataset to describe innovative activities in the world between 1978 and 2005 across different countries and technologies. However, the work is mostly descriptive in that it does not seek to explain the driving force of innovation and technology transfer, which is left for future research.

Sarnoff describes the current environment for technological innovation and transfer.[162] The interaction among patents, innovation and technology dissemination is discussed on the basis of theoretical and empirical analysis. The main contribution made by the author to the debate on patents and climate change is that some alternative approaches are put forward for developed and developing countries on how to relieve the said effect of patents on the innovation and transfer of ESTs from national and private levels. It is suggested by the author that 'internal agreements

[159] Hall and Helmers, 'The Role of Patent Protection in (Clean/Green) Technology Transfer' (n 14) 6. (The question whether stronger patent protection in host country encourages technology transfer to that country is easier to answer, but the question whether stronger patent protection is good for technology development in the country itself is more important for the social development of that country in the context of climate change, as technologies required by developed and developing countries may not be the same.)

[160] Ibid 28.

[161] Dechezleprêtre, Glachant, Hascic, Johnstone, Ménière, 'Invention and Transfer of Climate Change Mitigation Technologies on a Global Scale: A Study Drawing on Patent Data' (n 35).

[162] Sarnoff (n 6) 336. (It finds unbalanced worldwide patterns of innovation, patenting and technology transfer may result in tensions in international trade and patent protection and as well as exacerbate political division between developed and developing countries.)

should develop that further to regulate the international patent system'.[163]

Johnson and Lybecker focus on the challenges of innovation and dissemination of ESTs by summing up the findings of previous studies.[164] In their study, they suggest that the regulations; ETSs; and market, social attributes and political factors act together to complicate the spread of ESTs. They reveal that the combination of the market, regulations and cultural conditions can make contribution to the transfer of ESTs.[165]

[163] Ibid 355.

[164] Johnson and Lybecker, 'Challenges to Technology Transfer: A Literature Review of the Constraints on Environmental Technology Dissemination' (n 7) 3-4. (In the executive summary of this working paper, key findings are listed, including that 'challenges to technology transfer are generally concentrated in the field of eco-innovation; the rate of diffusion relies on whether the new technology is cost-effective; market-based tools are more useful to stimulate adoption of new technologies than regulatory tools; green technology is characterized by two market failures, the public goods nature of knowledge and environmental externalities; IPRs do not constitute a significant barrier that hinders developing countries' efforts in emission reduction, because in many cases, IPR protected technologies are not necessarily more costly than those not covered; there are a number of characteristics and circumstances of developing nations that hinder innovation; environmental issues are frequently local or regional in nature, so local knowledge and solutions are required; adoption is facilitated by environmental feasibility as well as cultural and political acceptance; it is critical that technology recipients have the prerequisite knowledge and scientific base to best exploit the information.')

[165] Ibid 25. (It suggests that the combination of market, regulation and cultural conditions can be conducive to technology transfer by creating a receptive environment and providing incentives to the transfer of technology.)

1.4 Research Plan and Research Methods

1.4.1 Research Plan and the Structure of the Thesis

Research framework	Research contents	Research methods
Context of study	EST-related IP issue has become the hot topic of climate negotiations but there has been little research on it and a proper path has not yet been found to ease the tension between technological measures against climate change and patent protection.	Literature review
Steps of study	Step1: focus on the infrastructure of regime building (necessity and feasibility). Step2: analysis of existing EST-related institutional arrangements at an international and domestic level to find their respective advantages and shortcomings. Step3: lessons learnt from the heated debate on drug patents and public health.	Doctrinal analysis in a comparative way
System design	WIPO chosen as a coordinator and administrator The structure of patent rights Key-sector based Classification Differentiated protection Exception to exclusive rights	Law and economics approach
Specific application	For the effective implementation of the universal patent regime specially-designed for ESTs relies on a specific context, China is chosen as a particular focus to answer the question about how to flexibly apply this universal EST patent system at the national level.	
	Conclusion and Prospects	

On the basis of the above plan, the basic structure of this thesis is organized as set out in the following paragraphs.

Chapter Two sets out the infrastructure of international harmonization of IPRs in the context of climate change. It first explores the relationship between ESTs and IPRs, and pinpoints the intersection at which IPRs and climate meet. The intrinsic link between the two topics reveals that the international patent system, which centers on the strengthening of exclusive rights, is counterproductive to global efforts to address climate change. This indicates that it is necessary to review the structure of patent rights in the context of climate change. Following this, the preparatory conditions, including necessity and possibility, are discussed for the establishment of a special regime from subjective and objective perspectives. It argues that harmonization between proprietary interests of IP and public response and joint effort required by the climate crisis is the infrastructure for the establishment of such a special regime.

Chapter Three conducts a systematic analysis of the existing international arrangements related to the transfer of EST, including agreements or provisions under the WIPO, the UNFCCC and the WTO. A summary of the drawbacks and deficiencies of existing systems is given so that difficulties brought by them to developing countries and LDCs can be better understood.[166] It finds that these arrangements are not as collaborative as expected, and are even contradictory, but the possibility of coordination should not be dismissed out of hand.[167] Their significance to date and drawbacks of the existing systems are valuable for devising new solutions to access to ESTs. It further argues that possible solutions to limit exclusive rights in the current international IP system, including public order provisions, the use of compulsory licenses and the exhaustion principle, are not enough to expand access to ESTs and

[166] Latif, Maskus, Okediji, Reichman, Roffe (n 93) 6-7. (The study points out some drawbacks that may prevent the use of IP-related flexibilities in the current system from being the best options for developing countries to successfully facilitate access to ESTs.)

[167] UNEP, EPO and ICTSD, 'Patents and Clean Energy: Bridging the Gap between Evidence and Policy: Final Report' (n 15) 52. (There are some cross-border collaborative mechanisms related to ESTs, such as patent pools, cross-licensing, joint venture and strategic alliance, and other collaborative IP-based activities in developing countries such as IP protection, scientific capabilities, infrastructure and human capital, market conditions and investment climate.)

nor are the other EST-related arrangements under the UNFCCC.[168] It is necessary instead to turn to WIPO for an optimal solution.

Chapter Four conducts comparison between pharmaceuticals and ESTs. The parallel starts from the economic perspective in order to analyze the similarities and differences between ESTs and pharmaceuticals. The similarities make it necessary to treat ESTs preferentially, and the differences indeed serve as a justification for establishing a differentiated patent regime based on ESTs' own characteristics. The substantive requirements and measures used to gain access to pharmaceuticals and ESTs are discussed. The justification of public interests in patent protection is a topic that cannot be avoided and the analogy between environment and health concerns is explored.[169] Some important lessons from harmonization between IPRs and public health are concluded in a comprehensive and comparative way, so that inspiration and a reference point could be provided for the discussion on patents and access to ESTs in the context of climate change.

Based on the previous analysis, Chapter Five explores the way to enhance access to ESTs by designing a patent regime, including the characteristics, the principles and the main body composed of the structure of patent rights granted to ESTs, the key sector-based classification of ESTs and the consideration of public interests from the user-friendly perspective. Most importantly, the path to create a special patent system is put forward through international multilateral negotiations under WIPO, which is finally implemented by the adjustment of domestic legislation. The conclusion of this

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[168] Estelle Derclaye, 'Intellectual Property Rights and Global Warming' (2008) 12 Marquette Intellectual Property Law Review 263, 284<http://ssrn.com/abstract=1016864> accessed on 24 October 2013. ('Indeed the transfer or re-use of IPR-protected products does not involve any of the exclusive rights in copyright and patent law.' Although IP holders may be tempted to override the principle of exhaustion by way of contracts or technological protection measure, it is against by regulations of the EU Treaty and some other countries on the free circulation of goods and services, meaning that the parallel import of ESTs is a tacit admission.)

[169] Van Smith, 'Enabling Environments or Enabling Discord: Intellectual Property Rights, Public-private Partnerships, and the Quest for Green Technology Transfer' (2011) 42 Georgetown Journal of International Law 817, 837-840. (The author points out that although the analogy between the controversy over access to drugs and the need for transfer of ESTs is not a perfect one due to several distinctions, it does raise significant concerns about promoting ESTs by necessary reform of TRIPS.)

part does not ignore the difficulties to achieve that time-consuming goal.

As the biggest emerging country and so one that clearly faces the dual pressure of economic transition and emission reduction, China is selected as a particular focus to explore the domestic application of this special patent system. Chapter Six discusses the flexible application of such a system in the specific EST-related context of China. This means that the effective implementation of the universal patent regime is determined by the interaction between the internal contradiction of this system itself and the external economic environment.[170] The conclusion drawn from this study is that under the dual pressures of economic transition and emission reduction, developing countries should be encouraged to actively fulfill their international obligations in accordance with their specific national circumstances.

Finally, the thesis comes to the conclusion that to create a patent regime for ESTs by forming a legally-binding agreement under WIPO could be the optimal choice to harmonize the international IP protection and cooperation on climate change mitigation, which would mostly be addressed through the innovation and application of ESTs. With valued-based judgment at its core, the differentiated patent regime could improve access to ESTs, so that their effectiveness could be maximized in accordance with local technology needs.[171] The reduction of the threshold of technology transfer and transaction costs under the guidance of principles, including risk distribution and benefit sharing, economic stimulus and environmental friendliness, could also be helpful to eliminate contrived barriers and prohibit the abuse of IPRs.[172] Consequently, environmental systems and patent systems are

[170] In my thesis, the internal contradiction of patent system itself means the dual role of patents in addressing climate change, i.e. to encourage innovation and impede access to patented technologies, and the external economic environment primarily denotes technological innovation capacity and technology development models.

[171] Ebinger and Avasarala (n 103). (A collaborative model between UNFCCC and private sectors is proposed by the authors in accordance with the assessment of technology needs that are 'country-specific technology requirements based upon geographic and demographic constraints'.)

[172] Christopher Gibson, 'Breaking Down Barriers to Technology Transfer: Reforming WTO Standard-Setting Rules and Establishing an Advisory Facility in Standard-Setting for Developing & Least Developed Countries' (2011) Suffolk University Law School Legal Studies Research Paper Series Research Paper 11-37 September 12, 2011< http://ssrn.com/abstract=1926413> accessed on 12 November 2012. (The threshold of technology transfer involves fairness in the international standard

proven not contradictory but complementary to each other, playing their own irreplaceable roles in meeting the various challenges of global climate change.[173]

1.4.2 The Research Methods and Limitations

Several approaches are taken to design a differentiated patent regime for ESTs in the context of climate change. Based on the cost-benefits analysis, this thesis explores an appropriate structure model of patent protection specially designed for ESTs, which consists of intensity (patentability), length (duration), and width (breadth). Different levels of the three dimensions have different incentive effects on the innovation and accessibility of technologies. Based on the quasi-public nature and major components of ESTs, an optimal structure of patent rights was put forward and accordingly, differentiated protection with value-based judgment at its core, is proposed for different types of ESTs, giving priority to the innovation of some ESTs and accessibility of other ESTs.

As mentioned above, in a comparative way how to break the impasse in the heated debate around patents and access to ESTs is identified. For example, a horizontal comparative analysis is used to conduct a systematic discussion of the existing international framework in relation to EST transfer under the three international organizations, with the most favorable choice to build up a patent framework under WIPO being selected, throughout the process of the study and during which several possible solutions are analyzed to find their advantages and disadvantages.

What is more, the parallel of pharmaceuticals and ESTs is conducted to draw

setting where IP rights are a quite important consideration, so its reduction will benefit countries with technological backwardness.)

[173] Estelle Derclaye, 'Should Patent Law Help Cool the Planet? An Inquiry from the Point of View of Environmental Law: Part 1' (2009) 31 (4) European Intellectual Property Review 168, 183. (To counter the so-called 'conflict' between patent and environmental laws, the author points out that it has already been internalized internationally in Article 27.2 of TRIPS and regionally in Article 53.a. of European Patent Convention and the relevant case law though they are not enough. Based on the analysis of environmental rules, it finds that environmental protection plays an active role in stimulating green innovation, so patent and environmental laws can work together in harmony to reach the ultimate goal of sustainable development.)

some lessons from the heated debate on drug patents and public health. The doctrinal analysis from a legal and economic perspective is used to find the similarities and differences between ESTs and pharmaceuticals. The similarities make it necessary to treat ESTs preferentially, and the differences serve as a justification for establishing a differentiated patent regime based on ESTs' own characteristics. Accordingly, the substantive requirements of patents granted to and measures to get access to the two quasi-public goods are different.

This thesis never denies that it is extremely difficult to define an ideal range of patent protection.[174] There is no sufficient empirical research to support the delimitation to the range of EST patents, especially when it comes to the assessment of technical needs in key concerned industries. For such a large and arduous task, although some efforts have been made, it is regrettable that the author did not have much access to primary data. In addition, the focus of this study is only placed on invention patents, which are arguably of massive significance above all for ESTs that can make substantial contribution to addressing climate change. As space is limited, minor creations that also make contribution to emission reduction and could be protected as utility models or other forms of IP are not discussed in this thesis.

[174] William M. Landes and Richard A. Posner, *The Economic Structure of Intellectual Property Law* (The Belknap Press of Harvard University Press 2003) 24. (It is pointed out that

> 'Ideally, in deciding how broad or narrow an intellectual property right to recognize, one would want to classify different forms of intellectual property according to the output likely to be produced with and without the recognition of such a right and grant such recognition only to those forms in which output would be seriously suboptimal without it. So in areas of intellectual property where fixed costs were low or other incentives besides the prospect of royalty income were present in force, intellectual property protection would be slight or would even be withheld altogether. Unfortunately, the empirical studies required to make such a classification have never been undertaken; and there is a danger that such a classification could become a political football, with politically favored producers of intellectual property being granted broader rights than others (to some extent this may already be happening)'.)

Chapter 2 The Infrastructure of International Harmonization of EST-related IPRs in the Context of Climate Change

'Climate change' means 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.'[1] Whilst its impact varies from country to country, climate change has become an undeniable issue that continues to have an adverse effect. In this context, the infrastructure of international harmonization of EST-related IPRs is explored below. Given the dual nature of ESTs and globalization of climate change, the global cooperation and coordination in EST-related innovation and transfer are tremendously significant at a critical historical stage when the discussion on IPRs and climate change becomes involved in an impasse.[2]

2.1 ESTs and IPRs

2.1.1 The Dual Nature of ESTs

The dual nature refers to the characteristics of ESTs bear of both proprietary and public goods. The two characteristics, apparently contradictory, can be mutually reinforcing. Approaches or practices to stimulate innovation through the creation and

[1] Article 1 of The UNFCCC <https://unfccc.int/sites/default/files/conveng.pdf> accessed on 12 March 2012.

[2] Bronwyn H. Hall and Christian Helmers, 'Innovation and Diffusion of Clean/Green Technology: Can Patent Commons Help?' (2011) National Bureau of Economic Research Working Paper Series No.16920, 4. (The environmental externality makes the diffusion and subsequent innovation of ESTs highly desirable, which has triggered 'an active debate on the role and usefulness of IPRs in the generation of climate change related innovation and its diffusion'. According to existing evidence, it is hold that IP protection has negative impact on follow-on innovation and welfare costs will be caused by limited diffusion.)

recognition of proprietary interests in ESTs serve public goods, and thereby contribute to the overall efforts required for mitigating climate change.[3] The application of ESTs can strengthen social adaptive capacity to climate change and generate considerable market profits, provided that these technologies are proven to be successful. While proprietary interests often conflict with the characteristics of public goods, coordination between the two sides when a public environmental emergency occurs could be helpful to enhance accessibility of ESTs, as long as the coordination is based on fair and reasonable terms.[4]

2.1.1.1 The Features of ESTs

ESTs are hopefully regarded as tangible or intangible property which exposes positive effect on nature and climate.[5] ESTs represent the trend of a new technology revolution with highly multi-technological intersection and integration, and as such are viewed as complex technologies that are closely related to some industries, such as energy industry, chemical industry, semiconductor industry and machinery industry.[6] One obvious feature of ESTs is their wide distribution in various technology fields, meaning that they are not 'a unified category but an umbrella term

[3] Robert Fair, 'Does Climate Change Justify Compulsory Licensing of Green Technology' (2009) 6 International Law & Management Review 21.

[4] Ahmed Abdel Latif, Keith Maskus, Ruth Okediji, Jerome Reichman, Pedro Roffe, 'Overcoming the Impasse on Intellectual Property and Climate Change at the UNFCCC: A Way Forward' (2011) 11 ICTSD Programme on Innovation, Technology and Intellectual Property November 2011 Policy Brief 1, 4. <http: //ictsd.org/i/publications/120254.> accessed on 12 May 2013. (Coordination between the two sides can be done through policies and mandates, mainly referred to as the practice of non-voluntary and public use licenses by the authors who believe that they could be useful for access to public goods with just and rational terms.)

[5] Thomas L. Brewer, 'International Technology Diffusion in a Sustainable Energy Trade Agreement (SETA): Issues and Options for Institutional Architectures' (2012) International Centre for Trade and Sustainable Development September 2012, 1, 4. (The notion of technology has been expanded and refined in climate negotiations where the technologies refer to know-how, and thus intangible, as well as tangible products.)

[6] Georg von Graevenitz, Stefan Wagner and Dietmar Harhoff, 'Incidence and Growth of Patent Thickets: the Impact of Technological Opportunities and Complexity' (2013) 61 (3) The Journal of Industrial Economics 521.

that covers many areas of technology'.[7] In accordance with the international patent classification issued by the Organization of Economic Cooperation and Development (OECD), the main environment-related technologies refer to general environment management, energy generation from renewable and non-fossil sources, combustion technologies with mitigation potential, technologies specific to climate change mitigation, technologies with potential or indirect contribution to emission mitigation, emission abatement and fuel efficiency in transportation and energy efficiency in building and lighting.[8]

ESTs cover a wide range of technologies from high-tech innovations to low-tech innovations, so they differ in many ways, such as investment cost, contribution to environmental protection and applicability across industries and borders.[9] With positive externality, there are a large number of ESTs can significantly improve the level of environment protection by reducing GHG emission.[10] Taking the technology of Carbon Capture and Storage (CCS) as an example, it refers to a series of

[7] Eric L. Lane, 'Building the Global Green Patent Highway: A Proposal for International Harmonization of Green Technology Fast Track Programs' (2012) 27 Berkeley Technology Law Journal 1119, 1163-1164. (Green technologies represent a wide range of products, services and processes and span many industry verticals. In this article, it includes 'renewable-energy generation technologies, energy storage technologies, transportation technologies, energy infrastructure technologies, building materials and lighting technologies, bio-based plastics and other materials, water filtration and desalination systems, technologies that reduce pollution and emissions and even carbon trading schemes and other green policies'.)

[8] OECD Patent Statistics ISSN:2077-7809 DOI:10.1787/data-00508-en. (The dataset consists of statistics on patents by main technologies such as information and communication technology, biotechnology, medical technology, nanotechnology, environmental-related technology under EPO,USPTO and PCT from 1976-2010. http://stats.oecd.org/BrandedView.aspx?oecd_bv_id=patent-data-en&doi=data-00508-en.)

[9] Bronwyn H. Hall and Christian Helmers, 'The Role of Patent Protection in (Clean/Green) Technology Transfer' (2010) No.16323 National Bureau of Economic Research Working Paper 1, 19. (According to the categories of green technologies given by Popp, it finds green innovations differ greatly and rang from 'high-tech innovations such as genetically modified crops to low-tech innovations such as mechanical farming techniques'. Thus, 'the fixed cost of innovation and adoption involved and their application across industries and climatic zones' varies considerably as well.)

[10] H-Holger Rogner, Dadi Zhou, Rick Bradley, Philipp Crabbé, Ottmar Edenhofer, Bill Hare, Lambert Kuijper, Mitsutsune Yanaguchi (2007) Chapter 1 Introduction in B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds), *Climate Change 2007: Mitigation of Climate Change* (Cambridge University Press 2007) 112. ('There are various types of technologies that can play significant roles in mitigating climate change, including energy efficiency improvements throughout the energy system (especially at the end use side); solar, wind, nuclear fission and fusion and geothermal, biomass and clean fossil technologies, including carbon capture and storage; energy from waste; hydrogen production from non-fossil energy sources and fuel cells.')

technologies that can separate CO_2 or CO from waste gases produced by industries or from the atmosphere through absorption and capture, and then fix and transport it to some places where obtained CO_2 or CO can be cast aside in order to stop it from entering the atmosphere or used as a raw material for production.[11] As early as 1990, CCS was recognized as integral part of technical prospect as to reduce the negative impact of GHGs on climate change in the IPCC report.[12] Currently it is one of the most practical ESTs related to CO_2 emission mitigation. According to the survey of the IPCC, the application of CCS could reduce CO_2 emission by 20% to 40%.[13]

As far as those ESTs that are of great significance to emission reduction and social development, some are in the initial stage of development which requires large investment and time-consuming R&D,[14] some develop into maturity in urgent need of market incentives for application, and some call for public acceptance and resolutions from the perspective of legislation.[15] No matter what type they belong to, IP protection may be imperative to ensure the advancement of this new round technological revolution.[16]

In addition, compared with the use of traditional fossil fuel technologies, cost may be a big obstacle that hinders the development and diffusion of ESTs. Without

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[11] Global Carbon Capture and Storage Institution. 'Understanding CCS: What is CCS and why is it important?' <http://www.globalccsinstitute.com/ccs/what-is-ccs> accessed on 5 May 2012.

[12] Climate Change: The IPCC Response Strategies (1990) Report prepared for Intergovernmental Panel on Climate Change by Working Group III. <http://www.ipcc.ch/ipccreports/far/wg_III/ipcc_far_wg_III_chapter_08.pdf> accessed on 5 May 2012.

[13] IPCC, 'Climate Change: The IPCC Response Strategies' (1990) Report prepared for Intergovernmental Panel on Climate Change by Working Group III. <http://www.ipcc.ch/ipccreports/far/wg_III/ipcc_far_wg_III_chapter_08.pdf>

[14] Alexander Adam, 'Technology Transfer to Combat Climate Change: Opportunities and Obligations under TRIPS and Kyoto Protocol' (2009) 4 Journal of High Technology Law 1, 18. ('The cost of research and development for ESTs is not universally high. While some technologies, such as photo-voltaic and fuel cells, require many years of development and concomitant capital investments, other technologies, such as energy efficient appliances and landfill-gas flaring, may carry little extra research and development costs.')

[15] Rogner, Zhou, Bradley, Crabbé, Edenhofer, Hare, Kuijper, Yanaguchi (n 10).

[16] Anastasia Lewandoski, 'Intellectual Property Rights to Enhance International Clean Tech Transfers' (2008) 9 Sustainable Development Law & Policy 51. (Given the high cost of R&D and significant role of clean technologies, the author argues that 'protecting intellectual property rights may be imperative to ensure technological advances continue to be made, even if for some time the technology may not be transferred for others to use.')

support from governments, it is difficult to implement projected ESTs and infrastructure.[17] For instance, in the absence of preferential policies and specific government funding, CCS will not be cost-effective for power plants.[18] For this reason, the EU[19], France[20], the United Kingdom[21], the United States[22], Japan[23] and other countries have committed to the development of CCS.

Another feature of ESTs is their uneven distribution among regions as most of ESTs are being developed in a small group of developed countries and emerging

[17] Bernice Lee, Ilian Iliev and Felix Preston, 'Who Owns Our Low Carbon Future?' (2009) A Chatham House Report on Intellectual Property and Energy Technologies 1, 60-61 <http://www.chathamhouse.org/sites/default/files/public/Research/Energy%20Environment%20and%20Development/r0909_lowcarbonfuture.pdf> accessed on 3 May 2013. (Climate change mitigation requires large-scale applications of such technologies as CCS and Concentrated Solar Power, but the complexities of these technologies are in need of governments' support based on strict planned proposals and infrastructures.)

[18] Matthias Finkenrath, 'Cost and Performance of Carbon Dioxide Capture from Power Generation' (2011) International Energy Agency and OECD 2011 Working Paper <http://www.iea.org/publications/freepublications/publication/name,3950,en.html> accessed on 4 February 2013. (It is stated in this paper that the isolation of CO_2 from industrial emissions and natural gases and the compression of CO_2 to a super-critical state before sequestration both require a lot of money. So does the transportation through pipeline to an injection point.)

[19] Global Carbon Capture and Storage Institution: Projects –Listing and Analysis of CCS Projects around the World < http://www.globalccsinstitute.com/projects/browse > accessed on 20 May 2013. (The EU plans to make investment of 6-7 billion Euros to build twelve CCS demonstration projects around the world and intends to equip the newly-build coal-fired power plants with CCS since 2020.)

[20] Global Carbon Capture and Storage Institution: French CCS Projects in the lead for EU Funding < http://www.globalccsinstitute.com/institute/news/french-ccs-project-lead-eu-funding> accessed on 23 May 2013. (The French multinational conglomerate Alstom has invested in eleven CCS demonstration projects around the world which are in the lead of EU funding for full commercialization of CCS.)

[21] Edward Davey, 'CCS Competition Launched as Government Sets out Long Term Plans' (Announcement from Secretary of State for Energy and Climate Change organized by Department of Energy & Climate Change, 3 April 2012)< https://www.gov.uk/government/news/ccs-competition-launched-as-government-sets-out-long-term-plans > accessed on 21 May 2013. (As announced by the UK Ministry of Energy and Climate Change in April 2012, the UK government formulated a series of plans on the development of CCS, including investment of 1 billion pounds to provide financial support for enterprises that are willing to develop large-scale commercial CCS projects.)

[22] International Carbon Capture and Storage Technology Survey (2009) Report Prepared for Gassnova by Innovation Norway Issue 5 2009 <http://ekstranett.innovasjonnorge.no/Felles_fs/CVCTeamNorway/Dokumenter/Surveillance%20of%20CCS%20projects%20and%20initatives%20Issue%205.pdf> accessed on 22 May 2013.(The U.S. had invested over 2 billion U.S. dollars in CCS demonstration projects since 2007 and in 2009 announced a plan to invest 67 million US dollars for ten CCS research projects.)

[23] Japan Cabinet: the Action Plan on Building a Low-carbon Society (2008) <http://paper.ce.cn/jjrb/html/2008-08/11/content_24757.htm> accessed on 22 May 2013. (In 2008, Japan cabinet meeting passed the Action Plan on Building a Low-carbon Society which aims to fully apply CCS with the cost reduction by 50% by 2020.)

countries, indicating the obvious gap between developed and developing countries.[24] According to the statistics about CCS patent applications to EPO, the innovations of CCS were mainly concentrated in the EU where the top five members are Germany, France, UK, Netherlands and Norway, US, Japan and Canada.[25] Despite the best performance in non-OECD countries, China accounted for less than 0.5% of the global aggregate.[26] CCS is still a club of developed countries. Given their uneven distribution, it is necessary to facilitate diffusion of and access to ESTs. As lessons learnt from reconciliation between patents and access to pharmaceuticals are important part of this thesis, features of ESTs will be emphatically discussed later when conducting comparison with pharmaceuticals.

2.1.1.2 The Mixed Characteristic of Proprietary and Public Goods of ESTs

Different from most of other technologies, ESTs are controversial products with both private and public properties. As confirmed and protected by national legislation and international treaties, inventors or creators should be entitled to the ownership of their minds.[27] As achievement of human intellectual efforts, the landscape of development and ownership of ESTs is principally depicted by patent statistics.[28] The

[24] Joshua D. Sarnoff, 'The Patent System and Climate Change' (2011) 16 (02) Virginal Journal of Law and Technology 302, 316-318. (Most of ESTs are being developed in the 'so-called big three of Japan, Germany and the United States', although some other developed countries such as the United Kingdom and France, and some emerging countries called as BRICS-plus countries have made some achievement in particular sectors. The geographic imbalances in innovation and patenting and costs of technology acquisition for developing countries 'are likely to further exacerbate existing intellectual property, trade, and scientific differences and to generate political tensions along the North - South divide.')

[25] OECD, 'Patents by main technology and by International Patent Classification (IPC)' (2011), OECD Patent Statistics (database) doi: 10.1787/data-00508-en.Accessed on 30 January 2013. (It is clear that during the decade from 1999 to 2009, the EU takes the top one place with the total number of 436.1 followed by the US with the number of 421.3 and Japan with the number of 118.9.)

[26] Ibid.

[27] Enrico Bonadio, 'Climate Change and Intellectual and Property' (2010) 1 European Journal of Risk Regulation 72, 73. (When it comes to the important relationship between IPRs and ESTs, the author believes that IPRs over ESTs are the optimal way to recoup the huge cost invested in the R&D of ESTs, and the protection of IPRs over ESTs is officially documented by domestic law and international conventions, in particularly referred as to TRIPS.)

[28] Keith E. Maskus and Ruth L. Okediji, 'Intellectual Property Rights and International Technology

ownership of ESTs can be defined as public-owned or private depending on the sources of investment. Legal issues about the ownership of IP are strictly limited by sovereign boundaries.[29] Issues concerning public goods or partially public goods need to be resolved at the international level, because national laws and policies do not particularly concern themselves with neighboring areas as much as their own territory, especially in respect of the topic of environmental pollution.[30]

The introduction of public goods provides a point at which to better analyze the nature and characteristics of ESTs. From an economic perspective, the standard used to distinguish between private and public goods depends on whether or not the goods are competitive in consumption and exclusive in use.[31] Inventors provide ESTs, but consumers of ESTs are separated into two categories. The first category is the direct adopter of ESTs, who is not only the direct consumer but also the producer or manufacturer of the technologies. From this point of view, ESTs are competitive in consumption and exclusive in application, because the direct adopter will be charged by the owners of technologies. The other category consists of the mass consumers, who are the direct or indirect beneficiaries by using ESTs.

For instance, power plants that purchase CCS products can reduce energy consumption by processing the amount of waste gases with the assistance of

Transfer to Address Climate Change: Risks, Opportunities and Policy Options' (2010) 32 ICTSD's Programme on IPRs and Sustainable Development Issue Paper 1. (In order to provide empirical evidence to examine the role of patents in investment in innovation of ESTs, the authors summarize features and trends of patent ownership of major ESTs based on the data study conducted by Cambridge IP institution and the joint research made by UNEP, EPO and ICSTD.)

[29] William Cornish and David Llewelyn, *Intellectual Property: Patents, Copyrights, Trade Marks and Allied Rights* (8th edn, Sweet & Maxwell 2013) para 1-29. (Since IPRs are adopted by States to satisfy economic needs of their own territories and thoughts of nationals with moral value, the rights are generated on the basis of sovereignty. As a result, the legal issues arise as the international obligations or commitments of States are supposed to shape and adjust rather than to displace the main body of national legal systems.)

[30] Keith E. Maskus and Jerome. H. Reichman, 'The Globalization of Private Knowledge Goods and the Privatization of Global Public Goods' (2004) 7 (2) Journal of International Economic Law 279, 284. (In the Footnote 13 of this article, the authors take air pollution as an example to explain an externality effect, stating that the pollution caused in one country may have a side effect on the citizens' health of other countries. Even so, policymakers or lawmakers will not take the welfare of another country into account consciously when making their own policies and laws.)

[31] Ibid 283. (In the section A International Public Goods and IPRs, the most-accepted definition of public goods was given by Paul A. Samuelson, who points out two key characteristics of public goods, that is 'non-rivalry in consumption and non-excludability in use'.)

technologies. As expected, the operating cost is decreased and economic efficiency is improved. It is undoubtedly competitive and exclusive as consumers purchase CCS products for the right of use. On the other hand, the affected residents within the geographic scope who pay for the electricity produced or the products made by the power plants will receive benefits due to the advantages of CCS in environmental protection and emission reduction. In its social contribution to climate mitigation, CCS technologies demonstrate characteristics of public goods. The benefits are shared by all consumers; one consumer's benefit will not be reduced by virtue of benefits given to other consumers.

The analysis of the mixed characteristics of ESTs from the economic perspective highlights the non-economic value of ESTs and public demand for them based on case-by-case analysis. In other words, the subject of rights and the subject of interests involved in environmentally sound innovations are not as consistent as it is involved in ordinary patents but partially detached.[32] This partial detachment drives people to consider seriously the conflict between providers, consumers and end-beneficiaries.

Based on the above analysis, the characteristic of ESTs can be described as that of environmental goods or services, with a positive impact on the environment and climate.[33] More specifically, ESTs are intangible products with dual nature akin to both private and public goods that play a multi-fold role in promoting economic and social sustainable development.[34] As it is discussed above that the development of

[32] Elizabeth Burleson, 'Dynamic Governance Innovation' (2013) 24 The Georgetown International Environmental Law Review 477, 492-496. (There are some competing rights involved in environmentally sound climate mitigation and adaptation innovations, including IPRs, human rights, and environmental sustainability. In her article, Burleson proposed that human rights and environmental public goods should be prioritized in environmentally sound innovation sharing via network coordination.)

[33] Lynn Mytelka, 'Technology Transfer Issues in Environmental Goods and Services: An Illustrative Analysis of Sectors Relevant to Air-pollution and Renewable Energy' (2007) ICTSD Trade and Environment Series Issue Paper No.6 2007, 14-15. (The current approach to define environmental goods applied by OECD is the end-use method which identifies environmental products and services simply based on the terminal products that offer marginal impact in environmental protection. However, Mytelka views that the approach should pay more attention to engagement in the complete changes of production process, because processes and methods integrated into definition of environmental goods will cover more goods than the end-use method.)

[34] Eric L. Lane, 'Chapter 1: Clean Tech IP Is for Real' (2011) *Clean Tech Intellectual Property: Eco-Marks, Green Patents, and Green Innovation* (Oxford University Press 2011) 3. (In this chapter,

ESTs requires large and significant investment, the commercialization of ESTs is one well-acknowledged way to recoup costly investment at the earlier stage of development of ESTs. The international IP system considerably strengthens the private element of ESTs by bringing in huge profits; the existing international legal requirement is in favor of the protection of mitigation and adaptation technologies, most of which are owned by a small number of developed countries and certain emerging economies.[35]

The fact cannot be ignored, however, that certain critical public goods are globally significant and in demand, for example pharmaceuticals and ESTs. With the frequency of climate-related events, the public characteristic of ESTs tends to be more prominent at these moments than at any other time in the history of human development. This means that the requirements deriving from climate protection aspect make the IP issues related to EST transfer more complex.[36] Consequently, considerable private and public investment in ESTs would only yield extensive access to ESTs if concrete coordination between private and public interests were to gain satisfactory results.[37]

2.1.2 The Scope of ESTs under Patent Protection

The gradual escalation of hostility between mitigating the effects of climate change and protecting IPRs requires a new legal philosophy integrated as guideline. Francis Gurry, Director General WIPO, sends an aspiring message to the world that

green technologies are characterized by three features, including diversity, accumulative innovation and their social commitment to the environment.)

[35] Sarnoff (n 24).

[36] Hall and Helmers, 'The Role of Patent Protection in (Clean/Green) Technology Transfer' (n 9) 18. (It is analyzed by authors that '[T]he global public good character of environmental protection adds another layer of complexity to the issue of IP protection and technology development and transfer discussed so far'.)

[37] Carlos M Correa, 'Fostering the Development and Diffusion of Technologies for Climate Change: Lessons from CGIAR Model' (2009) ICTSD Programme on IPRs and Sustainable Development Policy Brief No.6 2009. (According to the opinion of Correa, in order to ensure the public access to technologies funded publicly, it is in need to find a way towards the development and adaptation of climate technologies.)

WIPO is intensifying its efforts to establish a balanced IP system, encouraging the development and dissemination of green technologies and designs that are environmentally friendly from conception to disposal.[38]

The cutting-edged ESTs, on which the battle against climate change relies, can significantly enhance energy efficiency, and thus decrease the damage to the environment, while IP systems provide a regulatory framework in which these technologies can yield valuable performances and proceed on a healthy path.[39] ESTs are covered as patentable subjects, as long as they conform to the generally-acknowledged standards enunciated in TRIPS.[40] Alternatively, ESTs can be protected in the form of undisclosed information, but given the difficulty and huge cost in replication and commercialization, most inventors of ESTs are more willing to apply for patent protection.[41] No matter the form of IPRs, the question arises as to what criteria should be followed to grant IPRs to ESTs. A threshold that is neither excessively high nor too low is beneficial for the development of ESTs, as the former will lead to a waste of resource and the latter could decrease the value of IP overall.

The criteria of ESTs under IP protection vary territorially according to the overall level of each country's economic development and innovative capabilities. A strong market demand, adequate financial compensation and a reliable legal system that can provide sufficient protection to technologies are highly significant factors will be

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[38] Francis Gurry, 'World Intellectual Property Day 2009: Message from Francis Gurry, Director General World Intellectual Property Organization' (Speech on World IP Day, WIPO, 26 April 2009) <http://www.wipo.int/ip-outreach/en/ipday/2009/dg_message_09.html> accessed on 28 February 2013.

[39] John H. Barton, 'Intellectual Property and Access to Clean Energy Technologies in Developing Countries: An Analysis of Solar Photovoltaic, Biofuel and Wind Technologies' (2007) ICTSD Trade and Sustainable Energy Series Issue Paper No. 2. 2007.

[40] The Agreement on Trade-Related Aspects of Intellectual Property Rights, Apr. 15, 1994, signed as Annex 1C of Marrakesh Agreement Establishing the World Trade Organization, 1869 U.N.T.S. 229, 33 I.L.M 1197 (1994) <http://www.wto.org/english/docs_e/legal_e/27-trips_01_e.htm.> (The Article 27 of TRIPS states that patents can be granted to any invention including products and process in all fields as long as they are inventive, novel and useful. The three indicators may be expressed in slightly different words, but the core meaning is identical in effect.)

[41] Sarnoff (n 24). (A large amount of study has been carried on in order to examine whether the patent system and patent rights are the decisive factors for firms to consider the investment, R&D and disclosure of planned technologies. Sometimes these technologies might be protected as undisclosed business secrets, which, however, make troubles for the licensing and transfer of technologies.)

considered in standard-making processes.[42] Regardless of the extent of differences in criteria, the grant of IPRs to technologies highlights a core idea: to create a favorable legal condition for the innovation of ESTs as well as curbing the generation of products that cause environmental pollution.

The statutory grant of patents includes not only positive but also exclusive regulations.[43] Generally speaking, a patent will be granted to an invention that meets the standards of novelty, non-obviousness and industrial applicability.[44] As far as ESTs are concerned, the requisite qualification of industrial applicability is given a new interpretation, that economic and social effects yielded by an invention can be anticipated by technicians in the same field since the date of patent application.[45] Compared with the prior art, these effects play a positive and beneficial role in quality improvement, production growth, energy conservation, pollution prevention, and control. While on the other hand, some regulations are usually expressed such that an invention should be excluded where it is obviously in violation of sustainable development rules and has serious side effects on climate and natural environment should be excluded from patentability.[46] The issue of patentability should and must be treated on the basis of a careful and scientific argument. The suggestion and

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[42] Maskus and Okediji (n 28) 1.

[43] Cornish and Llewelyn (n 29) para 1-04. (IPRs are basically negative rights that stop others from doing some specific behaviors without the right-holders' authorization, but 'some aspects IP confer positive entitlements, such as the right to be granted a patent or to register a trade mark upon fulfilling the requisite conditions'.)

[44] World Intellectual Property Indicators, 'Section A: Patents, Utility Models and Microorganism' (WIPO Press Release, Geneva, December 11 2012) <http://www.wipo.int/export/sites/www/ipstats/en/wipi/pdf/941_2012_section_a.pdf> accessed on 1 March 2013.

[45] Keith Maskus, 'Differentiated Intellectual Property Regimes for Environmental and Climate Technologies' (2010) Environment Working Paper of Organization for Economic Cooperation and Development No.17 <http://dx.doi.org/10.1787/5kmfwjvc83vk-en> accessed on June 12 2013. (The implication for GHG emission is viewed as an important part of 'effective diffusion' of ESTs, which requires the application of ESTs bringing about environmental benefits can be fully understood by local technicians and firms.)

[46] Adam (n 14) 19. (According to Article 27.2 of TRIPS, 'inventions whose commercial exploitation needs to be prevent to protect human, animal or plant life or health or to avoid serious prejudice to the environment' can be excluded from patentability. Therefore, statutorily excluding subject matter from patent eligibility can be used to keep technology in public domain or restrain the development of technologies. For example, Article 5 of China's Patent law stipulates that 'inventions that violate laws of China or social morality or prejudice public interest would not be entitled to patent protection'.)

practice that ESTs should be granted patents or excluded from patentability indiscriminately are rather extreme and irrational.[47]

In addition to the shared characteristics of IPRs, such as boundary protection, duration of IPRs and intangibility, the value of ESTs under the protection of patents or confidential information is enhanced remarkably by the expanding scope and increasing frequency of use.[48] Further development of ESTs is required to reach a newer and higher technical level. The majority of products protected by traditional copyrights and trademarks do not evolve in such an encouraging way, except products related to the internet, as such invention patents are considered 'the most basic, the most valuable, and, to competitors, potentially the most dangerous, of all IP'.[49] Perhaps this contributes in part to the reason why right holders are cautions about EST transfer.

In relation to EST-related patents, innovative steps forward are taken from a procedural perspective, given the particularity of ESTs. Procedurally, in respect of the public characteristic of ESTs, certain initiatives have been advocated for and launched to reward and encourage the innovation of ESTs through IP protection. Examples of these initiatives include accelerated examination by the USPTO and UKIPO in 2009[50], reduction or waiver of application fees, cancellation of deferred examination for ESTs, advanced publication and strengthened protection at the stage of infringement[51], easy access to information on EST-related IPRs, and fast tracking of EST patent

[47] Lisa Larrimore Quellette, 'Addressing the Green Patent Global Deadlock Through Bayh-Dole Reform' (2010) 119 The Yale Law Journal 1727, 1728. (Out of the practical needs of access to ESTs, developing countries recommend to exclude green technologies from the range of patent protection and revoke existing green patents on the international occasions, which inevitably meet with the objection from industrial countries.)

[48] Cornish and Llewelyn (n 29) para 1-05. (The further development following the first invention in a special field ought to be embodied in products of all competitors if they are to occupy the market.)

[49] Ibid. (The authors hold the view that patents are required to be studied above both the other two central types of IPRs –copyrights and trademarks.)

[50] Hall and Helmers, 'The Role of Patent Protection in (Clean/Green) Technology Transfer' (n 9) 6. (In the opinion of Professor Derclaye, the patent system can be used to encourage green technologies and get rid of the opposite ones that cause the growth of greenhouse gases by adjusting patent procedures.)

[51] Estelle Derclaye, 'Not Only Innovation but also Collaboration, Funding, Goodwill and Commitment: Which Role for Patent Laws in Post-Copenhagen Climate Change Action' (2010) 9 J. Marshall Rev. Intellectual Property L. (Special Issue) 657.

applications[52]. These initiatives aim to improve efficiency of examination and grants of EST patents by opening a green channel, so as to accelerate the progression of innovative outcome.

Aside from the procedural adjustment, innovative breakthrough is also proposed from a substantive perspective, in relation to examining the inventiveness and industrial applicability of ESTs. This can otherwise be presented as the concept of environmental protection being incorporated as another new standard of patent examination, especially in innovative processes.[53] Objectively, the protection of EST-related IPRs should be remarkably helpful in controlling environmental deterioration and reducing energy consumption. New regulations and policies are of crucial importance as supplementary solutions to direct the innovation of technologies with commercial value towards those that have substantive potentials in combating climate change.[54] Other substantive legal issues, such as the argument about whether volunteer or compulsory licensing is justifiable for ESTs will be discussed in the comparison between EST patents and drug patents.

2.1.3 Recent Trends in EST-related Patents

The current study on ESTs is primarily based on patent applications to national and international patent offices. Analysis of patent data is only a rough index of EST innovation but it helps to obtain the overall information about dynamic development

[52] Ahmed Abdel Latif, 'Ways to Promote Enabling Environments and to Address Barriers to Technology Development and Transfer' (2012), Submission by ICTSD as responding a call for inputs from UNFCCC Technology Executive Office. <http://ictsd.org/i/publications/144613/.> accessed on 12 December 2012.

[53] Mytelka (n 33) 14-15. (Mytelka argues that more attention paid to innovative processes will be an incentive and guidance to potential creation, although the function of environmental goods is normally tested by end products from those firms that provide environmental services.)

[54] Hall and Helmers, 'The Role of Patent Protection in (Clean/Green) Technology Transfer' (n 9) 4. (Hall and Helmers made the same argument as Acemoglu that an endogenous model is conducive to lead the innovation of technologies towards environmentally friendliness, with the assistance of research subsidies or other temporary policy intervention.)

trends in ESTs among various sectors, and their geographic and spatial distribution.[55] In accordance with the patent statistics provided by OECD, the selected environment-related technologies are scattered unevenly in various sectors. During the decade from 1999 to 2008, there was a five-fold increase in the number of patents related to energy generation from renewable and non-fossil sources in the energy sector, the sector with the highest growth in patent applications, compared with the six other main sectors under international patent classification.[56]

Additionally, the classification of EST-related patents tends to be more professional and diversified. For instance, patents concerning renewable energy generation are primarily subdivided into wind energy, solar thermal energy, solar photo-voltaic energy, solar thermal-PV hybrids, geothermal energy, marine energy, hydro energy-tidal or stream, and hydro energy-conventional.[57] Most of the innovations in these sectors are concentrated in the USA, Germany, Japan, Denmark and other OECD members.[58] The unbalanced distribution determines the structure of EST market, which further confirms the necessity of the diffusion of ESTs.[59] As far as those countries that have been lagging in the innovation of ESTs, the wider the gap between them and the world's representatives of cutting-edge technologies, the greater the risk of non-effective integration of these advanced technologies into their production systems.[60]

As the patent classification becomes more detailed, new situations emerge. As

[55] K.Ravi Srinivas, 'Climate Change, Technology Transfer and Intellectual Property Rights' (2009) Research and Information System for Developing Countries Discussion Paper RIS-DP#153,2009.

[56] OECD (2011), 'Patents by main technology and by International Patent Classification (IPC)', OECD Patent Statistics (database) doi: 10.1787/data-00508-en.Accessed on 30 January 2013.

[57] Ibid.

[58] Ibid. (Other OECD members mainly refer to Netherlands, UK, Canada and Norway.)

[59] Srinivas, 'Climate Change, Technology Transfer and Intellectual Property Rights' (n 55). (Based on the analysis of patent statistics, the contradiction between centralization and transfer in ESTs field is created by the fact that most of ESTs are concentrated in the hands of a few countries.)

[60] Daniel K.N. Johnson and Kristina M. Lybecker, 'Challenges to Technology Transfer: A Literature Review of the Constraints on Environmental Technology Dissemination' (2009) 07 Colorado College Working Paper in the Project Supported by the National Peace Foundation and the United States Chamber of Commerce 1, 4. (The authors find that, in order to make the best use of the external information, it is crucial for technology recipients to enhance their own capability in building scientific R&D bases, as it is helpful to reduce the cost of technology introduction. Or otherwise these recipients will be challenged by technological backwardness.)

found by Ravi Srinvas, an EST may apply for more than one patent, which results in the strengthening of monopoly and the peripheral development of that EST becoming very difficult.[61] One patent could be utilized in various fields, meaning the success of certain important ESTs is built upon multilateral technical cooperation and cumulative invention.[62]

The market for ESTs is expected to have a bright prospect, with increasing attractiveness to investment from which therein arises fierce competition, which leads to a growth in international EST-related litigation.[63] Bonadio believes that the increase in international litigation concerning EST-related patents is attributable to divergent national IP strategies and enforcement.[64] Although TRIPS provides a minimum standard of international IP protection, comparisons on the issue of IP enforcement in different jurisdictions produce a considerable number of differences. According to the findings of Archibugi and Filippetti, in some countries strong IP protection is implemented to ensure that any infringement of IPRs will be prosecuted and damages will be awarded, while in other countries where public legal awareness of IPR infringement is not as prevalent, the community tolerates violations of IPRs with more patience.[65]

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[61] Srinivas, 'Climate Change, Technology Transfer and Intellectual Property Rights' (n 55) 3. (It is pointed out by Srinivas that the patent package established around one environmentally sound technology is a strategy often used by some companies. Currently, the majority of low-carbon technologies belong to highly technology-intensive ones which usually contain various patents, and companies with competitive advantages have applied for a series of relevant patents as a kind of strategy, so it is relatively difficult to 'invent around' for developing countries.)

[62] Maskus and Okediji (n 28) 26-27. (For the proposal to extend the patent protection period, the authors believe that it may block the follow-on innovation, and there is no actual evidence shows that a longer term of protection stimulates patent holders to accelerate the pace of innovation.)

[63] Srinivas, 'Climate Change, Technology Transfer and Intellectual Property Rights' (n 55) 4-5. (With the reference to the study conducted by R.T. Miller, Srinivas follows the opinion that the number of patents in clean technologies is growing with good future and therein will an increasing investment and competition be accompanied by more lawsuits.)

[64] Bonadio (n 27) 75. (The author views that the international EST-related patent litigation has witnessed a significant growth of the lawsuits witnessed because of 'the aggressive IP strategies and enforcement'.)

[65] Daniele Archibugi and Andrea Filippetti, 'The Globalization of Intellectual Property Rights: Four Learnt Lessons and Four Theses' (2009) Working Paper 1, 4 <http://ssrn.com/abstract=1486071 or http://dx.doi.org/10.2139/ssrn.1486071> accessed on 4 May 2012. (The IP system is defined as written and customary rules in an individual political community which presents its own attitude towards the enforcement of IPRs.)

In order to clearly understand the reason for the growth in the international EST-related lawsuits, take the United States as an example. As the global competition center, the United States exerts great influence on the global enterprises with the largest number of IP lawsuits, a considerable part of which are identified as foreign-related cases.[66] From a legislative perspective, the reasons principally refer to the lack of uniform standards to interpret patent claims, the cramped principle of equality in patent litigations, and the expansion of patent protection scope.[67]

Different jurisdictions yield different results based on similar facts. There are no clear winners in these lawsuits, which are usually costly and prolonged fights that can postpone the marketing and application of crucial ESTs.[68] The litigation can be used as a strategy to crack down on all infringements and threaten competitors, but if it is only used in such an aggressive way, rather than to encourage innovation, then legitimate IPRs are detached from the fundamental pursuit.[69] Similarly, if companies apply for a patent in order to circumvent the threat of litigation from competitors, rather than to stimulate innovation, the industry as a whole will be caught in a vicious competition caused by inappropriate use of IPRs.[70]

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[66] James Bessen, Jennifer Ford and Michael J. Meurer, 'The Private and Social Costs of Patent Trolls' (2011)
Boston University School of Law Working Paper No. 11-45. <http://www.bu.edu/law/faculty/scholarship/workingpapers/2011.html> accessed on 3 May 2013.

[67] Maskus and Reichman (n 30) 297. (Even in the U.S., there is not a unified standard of patent protection. In the past few years, the way to interpret patent claims changed, and the principle of equality was narrowed by the federal courts which extend patent protection to some areas that are against by both domestic community and EU.)

[68] Bonadio (n 27) 75. (The current situation is worrisome, because the lawsuits concerning ESTs will cause losses to parties, not only because of its high litigation costs and long period but also the delay in the dissemination of ESTs.)

[69] Sean M. O'Connor1, 'IP Transactions as Facilitators of the Globalized Innovation Economy' (2009) Rochelle Dreyfuss et al., *Working within the Boundaries of Intellectual Property* (Oxford University Press 2010). (Some firms are criticized for doing nothing and being silent at the time when other competitors develop, manufacture and market products, and then bringing an accusation against product-distributors for infringement.)

[70] Sarnoff (n 24) 315. (In order to guide intentions of patent application in the right direction, the US Federal Trade Commission noted that 'defensive patenting could act as a tax on innovation – if companies acquire patents only to be free from litigation threats of competitors – rather than as a stimulus to innovation' in 2003.)

2.2 The Intersection of IPRs and Climate Change

The invention of a technology is in the large measure of integration and effective use of resources, including social and natural resources, in pursuit of economic benefits.[71] Unfortunately in reality, conflict arises between the maximum of economic benefits and environmental protection. Unrestrained exploitation and consumption of natural resources is the root cause of environmental problems that are triggered by the production of new outcomes under the influence of IP protection.[72] Admittedly, the existing international IP system itself is not designed for solving the problem of climate change. Notwithstanding with the purpose of finding a balance between private interests and the interests of society, it is incapable of dealing well with the issue regarding the specialness of public goods characteristic of ESTs.[73] As the international IP system proceeds in a dynamic manner, rather than once and for all, appropriate adjustments of the international IP system in accordance with the development of ESTs should be paid respect to as a positive response to climate change.[74]

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[71] Rasmus Lema, Adrian Lema, 'Technology Transfer? The Rise of China and India in Green Technology Sectors' (2012) 2 (1) Innovation and Development 2012.Available at SSRN: <http://ssrn.com/abstract=2003367 or http://dx.doi.org/10.2139/ssrn.2003367> accessed on 3 March 2013. (When discussing the learning process and localized innovation, the authors hold the opinion that, from the point of micro-level, technical innovation and technological learning is a process which involves integration of firm's endogenous capability and external knowledge.)

[72] Estelle Derclaye, 'Intellectual Property Rights and Global Warming' (2008) 12 Marquette Intellectual Property Law Review 263 <http://ssrn.com/abstract=1016864> accessed on 24 October 2013. (It is observed by the author that the most significant inventions created in the 19th and 20th centuries, such as cars, trains, aircrafts, family equipments and computers, need a huge amount of energy to put into practice, which contributes largely to the increasing amount of CO_2 in the atmosphere. However, IP research institutions paid little attention to this fact.)

[73] Hall and Helmers, 'The Role of Patent Protection in (Clean/Green) Technology Transfer' (n 9) 28. (While IPRs can narrow the gap between private and social returns to innovation due to the public goods characteristic of knowledge, IP cannot provide a solution for environmental externalities which must be addressed by specific measures.)

[74] Philippe Nonet and Philip Selznick, *Law and Society in Transition: Toward Responsive Law* with A New Introduction by Robert A. Kagen (2nd ed Transaction Publishers 2001) 87. (The authors hold the view that the law reform should be towards 'responsive law' which regards social pressure as a source of understanding and an opportunity of self-correction. Here, climate change is viewed as an external factor that IP legal system ought to respond to.)

2.2.1 The Dual Role of IPRs in Addressing Climate Change

The dual role of IPRs, namely, to encourage innovation and diffusion of technologies, is classically expounded in TRIPS.[75] Hard trade-off has to be made between the innovation and application of knowledge while developing an IP system. For most part, innovation is stimulated by IP law and public finance, while the dissemination of ESTs is closely linked to international trades and foreign investment policies in addition to IP. The latter is much more complex.[76]

In the context of climate change, the two aspects of the dual role of IPRs are easily to be misinterpreted, or even set against each other. This is perceived on many international occasions where the requirement of IP protection for innovations and the appeal of access to ESTs are being intentionally separated from each other.[77] The role of IP in innovation and transfer of technologies varies considerably with sectors and countries, although global harmonization of IPRs is supposed to bring in a new round of technological innovation and information exchange through no-barrier market.[78]

2.2.1.1 EST-related IPRs and Developed Countries

Quite apparent is the fact that the incentive and protective role that IP plays in driving innovation is growing day by day in developed countries.[79] As far as ESTs

[75] TRIPS Article 7 expounds that the objectives of 'the protection and enforcement of IPRs should contribute to the promotion of technological innovation and to the transfer and dissemination of technology…'.

[76] Latif, Maskus, Okediji, Reichman, Roffe (n 4) 4. (The authors point out that the role of IP in the dissemination and transfer of ESTs is much more complicated, as ESTs vary from one another in performance and are subject to many other factors, mainly referring to economic and institutional ones.)

[77] Ibid.

[78] Maskus and Okediji (n 28) 5. (The negotiation about the single issue concerning ESTs under the UNFCCC in 2009 includes the topics on how to stimulate innovation of ESTs by IP policies and encourage diffusion through free trade and foreign investment, as well as how to use global technology fund to complete the goal set by the conference.)

[79] Cornish and Llewelyn (n 29) para 1-04. (It is recognized that 'IP is growing in importance, to the advanced industrial countries in particular, as the fund of exploitable ideas becomes more sophisticated and as their hopes for a successful economic future come to depend increasingly upon their superior

are concerned, the reasons for that are presented by the following two aspects. First, as stated in 2.1.1.1, the high cost of innovation of ESTs and increasing risk thereof constantly enhances the dependence of inventors on IPRs. In general, marketing an EST is a long and arduous process, with no shortcut to be found. For example, renewable-energy generating equipments, energy storage facilities and clean energy-powered transportation vehicles have to undergo complex and costly manufacturing processes.[80] What is more, capital is a huge problem for the production of these devices. It is quite likely that difficulties in recovering cost in a short period of time increase and the high risk of a broken money trail occurs, even for rather popular ESTs.[81] The International Chamber of Commerce stressed that IP protection is so important for the innovation of ESTs that any adjustment to the existing international IP protection regime will have a profound impact on the future of clean technologies and know-how.[82]

Second, a lucrative prospect based on the positive effect of ESTs on the external environment is a built-in incentive to encourage innovations which are legally protected. By virtue of the technical monopoly embodied in IPRs, enterprises can establish a promising business that runs in a virtuous circle with more funds for further innovation.[83] Alternatively, by purely licensing patented ESTs, high returns can also be obtained, and the funding problem of the entrepreneurial threshold is avoided.[84] As a result, inventors or patent holders are able to focus on innovation,

corpus of new knowledge and fashionable conceits.')

[80] Lane, 'Chapter 1: Clean Tech IP Is for Real' (2011) *Clean Tech Intellectual Property: Eco-Marks, Green Patents, and Green Innovation* (n 34) 3. ('Unlike the computer-based businesses of the Internet boom before it, the energy-generating equipment, energy storage components, and hybrid vehicles of the clean tech industry today are complex and expensive to manufacture.')

[81] Ibid. (It reveals that the commercialization in clean technologies is not easy at all, along with high cost and risk, which can be found in manufacture and popularization.)

[82] The International Chamber of Commerce (ICC) Optimistic Progress Can Be Made at Copenhagen Climate Summit (2009)<http://www.iccwbo.org/News/Articles/2009/ICC-optimistic-progress-can-be-made-at-Copenhagen-climate-summit/ >accessed on 28 July 2012.

[83] Lane, 'Chapter 1: Clean Tech IP Is for Real' (2011) *Clean Tech Intellectual Property: Eco-Marks, Green Patents, and Green Innovation* (n 34) 4. (As a core EST is usually constituted by multiple patents, with one or two can inventors earn money during the period of patent protection or even longer period of time.)

[84] Ibid 5. (The author exemplifies the model of licensing as a good choice for inventors to avoid being

without too much worry about the commercialization of products. It is therefore concluded that IPRs accelerate the pace of the innovation of ESTs, especially for developed countries with strong creative capacity in ESTs.

From the perspective of those industrial countries that are in requirement of a strong IP regime, the role of IPRs in the application and dissemination of ESTs should and can only be played under the rule of market through free licensing negotiations and FDI, and certainly it is closely and inseparably associated with the ability of recipients to absorb advanced technologies.[85] Or more accurately, the lack of such capacity will definitely fail recipient nations' desire to seek transfers of ESTs.[86] Besides enhancing R&D capacity and reforming market, the capacity here in the eyes of developed countries refers to providing legal guarantee for the stringent enforcement of IP protection in the recipient countries.[87]

As a kind of emerging industry with bright market potential, it is reasonable that the development and application of ESTs relies on market, but for the object of the application of ESTs, the global climatic environment is interrelated and mutually influenced, despite of regional features, not controlled by market. Therefore, institutional arrangements are essential to balance the gap between innovation and application of ESTs that cannot be solved by one single method or measure in the real world, though they are combined perfectly in theory.[88]

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trapped in the high cost of business startup and other relevant difficulties.)

[85] Maskus and Okediji (n 28). (In contrast to the market-oriented view of industrialized countries, many developing and less-developed countries pin hopes on institutional adjustment to promote access to ESTs. In the executive summary, the authors believe that neither is a correct or an ideal way to solve this thorny issue.)

[86] Kalpana Murari, 'Transfer of Technology in A Post-Kyoto Framework' (2010) Working Papers Series 2010, 1 <http://ssrn.com/abstract=1909468 or http://dx.doi.org/10.2139/ssrn.1909468> accessed on 20 April 2013. (In the first part of this paper, the author points out that the capability of countries to absorb and transform advanced ESTs is well regarded as 'a criterion' that could be a booster or otherwise a major impediment to transfer of ESTs across borders.)

[87] Ibid. (In terms of policies and measures, governments of developing countries are demanded to strengthen institutional norms and capacities including R&D capital, market mechanisms and innovation capacity.)

[88] Hall and Helmers, 'The Role of Patent Protection in (Clean/Green) Technology Transfer' (n 9) 12-17.

2.2.1.2 EST-related IPRs and Developing Countries

As analyzed in 2.2.1.1, EST-related IPRs can encourage innovation, accelerate domestic economic growth, and promote technology transfer by domestic and foreign investment. However, it may not have the same effect in developing countries as it does in developed countries. Here two questions need to be answered: will EST-related IP protection in developing countries generate expected results that spur domestic innovation and catch-up of ESTs? How does EST-related IPRs affect decisions made by foreign countries that have potential willing to transfer ESTs to developing countries in forms of licensing or other mutually-beneficial trading ways?

The influence of IPRs on an industry depends largely on the market structure of that industry prior to the introduction of IP protection.[89] In the market of developing countries where an upward competition emerges, the grant of IPRs might result in waste of social innovation resources.[90] Moreover, IP systems may prevent those countries where ESTs imports take the dominant position in their foreign trade from learning and imitating technologies, and thus foreign companies can seize the market by acquiring patent protection, or in other word, 'monopolistic rights' given by IP legal protection.[91] The speed of domestic innovation of ESTs in developing countries may be not fast enough to keep pace with rapid environmental degradation because of its weak innovative foundation, although some technological progress has been made

[89] Julio J. Nogués, 'Social Costs and Benefits of Introducing Patent Protection for Pharmaceutical Drugs in Developing Countries' (1993) 31 (1) The Developing Economics 24.(It is confirmed by the author that the social costs and benefits of enforcement of patents are decided to a great extent by the 'pre-patent' market of pharmaceutical industries.)

[90] Mohammed K El Said, *Public health related TRIPS-plus Provisions in Bilateral Trade Agreements: a policy guide for negotiators and implementers in the Eastern Mediterranean Region* (World Health Organization *Regional Office for the Eastern Mediterranean and ICTSD* 2011) 134. (In this publication, some argue that data on drugs should be excluded from IP protection, because it will lead to a waste of resources through frequent repetition of expensive and time-consuming effort made by generic competitors.)

[91] Bonadio (n 27). (The developing countries claim that IPRs could be used by foreign companies to monopolize the market of ESTs, which limits competition and wastes resources.) However, there is an opposite opinion. See Kalpana Murari, 'Transfer of Technology in A Post-Kyoto Framework' (2010) Working Papers Series 2010, 6-7 <http://ssrn.com/abstract=1909468 or http://dx.doi.org/10.2139/ssrn.1909468> accessed on 20 April 2013. (Foreign enterprises are often stronger than local companies with higher production which helps to reduce the technology application cost for developing countries.)

in couple of developing countries such as China, India and Brazil.[92] Therefore, for developing countries, EST-related IPRs may not play such a remarkable role in stimulating innovation as in developed countries.

As the protection of EST-related IPRs is a double-edged sword, with the intensified globalization of IP protection, it is justifiable for developing countries to clearly understand the positive significance of EST-related IPRs to their own development.[93] Patent systems can help to strengthen or eliminate monopoly. As for countries with relatively weak innovation ability, patent systems could easily lead to monopoly, because most of ESTs are introduced into domestic market by imports, the consequence of which is the high cost of technology acquisition.[94] Although the establishment of patent systems may strengthen the monopoly, or lead to the transfer of monopoly power, on the other hand, it means that technology information will enter the public domain after the expiration of patents, and at that time the public can take advantage of the information for improvement and innovation of ESTs, thus contributing to the elimination of monopoly.[95] Moreover, the cooperation between domestic and international research institutions and manufacturers can be realized through licensing agreements, which is objectively in favor of improvement of domestic technology and acceleration of innovation.[96]

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[92] Lee, Iliev and Preston (n 23). (In the executive summary of this report, it points out that though the innovative capability of some emerging economies such as China, India and Brazil has been demonstrated by the good performance of their domestic companies, none of them can enter the rank of global top 10 in any sector of clean industry.)

[93] Lewandoski (n 16). (Jeffrey Sachs in his article of 'Keys to Climate Protection' acknowledges that patent protection may be a double-edge sword. Although a limited period of IPRs provides incentive to innovate and allows people to enjoy scientific advancement, it still prevents some poor countries from getting access to technologies at some time.)

[94] Fair (n 3) 22. (The high startup and transfer costs caused by the protection of EST-related IPRs may actually hinder the development of domestic ESTs and the transfer of ESTs to developing countries, which are often big emitters with urgent demand for ESTs.)

[95] Andrew Beckerman-Rodau, 'The Problem with Intellectual Property Rights: Subject Matter Expansion' (2010) 13 Yale Journal of Law & Tech. 35, 42. (One of the intrinsic characteristics of a healthy economy is presented by the performance that innovative knowledge entering the public domain is maximized because 'innovators and creators, to whom IPRs are given just as a reward not a natural right in his inventions, do not work in a vacuum'.)

[96] Lee, Iliev and Preston (n 23). (According to the statistics, the authors find that the current cooperation on innovation is not internationalized enough to meet the requirement of EST transfer. However, some author points out that a pure scientific cooperation does not necessarily promote the

As far as the second question is concerned, some research shows that technology owners are more willing to transfer ESTs to countries with a severe legal system and rigid enforcement of IP protection. Pursuant to the survey jointly conducted by UNEP, EPO and ICSTD on licensing practice in clean energy sector, it indicates that 58% of respondents had not signed or made licensing contracts with companies in developing countries in the three years from 2008 to 2010.[97] A notable point worthy of being mentioned is that public R&D centers and academic institutions, by contrast, are more willing to license ESTs to developing countries with more flexible terms[98] than private owners, who will not initiate the transfer and sharing of technologies if they are not well protected under IPRs.[99]

Strong IP protection is not necessarily the factor that affects the decisions of foreign investors on technology licensing. The U.S. could be taken for an example. According to the statistics, the U. S. conducted a substantial investment, which accounted for a large part of its foreign direct investment in 1980s, in developing countries where the IP legal system was not sound or the enforcement of IP protection was not encouraging.[100] Therefore, it should be carefully analyzed, and cannot be generally concluded the extent to which EST-related IP protection in developing countries will have a practical effect on the willingness of developed countries to make a decision of EST transfer.[101] The best advice is to admit that this kind of effect

know-how exchange to developing countries); See also Padmashree Gehl Sampath and Pedro Roffe, 'Unpacking the International Technology Transfer Debate: Fifty Years and Beyond' (2012) Working Paper <http://ictsd.org/downloads/2012/07/unpacking-the-international-technology-transfer-debate-fifty-years-and-beyond.pdf> accessed on 3 May 2013.)

[97] Latif, Maskus, Okediji, Reichman, Roffe (n 4) 5. (It finds in the survey that the legal protection of IP is regarded as the more important factor by 'licensing-intensive respondents' than any other considerations, such as R&D infrastructure, qualified stuff and investment environment.)

[98] Latif (n 52) 2. (It is suggested that more attention should be paid to the significant role of public R&D centers and academic institutions in promoting technology diffusion by some modes, for example the Consultative Group on International Agricultural Research.)

[99] Srinivas, 'Climate Change, Technology Transfer and Intellectual Property Rights' (n 55) 34.

[100] Bonadio (n 27). (From the perspective of FDI, the author believes that IP protection does not necessarily stimulate technology transfer.)

[101] Thomas J. Bollyky, 'Intellectual Property Rights and Climate Change: Principles for Innovation and Access to Low-Carbon Technology' (2009) 1557196 Center for Global Development Note 1, 2-3. (The author believes that the role of IPRs on the innovation and transfer of ESTs seems not as important as

that cannot be overstated or ignored has a lot to do with other factors, such as the constitution of ESTs, the source of funding for R&D, and pathways of EST transfer.

2.2.2 The Bargain for IPRs in the Context of Climate Change

The topic of EST-related IPRs is an unavoidable issue in response to global climate change at international occasions. Currently, the bargain for IPRs is still demonstrated by obvious differences, which should be handled properly and urgently. The bargain on this issue has far-reaching implications for the establishment of a legal regime to harmonize IPRs internationally in the context of climate change.

2.2.2.1 The Stalemate between North and South

Many of participants in climate negotiations agree that it is necessary to elaborate the role of IPRs in addressing climate change or the relationship between IPRs and climate change, in which ESTs do play a role as a bridge to connect the two. However, parties have their own ideas about how to look upon or deal with such a relationship.[102]

Developed countries, while emphasizing the positive role of global IP protection on innovation on the one hand, are opposed to the incorporation of IP issues into climate negotiations on the other hand.[103] Does it seem paradox? The purpose of

claimed at this historical stage, but in future, especially with the increasing amount of emission in developing countries and the gradual growth of their economic and political power, the role of IPRs will be prominent.)

[102] Ahmed Abdel Latif, 'Change and Continuity in the International Intellectual Property System: A Turbulent Decade in Perspective' (2011) 3 (1) WIPO Journal 36, 43. (Different sides of negotiations have different implied meanings when discussing the role of IP in development issues, which makes the vision more confusing.)

[103] Ahmed Abdel Latif, 'Intellectual Property Rights and Green Technologies from Rio to Rio: An Impossible Dialogue?' (2012) 14 International Center for Trade and Sustainable Development Programme on Innovation, Technology and Intellectual Property July 2012 Policy Brief 1. (The deadlock caused by the heat discussion on whether IP is an obstacle to the transfer of ESTs forces major industrial countries to avoid arguing or mentioning IP issues in international negotiations about joint actions against climate change as a responsive strategy.)

these countries is to maintain competitive advantages in ESTs without any compromise in the international transfer of ESTs, because it is firmly believed by them that the claimed harmonization of IPRs in the context of climate change is a great movement against IP.[104] Meanwhile, with the increasing pressure exerted by emission reduction and adaptation to climate change, the voices of developing countries are continually raised, to inform the international community of their actual development plight which needs placing restriction on the traditional IP protection.[105]

Extensive modification of the existing international IP system may reduce the willingness of developed countries to take part in negotiations, but for the demand side of ESTs, non-ideal acquisition certainly frustrates efficiency of their emission mitigation efforts.[106] As previously analyzed, holders of ESTs believe that the effect of EST transfer largely depends on the transformative and absorptive ability of recipients. The concerns proposed by both sides are real and partly reasonable, but neither of them would like to take the initiative in moving forward.[107] Seen from the stalemate between the two sides, developed countries, as the representative of holders of ESTs, take a dominant position in climate negotiations.

There are reasons from different perspectives behind the stalemate. The fundamental reason is that due to lack of economic incentive, there are no sufficient efforts devoted to the transfer of ESTs to developing countries.[108] Another reason may be that the negotiation on IPRs in the context of climate change has been preset within a wrong framework where arguments of the two diametrically opposite views

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[104] Ibid 5.

[105] Sarnoff (n 24) 308. (With the increasing pressure posed by emission reduction and fast development of required ESTs, the efforts made by developing countries on both national and international levels will be intensified, including 'patent pooling', 'royalty –free compulsory licensing', 'excluding green technologies entirely from patenting and even retroactively revoking existing patent rights'.)

[106] Barton (n 39).

[107] Quellette (n 47) 1732. (As for most green technologies funded by governments, the protection of IPRs is not a justifiable excuse taken by developed countries to refuse to participate in transfer and cooperation of ESTs, because some politicians only concern about the legitimacy of IP in private sectors.)

[108] Sarnoff (n 24). (Developed countries rely much on the existing IP system both nationally and internationally, and furthermore, the huge profits guaranteed by IPRs protection for a wide range of technologies mainly come from 'South countries'.)

have always occupied the dominant positions.[109] As a result, meaningful discussions are easily categorized out of different political interests. Due to the divergence in ideology, a feasible stage of negotiations is hard to achieve.

2.2.2.2 The Implication for International Harmonization of IPRs in the context of Climate Change

The trend of globalization of IP system and the relevant international climate negotiations have great impact on all countries, especially developing countries. The potentials of ESTs for environmental protection have not been brought into full display, according to some study that the global task of reducing emission by 2030 could be realized by present ESTs.[110] The problem that has already got in the way is not the matter of weak innovation but by which means that the barrier-free communication and cooperation could be achieved between holders of ESTs and the demand side. Therefore, the role of IP in ESTs transfer clearly outweighs its role in the innovation of ESTs in the movement of GHG emission reduction.

The negotiation about EST-related IPRs in the context of climate change is set in the background against which IP systems have been tightly formed in developed countries, surely adding difficulties to the restructure of the relationship between IP protection and access to ESTs. An active dialogue is put forward as the first step. The North and South can gain a win-win situation if climate negotiations are institutionalized by reasonable negotiations, or otherwise both sides gain a 'zero-sum' bargain if climate negotiations are under the siege of political atmosphere.[111]

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[109] Latif, Maskus, Okediji, Reichman, Roffe (n 4) 2-3.

[110] Per-Anders Enkvist, Tomas Nauclér, and Jerker Rosander, 'A Cost Curve for Greenhouse Gas Reduction' (2007) 2007 No.1 The McKinsey Quarterly: The Online Journal of McKinsey & Co. 35 < http://www.epa.gov/oar/caaac/coaltech/2007_05_mckinsey.pdf> accessed on 8 May 8, 2013. (According to a cost curve for the abatement, 70% of the emission reduction target with 27 billion tons of CO_2 can be achieved by 2030 through the application of existing ESTs, and the rest 30% through commercialization.)

[111] Frederick M. Abbott, 'Innovation and Technology Transfer to Address Climate Change: Lessons from the Global Debate on Intellectual Property and Public Health' (2009) ICTSD's Programme on IPRs and Sustainable Development, Issue Paper No. 24, June 2009, 17. (From the standpoint of

International harmonization of IPRs in the context of climate change does not restrict itself to the stimulus of innovation and dissemination of ESTs, but extends its concerns over the effect on climate protection. Therefore, mechanisms and rules should be established with the purposes of protecting EST-related IPRs and promoting the transfer of EST as well, so that a smooth transfer and cooperation in the field of ESTs could proceed in an optimal way.

2.3 Necessity and Possibility for International Harmonization of EST-related IPRs in the Context of Climate Change

The global IP legal system undergoes a dynamic progress of modification and improvement as an active or passive response to constantly changing realities.[112] In the context of climate change, market inefficiencies and failures triggered by the proprietary characteristic of EST-related IPRs are accused by the international community.[113] In view of climate change related to the survival and welfare of all mankind and the vulnerability of poor countries in response to climatic disasters, though many proposals are often discussed, it is of crucial significance to explore necessity and possibility of harmonization of EST-related IPRs in the context of climate change, in order to avoid duplication of meaningless debate before effective solutions come up.[114]

developing countries, lessons from heated debate on public health and IPRs teach us that a 'zero-sum' bargaining does not work and the calling for fairness is not enough. The best choice for developed and developing countries is to carry out the joint economic arrangements which are mutually beneficial.)

[112] John F. Duffy, 'Harmony and Diversity in Global Patent Law' (2002) 17 Berkeley Technology Law Journal 685. (The history of global patent law has not only witnessed the reality and value of technological progress, but also proved the fact that the law is evolved with a changeable nature in order to encourage the progress.)

[113] Maskus and Reichman (n 30). (New technologies required by climate change mitigation are basically non-competitive, or at least partially non-exclusive, but unfortunately private market would not be supportive to that demand.)

[114] Charles K. Ebinger and Govinda V. Avasarala, 'Transferring Environmentally Sound Technologies in an Intellectual Property Friendly Framework' (2009) Energy Security Initiative Policy Brief 09-08 by Brookings Institution. (The necessity of environmental policy reform has not been discussed in consideration of the predictable emission of the whole world and the vulnerability of poor countries,

2.3.1 Necessity

2.3.1.1 Privatization of Innovation and Transfer of ESTs

Transfer of ESTs is mainly achieved through cross border contracts between enterprises. Regardless of content, an autonomous and formally equivalent exchange is the basic rule for the transfer of ESTs, which is viewed as primacy in a fair contract.[115] As such, it is not difficult to understand why developed countries are always opposed to developing a so-called universally binding agreement or treaty that facilitates technology transfer by redistribution.[116] As a major means by which technological progress makes due contribution to the improvement of social welfare, IPRs have inherent defects in dissemination of ESTs, which may erode the undertaking against climate change.[117] The question of how the defects influence the innovation and transfer of ESTs will be discussed from the standpoints of the private and public sectors respectively.

Private activities involving IP legal systems are characterized by their potential high risk as profit-driven acts. Under improper motivation, such activity can easily lead to the opposite of fair competition that is supposed to be protected by IP law. It often happens under the existing patent protection system that right holders use their

though the recommended reference and regulatory frameworks are often deputed, because every country is reluctant to make concession.)

[115] Robert Cooter and Thomas Ulen, *Law and Economics* (Addison Wesley Pearson, 5th edn, 2007) 209. ('In the language of law, a contract is fair when the value of the promise is proportional to the value of the consideration. Conversely, in an unfair bargain, the value of the promise is disproportional to the value of the consideration.')

[116] Ibid.9. (Redistribution which is favored in public law is not the primacy of private law. Pursuing redistribution through private law such as the law of property, contracts and torts is 'an exceptional use of private law that special circumstances may justify but that ought not be the usual use of private law'.); Hall and Helmers, 'The Role of Patent Protection in (Clean/Green) Technology Transfer' (n 9) 28. (Due to a wide range of classification of ESTs which are used to solve specific climatic problems, it is little probable to reach a universal mechanism to relieve the tension between IPRs and the transfer of ESTs.)

[117] Maskus and Okediji (n 28) 38. (Coupled with limited socio-economic levels of a great number of developing countries and less developed countries, technology transfer driven by market forces is far able to realize the desired aim of reducing climate risk.)

rights unreasonably by initiating patent battles against fellow competitors and leaving new technologies lying idle, consequently hindering the pace of innovation.[118] The locality of short-term private commercial activities frequently conflicts with the long-term interests of the international community. Nowadays, a great deal of EST-related business has expanded across borders. Rather discouragingly, however, EST transfer between developed countries and developing countries gives rise to an uneven result where one side wins more than the other.[119] In addition, the transfer of ESTs from developed countries is a lure for developing countries who are forced to accept the transferred industries with heavy pollution and high energy consumption.[120]

How are things going with the innovation and transfer of ESTs funded by public sectors? Taking the U. S. for instance, most of its basic research into green energy industry made by universities, laboratories and other research institutions is funded by the Federal Government. Based on statistic data from 2006, 60% of fundamental green innovations are funded by the Federal Government, 21% directly by universities and other nonprofit institutions, and only 15% by industries. Moreover, in 2009 6.77 billion and 8.18 billion US dollars were invested in basic science research in the Department of Energy and the National Science Foundation respectively, which

[118] Padmashree Gehl Sampath and Pedro Roffe, 'Unpacking the International Technology Transfer Debate: Fifty Years and Beyond' (2012) Working Paper 1, 38<http://ictsd.org/downloads/2012/07/unpacking-the-international-technology-transfer-debate-fifty-years-and-beyond.pdf> accessed on 3 May 2013. (In the past decade, IP, especially patents, plays a crucial role in company's strategic decisions. The defensive and aggressive patent strategies are often adopted by some companies to impose leverage over licensing negotiations or defeat competitors. In accordance with the latest report issued by WIPO, much overlap in patents postpones accumulation of innovation. The huge transaction cost keeps small companies from obtaining some core and necessary technologies. Therefore, the patent strategy has negative impact on 'the nature and intensity of competition'.)

[119] Cynthia Cannady, 'Access to Climate Change Technology by Developing Countries: A Practical Strategy' (2009) ICTSD's Programme on IPRs and Sustainable Development, Issue Paper No. 25, International Centre for Trade and Sustainable Development, Geneva. (The 'one-sided' technology contracts occur abundantly between parties from developed and developing countries. Three examples of contracts which involve universities, scientists and corporations are given by the author to demonstrate what a 'one-sided' contract is.)

[120] Elizabeth Burleson, Winslow Burleson, 'Innovation Cooperation: Energy Bioscience and Law' (2011) 2011 (2) University of Illinois Law Review 101, 128. (Patents are viewed as 'currency' that can attract capital and a bargaining ship to enter international markets and mergers as well.)

obviously surpassed the budget in the economic stimulus plan of that year.[121] These publicly funded green technologies did not, however, escape the threat of market imperfections that resemble market inefficiencies in private sectors. The large-scale dissemination of these technologies at acceptable prices is frustrated, because the Bayh-Dole Act encourages universities and research institutions to patent their inventions, hindering public access to these technologies not only in the United States, but also in the rest of the world.[122] It is argued that contrary to the original intention of the federal funding, over-commercialization is a prominent issue within the federally funded R & D projects, just as it affects the private sector.[123]

A specific regulatory framework is needed, therefore, to orientate involved parties towards predictable results through the creation of institutions, principles and procedures, though it would be enormously difficult to compel all participants follow it strictly.

2.3.1.2 Climate Change as Part of National Public Policy Requires Coordination across Borders

The most significant impact of climate change lies in the truth that serious consequences of extreme climatic disasters force people to think about changes in production modes and lifestyle. In order to maintain sustainable development, a more rational production mode and lifestyle needs to be discovered.[124] Isolationism is unacceptable in the context of climate change, which requires international

[121] Quellette (n 47) 1729.

[122] Archibugi and Filippetti (n 65) 9-11. (The authors state that 'the silent revolution in IPRs' is initiated by the United States. For example, the Bayh-Dole Act in 1980 creates a favorable environment for publicly-funded projects towards market orientation, which is followed by other OECD countries.)

[123] Barton (n 39) 7-8. (In the United States, many results of government-funded projects are almost protected in the form of patent protection, and manufacturers are favored by the Bayh-Dole Act to manufacture products in quantity.)

[124] Rio Declaration on Environment and Development (1992) The United Nations Conference at Rio de Janeiro from 3 to 14 June 1992. (It is clearly declared that the philosophy of environment protection should be incorporated into sustainable development for human beings who 'are entitled to a healthy and productive life'.)

consultations on how to mitigate and adapt to climate change, as well as the adjustment of legislation in order to fulfill international and domestic commitments.

Climate change compels political entities to cooperate in pursuit of their own interests. As national IP laws vary between countries, it is debatable whether the UN climate negotiations provide the right forum to find solutions to EST-related IP issues, considering the political nature of the UN.[125] The effect and binding force of a future agreement under the UNFCCC depends on whether it is a pure legal document or a political document.[126] In this regard, it argues in this thesis that the first essential step is to seek an appropriate platform to discuss climate change and IP issues, despite the difficulties. The general consensus is that sovereign states play a crucial role in coordinating the relationship between climate change mitigation and IP protection, which is an integral part of state public policies.[127] As the IP issue is an inevitable topic in the discussion about the transfer of ESTs in climate negotiations, the effort to coordinate the relationship between the two carries political significance.[128]

Regardless of the outcome of these disputes, certain conflicts between technology holders and the demanding side continue to exist throughout the entire negotiating process. Maskus and Okediji optimistically believe that to maintain the fundamental balance of public welfare, the existing climate change system provides a good platform to initiate effective and flexible negotiations on the conditions of access to

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[125] Srinivas, 'Climate Change, Technology Transfer and Intellectual Property Rights' (n 55). (Currently, most of the transfer of ESTs is advanced in the form of bilateral cooperation and gets a third party involved besides the two governments. There is a gloomy prediction that the negotiations under UN may not generate outcomes that satisfy all parties.)

[126] Krishna Ravi Srinivas, 'Technology Transfer and Intellectual Property Rights' (2010) 606 India Seminar 23 <www.india-seminar.com> accessed on 10 February 2012, 23. (It is suggested by the author that the role of UN about how to allocate the climate funds should be transparent. At the same time, the significance of a possible agreement under the UNFCCC would not be far reaching if it s just a political document.)

[127] Henning Grosse Ruse-Khan, 'Sustainable Development in International Intellectual Property Law – New Approaches from EU Economic Partnership Agreements?' (2010) 29 ICTSD Programme on IPRs and Sustainable Development 1. (As the main executor of international treaties, individual State should perform well to realize treaties' objective of sustainable development.)

[128] Rogner, Zhou, Bradley, Crabbé, Edenhofer, Hare, Kuijper, Yanaguchi (n 10) 112. (The financial support from governments by spending more money on innovation of ESTs is considered helpful to guide the trend of greenhouse gas emission reduction. However, things are different with respect to the dissemination of ESTs.)

ESTs.[129] In turn, the global IP regime could be improved under the principle of justice.

2.3.1.3 Reconstruction of the Unbalanced Economic Interests

Climate change must be addressed through negotiations to establish a long-term emission reduction target, a sine qua non for which is the transfer and cooperation of ESTs. In respect of practical interests, the transfer of technology goes ahead for objective reasons. In developed countries, there are two reasons. First, technology transfer is a relatively safe way for technology holders to enter another country's market, avoiding political risks.[130] Secondly, it is an effective way to share R&D costs; no individual country can meet the needs of technology development with limited resources. For developing countries, weak R&D capacities and a lack of technical personnel means that it takes more time and money to innovate; these countries then have to obtain technologies through imports. Unfortunately, in the long run, this method is unhealthy and would result in more imbalances. As the majority of core technologies are held by developed countries, progression of patent rights in creations has reached a much higher level than in developing countries.[131] The majority of monopoly profits awarded by patents are issued to developed countries.

The new proposed coordination regime requires jumping out of the current outdated thinking box of meaningless bargaining to readjust economic interests.[132] At a time when negotiations related to economic interests fall into an impasse, any delay

[129] Maskus and Okediji (n 28).

[130] Elizabeth Burleson, 'Energy Revolution and Disaster Response in the Face of Climate Change' (2011) 22 (169) Villanova Environmental Law Journal 101, 107. (The author holds the view that it is quite important to be clearly aware of the negative impact of regional political risks and legal systems that already exist on potential actions against climate change.)

[131] Maskus and Reichman (n 30) 306. (TRIPS-plus levels of intellectual property protection adopted by developed countries tend to 'expand and multiply exclusive rights, limit access to the research commons, and diminish the space for reverse engineering or other pro-competitive strategies built around value-adding applications of new technologies'.)

[132] Srinivas, 'Climate Change, Technology Transfer and Intellectual Property Rights' (n 55). (In order to make sure that IP would not become a barrier in addressing climate change, it may make a difference if the brain of decision makers frees itself from a small box.)

would only make the problem worse. As the main body for global public affairs, it is the time for the political will of governments to play a decisive role.[133]

2.3.2 Possibility

2.3.2.1 Theoretical Feasibility

The solution to the climate crisis depends on the wide use of ESTs around the world. From a theoretical standpoint, imbalance of technological development at different levels makes technology transfer possible, and provides an easily performable choice for the international community to address climate change.[134] In the aim of the transfer and application of their own technologies in market, costs invested into R&D by owners of technologies can be rewarded with added profits. On the other hand, due to energy shortages, environmental stress and limited technical capacity, there is a great and urgent demand for ESTs in the international market, especially in developing countries.[135]

Nevertheless, the supposed smooth transfer of ESTs to recipient countries may be hampered by various obstacles, such as local market conditions and investment climate, scientific infrastructure, human capital.[136] Fear of potential investment

[133] Jean O. Lanjouw, 'A New Global Patent Regime for Diseases: U.S. and International Legal Issues' (2002) 16 (1) Harvard Journal of Law & Technology 85. (Economists and political decision-makers are not willing to provide differential treatment for ESTs innovation and transfer, meaning that they do not want to regard ESTs as an exceptional target under IP protection, notwithstanding that a strong theoretical basis proves the movement is feasible.)

[134] Albert Mumma, David Hodas, 'Designing a Global Post-Kyoto Climate Change Protocol that Advances Human Development' (2008) 20 The Georgetown International Environmental Law Review 619. (It is stated in the article that the demand for new energy will be sharply decreased theoretically if developing countries are allowed access to needed ESTs.)

[135] Sarnoff (n 24). (Due to the unbalanced nature of global innovation and ownership of ESTs and the 'time-sensitivity of the need for these technologies', the tension arises between the technology holders and the demand.)

[136] UNEP, EPO and ICTSD, 'Patents and Clean Energy: Bridging the Gap between Evidence and Policy: Final Report' (2010) 9 < http://www.ictsd.org/themes/innovation-and-ip/research/patents-and-clean-energy-bridging-the-gap-between-evidence-and-policy>accessed on 20 September 2014. (In addition to IP protection, scientific infrastructure, human capital and market conditions and investment climate in recipient countries are

security problems drives technology holders, especially licensing-intensive ones, to rely heavily on the protection of IPRs for the purpose of maintaining market dominance and competitive advantages.[137] Recipients of ESTs also have their own concerns, such as the practical effectiveness of transferred technologies, unreasonable licensing fees, and restrictive clauses in license contracts.[138] The coordination between suppliers and demanders, particularly with legal tools and related policies, is able to bridge the gap generated by the lack of necessary trust between the two sides.[139]

Nowadays, the transfer of ESTs has gone beyond its traditional sense, i.e. the transfer of equipment through trade, investment, licensing and aid. It is now considered to signify a process of technological exchange and upgrading.[140] Developing countries ought to seize these opportunities to enhance their independent R&D capabilities. At the same time, developed countries also need to show their sincerity towards cooperating in ESTs transfer, so that a positive interaction can be formed in a teaching-learning mode.[141] The proposed regime under which IP protection and emission reduction could be harmonized in a sound way should consist of a neutral institutional architecture.

important considerations for a successful licensing agreement.)

[137] Ibid. (It finds that licensing-intensive respondents attach somewhat greater importance to IP protection than to other factors that may affect their decisions on technology transfer.)

[138] Srinivas, 'Climate Change, Technology Transfer and Intellectual Property Rights' (n 55). (The practice of the transfer of clean coal technology to Asian countries indicates that patent rights hinder the transfer of technologies indeed and transferors place some mandatory conditions in transfer and licensing contracts, which drives transferees into a very passive position.)

[139] Elizabeth Burleson, 'Dynamic Governance Innovation' (2013) 24 The Georgetown International Environmental Law Review 477, 503. (A transparent, legitimate and credible government will play a positive role in reaching cooperation which requires time and mutual trust with others in some important international occasions. Governments with good reputation know well how to respect diversity in terms of cultures and values by upholding the principle of justice.)

[140] Mytelka (n 33). (The intention of transfer of technologies has been renewed by adding more requirements that means the ability of the recipient is not limited to mastering the operation skills but includes adapting, updating and innovating technologies and know-how.)

[141] Ibid. (Changes in production methods, new IP and trade rules and environmental commitments present new possibilities for wealth creation and also set a higher qualification for developing countries in terms of learning and mastering technologies, or otherwise, it is difficult for most of developing countries to break into the international market.)

2.3.2.2 The Experience from International Coordination between IPRs and Climate Change as well as other Common Concerned Issues

International coordination arises from the need for interdependence among countries. Countries come to realize that they are unable to deal effectively on their own with common problems, such as health, climate change and other environmental challenges.[142] Furthermore, it would become more difficult to control behaviors that circumvent the law without international coordination.

Since the issue of climate change has been highlighted at an international level, efforts in international coordination have been strenuously intensified in this aspect. The birth of the UNFCCC and the subsequent Kyoto Protocol marked the initial results of international coordination. In the recent decade, however, expected results do not seem to arise with the progression of the issue.[143] As IP issues are not mentioned frequently during climate negotiations, the emerging discord between IPRs and climate change is not being addressed.[144] In addition to IP issues, climate change mitigation undoubtedly requires a series of concrete actions, including EST-related funds and time arrangement, although the international coordination discussed in this thesis focuses on regime building.

International coordination of IPRs and climate change is basically still at the exploring stage. Doubts have been cast on whether TRIPS can effectively promote the transfer of ESTs.[145] As private rights essentially conflict with public interests, it is

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[142] Burleson (n 130) 118. (The instinct of human to avoid harms brings the global together for the best solution to natural and anthropogenic disasters.)

[143] Daniel Bodansky, 'Climate Change and Human Right: Unpacking the Issues' (2010) Volume 38 Issue No.3 Georgia Journal of International and Comparative Law 511, 512. (In recent years, the UNFCCC negotiations did not yield satisfactory progress, which can be perceived from the Copenhagen Conference in which no fresh legal document came out, though the widely-criticized Copenhagen Accord was passed.)

[144] Bollyky (n 101). (The clauses about EST transfer under the UNFCCC and Kyoto Protocol do not get IP issue involved, but IPRs have to be discussed when it comes to EST protection and transfer, influenced by the heated debate on pharmaceutical patents.)

[145] Cameron Hutchison, 'Does TRIPS Facilitate or Impede Climate Change Technology Transfer into Developing Countries?' (2006) 3 (2) UOLTJ 517, 537. (From the perspective of effects on local innovation and the use of compulsory license for export to developing countries, the effect of TRIPS on the transfer of ESTs is discussed. It finds that 'TRIPS conflicts with obligations in the climate change regime to push technology transfer into developing countries and the export prohibition on compulsory

necessary to coordinate IPRs and legal rights in public sectors, such as health, security, traditional knowledge and genetic resources protection.[146] The Doha Declaration on TRIPS and public health opens up a new opportunity to consider the issues surrounding IPRs and climate change, though comparability of the two needs further study. What is gratifying, is that these experiences in international coordination provide valuable lessons for further debates.

2.3.2.3 The Experience from National Legislations

In addition to the need for international coordination in addressing climate change, emission reduction goals are also inseparable from the adjustment and support of national IP systems. Territorial jurisdiction makes national law particularly important in issues of IP implementation.[147] Both developed and developing countries have made attempts and are exploring EST-related legislations, in order to encourage the innovation and application of ESTs.

As IP systems have been tightly formed and deeply rooted in people's minds within developed countries, the innovation and transfer of ESTs is supposed to principally rely on equal transactions based on the principle of autonomy, without government interference except to prevent monopoly and unfair competition.[148]

licensing should therefore be abandoned'.)

[146] Malcolm Spence, 'Negotiating Trade, Innovation and Intellectual Property: Lessons from the CARIFORUM EPA Experience from a Negotiator's Perspective' (2009) UNCTAD - ICTSD Project on IPRs and Sustainable Development Policy Brief No.4 Sept. 2009. (The international community has been working on how to deal with the relationship between IPRs and public interests. The efforts in this aspect are emphasized by the documents issued by WIPO, WTO and other organizations, for example, the Framework of the Intergovernmental Committee on Genetic Resources, Traditional Knowledge and Folklore under WIPO, the Convention on Biological Diversity, and the Doha Declaration on the TRIPS Agreement and Public Health under WTO. Some regional organizations, EU and CARIFORUM here in this article, recognize the importance of coordinating relationship between IPRs and public interests and agree to work together to find better solutions under organizations of global influence.)

[147] Maskus and Okediji (n 28) 19. (Although IP as international public goods is in part securely protected by TRIPS, it is highly subject to legal rights in different regions.)

[148] Cooter and Ulen (n 115) 128. ('Private property creates a zone of discretion within which individuals are not accountable to government officials. Private property has thus been viewed by some philosophers as a bulwark against the dictatorial authority of governments'. For example, the U.S. Constitution was probably drafted with this idea in mind.)

Unfortunately, in face of various accusations about market inefficiencies, governments of developed countries have to appease pressure from both home and abroad, by increasing public financial support for EST innovation and adopting non-excludable licenses while keeping existing IP laws unchanged.[149]

As a recipient of technologies and in order to reduce risks in trade openness, developing countries typically manage imported technologies with domestic regulatory systems, dependent on overall national economic development.[150] Due to their backward technological and operational systems, companies from developing countries are often unable to identify the merits and practicability of ESTs; consequently, they are placed in an inferior position in international negotiations.[151] Accordingly, the transfer of ESTs to developing countries calls for support from national IP and environmental law, so that the transfer of advanced green technologies is encouraged and further innovation can be achieved successfully.

The efforts made by developed and developing countries in facilitating access to ESTs in the context of climate change offers possibilities for the establishment of international institutional architecture on this subject, since international negotiations on IPRs and climate change is progressing inseparably from national legislations and practices.

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[149] Quellette (n 47). (Taking the U.S. for example, the market failures caused indirectly by Bayh-Dole Act needs to be revised, not only for interests of the United States but also for the whole world.)

[150] James B. Ang, ‘CO_2 Emissions, Research and Technology Transfer in China’ (2009) 68 Ecological Economics 2658, 2659. (One of the findings in this article is that greater trade openness tends to generate more CO_2 emissions. The author argues that ‘if a large proportion of the imported technology focuses on pollution abatement and R&D activities relate to the creation of clean technology that better protects the environment, there will be higher productivity growth and better environmental performance.’)

[151] Christopher Gibson, ‘Breaking Down Barriers to Technology Transfer: Reforming WTO Standard-Setting Rules and Establishing an Advisory Facility in Standard-Setting for Developing & Least Developed Countries’ (2011) Suffolk University Law School Legal Studies Research Paper Series Research Paper 11-37 September 12, 2011< http://ssrn.com/abstract=1926413> accessed on 12 November 2012. (It finds that companies from developing and less-developed countries are often marginalized or unable to get access to the technology standard-setting process, which means that these countries are in a vicious cycle of innovation and technological backwardness.)

Chapter 3 The Examination of Coordination Arrangements around Patents and Accessibility of ESTs

There is little reason to doubt that IPRs and climate change are closely linked by the issue of the innovation and application of ESTs. So far, however, no specific international legal system or mechanism has been put in place to harmonize IPRs and climate protection, even though these two topics have both been on the negotiating table for years.[1] The relevant provisions concerning the international transfer of ESTs are scattered across treaties and agreements, and most of the arrangements associated with ESTs and climate change abatement are more of a political statement without legally binding effect; their effective implementation is necessarily dependant on certain specific international legal regime.

While the international climate regime offers legal grounds for the mitigation and adaptation to climate change, the international IP system, which here mainly refers to patents, provides a legal guarantee for the innovation and transfer of ESTs.[2] It should be noted that the international IP system occupies a dominant position when it comes to the issue of EST transfer, because documents under the international climate regime, as s a relatively new regime, are inferior to IP laws in terms of enforceability and legal effect.[3]

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[1] Charles K. Ebinger and Govinda V. Avasarala, 'Transferring Environmentally Sound Technologies in an Intellectual Property Friendly Framework' (2009) Energy Security Initiative Policy Brief 09-08 by the Brookings Institution. (The authors believe that the introduction of IP issue into climate negotiations is an imprudent decision, because once IP is brought in the confine of WTO or UNFCCC, negotiating processes would be hindered and very costly in schedule, which could been observed from the history of the Doha Declaration negotiations.)

[2] Abbe E L Brown, 'Securing Access to Climate Change Technologies: Answers and Questions' (2010) 21 University Edinburgh School of Law Working Paper Series 1, 2. (The view is hold by the author that technologies used to deal with climate change are in fact subject to the jurisdiction of intellectual property rights, although a proposal of a new fund to promote the transfer of these technologies has been put forward in the Copenhagen Accord.)

[3] Peter Drahos, 'Bargaining over the Climate: Lessons from Intellectual Property Negotiations' (2011) 2 Climate Law 1, 5. (Drahos observes that compared to international IP system whose history could date back to nineteenth century, the climate change regime which began in the late twentieth century is quite young.)

This Chapter attempts to point out the main problem in the existing coordination system from a legal logic perspective, through the analysis of EST-related provisions and arrangements in TRIPS and other key international documents under the UNFCCC and WIPO. Additionally, the following part conducts a critical assessment of the current proposals for reconciling patent protection of and access to ESTs. A further aim of this Chapter is to find justifications for establishing a win-win regime under WIPO that can be responsive to the actual demands of climate protection, by healing under the common goal of sustainable development the division in the development of the two systems.[4]

Therefore, this chapter is divided into three main parts:

1. An enquiry into the drawbacks in the existent arrangements concerning patents and accessibility of ESTs under the UNFCCC, WTO and WIPO.
2. Analysis of the relationship between these arrangements, namely whether it is conflicted or integrated?
3. Discussion on existing proposals to reconcile patent protection and access to ESTs in the international community.

3.1 The Existing Coordination System concerning EST Patents and Climate Change

The existent legal coordination system concerning EST patents and climate change here mainly refers to international arrangements which are formulated to deal with the crossed issue between patents and climate change, that is, the innovation and application of ESTs. The key to effective mitigation and adaptation to climate change lies in continuous innovation and global spread and application of ESTs. The

[4] Peter Ollier, Interview with Geoffrey Yu, Former WIPO Deputy Director-General, 'What WIPO Should Do Next' (2008) 181 Managing Intellectual Property 24. (Geoffery Yu said WIPO is committed to win-win solutions to issues that should be 'addressed with a sense of realism and a feeling that all countries participating in the process should be able to take something away from it'. With regard to what IP laws and issues most need to be harmonized, he attached great importance to the protection of traditional knowledge, access to and use of genetic resources, and benefit sharing.)

international community, recognizing this, has made efforts through a series of agreements and arrangements, to specify the obligations of developed countries to developing countries and build mechanisms for the international transfer of ESTs.[5]

So far, international arrangements concerning access to ESTs are presented at two levels: in the international documents under the framework of UNFCCC and in the international patent systems, including provisions and mechanisms regulated in some conventions and agreements under the WTO and WIPO.[6] In view of the respective emphasis and defects of the two levels, this part is intended to provide some suggestions for the reconciliation of climate protection and patent rights, through the study on EST-related multilateral mechanisms and their associated imperfection as well.

3.1.1 The TRIPS Agreement under the WTO and Access to ESTs

3.1.1.1 The Interpretation of Relevant Articles of TRIPS in the Context of Climate Change

Article 7 of TRIPS is the one closely associated with ESTs, because the goals supposed to be achieved through the protection and enforcement of IPRs is set out in this article for the WTO members. These include five key phrases: 'technological innovation', 'the transfer and dissemination of technology', 'producers and users of technological knowledge', 'social economic welfare' and 'a balance of rights and obligations'.[7] As can been seen, the first three goals mainly focus on IPRs relevant to

[5] Ebinger and Avasarala (n 1) 11-15. (In Part 3, the importance of technology transfer to climate change mitigation has been expounded through the history of international negotiations and the following achievements, including 1972 UN Conference on the Human Environment in Stockholm, 1985 Vienna Convention, 1987 Montreal Protocol, the creation of IPCC in 1988 and the establishment of UNFCCC in 1992.)

[6] The provisions and mechanisms related with ESTs in WTO and WIPO here primarily refer to TRIPS, Paris Convention and Patent Cooperation Treaty, which will be analyzed in detail later and interpreted in the context of climate change.

[7] Article 7 of TRIPS states that '[T]he protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and to the transfer and dissemination of

technological development, namely those objects with a technological nature, such as patents, layout-designs of integrated circuits, undisclosed information, and copyrights relating to technological innovation such as the protection of computer software.

It is observed from the progressive relationship of the five key phrases that the dual role of IPRs is reflected in this article, and IPRs themselves are not the ultimate goal of IP protection, which should be to increase social and economic welfare and in this process to maintain a balance between rights and obligations.[8] The question of how to achieve the balance between rights and obligations needs further understanding based on case-by-case study.[9] It is also clear in Article 7, that IP protection does not necessarily promote technological innovation and transfer in an automatic manner; the ultimate goal could be realized only if the mutual benefits of knowledge producers and users are facilitated in a way that is conducive to social and economic welfare.[10] Article 7 is regarded as an important clause concerning public interests with general applicability, as it is a specific article devoted to the relevant content of the Preamble[11] and reserves policy space for future implementation of exceptions and limitations in TRIPS.[12]

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technology, to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to a balance of rights and obligations.' http://www.wto.org/english/docs_e/legal_e/27-trips_01_e.htm.

[8] Ahmed Abdel Latif, 'Ways to Promote Enabling Environments and to Address Barriers to Technology Development and Transfer' (2012), Submission by ICTSD as responding a call for inputs from the UNFCCC Technology Executive Office. <http://ictsd.org/i/publications/144613/.> accessed on 12 December 2012. (The author believes that the duality of IPRs' role in technological innovation and transfer is interpreted classically in Article 7 of TRIPS.)

[9] Peter Drahos, 'The China-US Relationship on Climate Change, Intellectual Property and CCS: Requiem for A Species?' (2009) Queen Mary School of Law Legal Studies Research Paper No.36 or 1 WIPO Journal 124 <http://ssrn.com/abstract=1504246> accessed on November 13, 2013. (Drahos insists that the climate negotiation is not an appropriate occasion to discuss IP issues which should instead be resolved on a case-by-case basis in the light of specific ESTs.)

[10] Duncan Matthews, 'Patents in the Global Economy' (2010) Queen Mary University of London, School of Law Legal Studies Research Paper No. 73/2010 1, 16 <http://ssrn.com/abstract=1759522>accessed on 25 April 2012.

[11] Paragraph 5 of the Preamble of TRIPS states that the public policy objectives of national systems for IP protection should be recognized and highlighted. http://www.wto.org/english/docs_e/legal_e/27-trips_01_e.htm.

[12] Moustapha Kamal Gueye, 'Technologies for Climate Change and Intellectual Property: Issues for Small Developing Countries' (2009) ICTSD Information Note 12 2009, 4 < http://ictsd.org/i/publications/57611/ > accessed on 8 January 2014. (With further discussion about the Bali Action Plan advanced, it is well recognized that the most important topic needs to focus on the

However, there remains a large divergence in the understanding or interpretation of the meaning and effect of Article 7 of TRIPS. For most of the developed country parties, denying its legal effect or restricting its use could make the exclusive rights of IP holders in these countries subject to fewer limitations, so their attitudes towards objectives of public policies of the developing country parties are entirely different from those of their own countries when explaining the terms of Article 7.[13] The majority of the developing and LDC Members, as users of technological information and knowledge, have to place due emphasis on the objective of public policies ultimately pursued by IP protection and the public goods nature of ESTs, which must be taken into account in the interpretation and application of provisions to clarify rights and obligations of parties in the context of climate change.[14]

Article 8 gives the principles for how to implement TRIPS within the scope of sovereignty of Member States.[15] Article 8.1 states Members may take necessary measures to protect public health and public interests in crucial sectors of socio-economic and technological development. Moreover, in the wording of Article 8.2, it is expressed explicitly that Members are allowed to take appropriate measures

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particular approach and motivation to promote ESTs transfer to the least developed countries according to their specific conditions. Therefore, the Members of the UNFCCC should figure out a variety of ways to ensure that IP protection performs its function very well in facilitating technology dissemination and sustainable development, such as non-excludable policy space that could be applied in international IP rules and norms, more available policy space by the modification of IP rules, or new incentive mechanisms that may be not necessarily or directly associated with IP.)

[13] Daniele Archibugi and Andrea Filippetti, 'The Globalization of Intellectual Property Rights: Four Learnt Lessons and Four Theses' (2009) Working Paper Available at SSRN: <http://ssrn.com/abstract=1486071 or http://dx.doi.org/10.2139/ssrn.1486071> accessed on 4 May 2012. (Over the past three decades, intensive efforts have been made by the United States to strengthen the proprietary nature of knowledge, with the support of other developed countries. Although the protection over the private nature of knowledge has been strongly confirmed by TRIPS which largely follows the mainstream IP system in Western countries, the attribute of knowledge will not be altered and nor will the path of its transfer.)

[14] Drahos, 'Bargaining over the Climate: Lessons from Intellectual Property Negotiations' (n 3) 2. (The author argues that IPRs are not the traditional property rights but 'duty-bearing' privileges which cause much doubt and the heated debate on whether or at what extent IPRs should be applied against the public good character of knowledge.)

[15] Article 8 of TRIPS, including two paragraphs, provides in Paragraph 1 that '[M]embers may, in formulating or amending their laws and regulations, adopt measures necessary to protect public health and nutrition, and to promote the public interest in sectors of vital importance to their socio-economic and technological development, provided that such measures are consistent with the provisions of this Agreement'. http://www.wto.org/english/docs_e/legal_e/27-trips_01_e.htm.

to prevent the misuse of IPRs.[16] The reasonable explanation for the jurisdiction or sovereignty of Members is that, these measures are legitimate and acceptable, as long as Members do not give up IP protection in formulating or amending laws or regulations out of the mere pursuit of the goals of these measures.[17]

There is an argument that the consideration of objectives of public policies is not enough to justify the measures which are inconsistent with the provisions in TRIPS, and conversely the measures which are consistent or not contradictory with TRIPS could only assume that there is no conflict between these measures and the legitimate protection of IPRs or, if any, that the conflict is reasonable when legitimate interests of a third party are taken into consideration.[18] Accordingly, from the standpoint of Article 8, the assessment of any measure taken to limit trade-related IP protection for the realization of public policies relies on whether the discord between these measures and the protection of IPRs is confined in a reasonable range, which means that the discord could be settled within the framework of TRIPS.[19]

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[16] Article 8.2 of TRIPS regulates that Member States may take measures to prohibit the abuse of intellectual property rights or the practice of restricting trade or exerting serious effects on international technology transfer on unreasonable grounds. http://www.wto.org/english/docs_e/legal_e/27-trips_01_e.htm.

[17] Xiangjun Kong, *The TRIPS Agreement of WTO and Its domestic Applications* (Legal Press 2002) 471. (The author holds the view that the way to the extreme should be given up by Members in the balance between protection, transfer and dissemination of technologies, preventing the abuse of IPRs and maintaining the reasonable international trade.)

[18] WTO, The Report of the Panel on Canada-Patent Production of Pharmaceutical Products (2000) WT/DS114/R para 4.33. (In this case, the focus of the debate is whether the measures taken by Canada are in the range of 'limited exception' in Article 30. In order to find an appropriate interpretation, the legitimate interests of the third parties in this case should be considered seriously by reference to the societal values embraced in Article 7. EU contended that TRIPS was in a neutral state towards social values by denying the far-reaching significance of Article 7, 8 and 30. The third parties of this case except Switzerland agreed that Article 30 could be interpreted as enabling Members to strike a balance between important public policies and the rights of patent holders and additionally the practice in Canada was conducive to protecting legitimate interests of the third parties without damaging commercial interests of patent holders in the protection period. Both Canada and the third parties except Switzerland believed that the so-called 'economic expectation' of patent holders declaimed by EU was merely a business concept without relevance to IPRs. Consequently, the extension of patent protection demanded by EU is not the right granted by TRIPS, nor should Canada be obliged to cater for this demand.)

[19] Matthews (n 10) 16. (The view is hold by the author that although no definition of public interests could be found in TRIPS, it is implied in Article 8 that measures taken by Members should be assumed consistent with TRIPS unless another member could prove that these measures are incompatible with TRIPS because it is beyond the boundary of discretion under the framework of TRIPS.)

Article 27.1 provides that Members shall ensure that inventions in all fields of technology, no matter products or processes, are patentable, which is the application of the principle of non-discrimination in patent grants.[20] For the question whether an EST-related patent system or a special patent system tailored for ESTs violates the principle of non-discrimination, the WTO Dispute Settlement Panel has explained that the aim of this article is to prevent unfair treatment in technological fields to ensure fairness in the coverage of patent grants, but it does not preclude special preference to certain technology in legislations or policies.[21]

Article 27.2 provides the conditions for the refusal to grant a patent and the exceptions to commercial exploitation of patentable inventions within the territory of Members. In addition to being prohibited by law, commercial exploitation of restrained inventions is also considered immoral due to its side effect on public order or 'serious prejudice to the environment'.[22] However, a clearly-defined criterion of 'serious prejudice to the environment' on the extent to which the prejudice could be regarded as serious and further how to determinate whether the prejudice is real or just possible could not be found in this article.[23] On the other hand, the word 'avoid' means bringing environmental damage under control at source. However, given the cumulative feature of environmental damage, it seems that the word 'avoid' may

[20] Ken Shadlen, 'Policy Space for Development in the WTO and Beyond: The Case of Intellectual Property Rights' (2005) Tufts University Global Development and Environment Institute Working Paper No. 05-06, 12 <http://ase.tufts.edu/gdae> accessed on 31 May 2012. (It is noted that Article 27.1 reduces the discretion of Members in terms of patentable subject matter, because this Article requires that patentable technologies in all fields are granted the protection period of twenty years. This is new interpretation of the principle of non-discrimination, meaning that the principle is no longer limited in patent practice across border but extended to apply to various economic sectors.)

[21] Keith Maskus, 'Differentiated Intellectual Property Regimes for Environmental and Climate Technologies' (2010) Environment Working Paper of Organization for Economic Cooperation and Development No.17 <http://dx.doi.org/10.1787/5kmfwjvc83vk-en> accessed on 12 June 2013.

[22] It is regulated in Article 27.2 that 'Members may exclude from patentability inventions, the prevention within their territory of the commercial exploitation of which is necessary to protect ordre public or morality, including to protect human, animal or plant life or health or to avoid serious prejudice to the environment, provided that such exclusion is not made merely because the exploitation is prohibited by their law.' http://www.wto.org/english/docs_e/legal_e/27-trips_01_e.htm.

[23] Estelle Derclaye, 'Intellectual Property Rights and Global Warming' (2008) 12 Marquette Intellectual Property Law Review 263, 275 <http://ssrn.com/abstract=1016864> accessed on 24 October 2013. (It is argued that EPO may have to be cautious, when applying Article 27.2 of TRIPS as to non-patentability in case of 'serious damage to environment' which seemingly includes potential as well as actual damage.)

narrow the criteria, intentionally or not, excluding the circumstances under which patents are refused or restricted in order to reduce or repair the undergoing environmental damage.[24]

Article 30 and 31, respectively titled 'Exceptions to Rights Conferred' and 'Other Use without Authorization of the Right Holder', legalize some exceptions in such a manner that the conditions for the use of these exceptions are listed in detail.[25] The reason why these two articles are considered closely related to the transfer of ESTs is that they provide fundamental legal background for solutions to the conflict between TRIPS and public health, which is of reference value for the coordination of IPRs and climate change. In order to alleviate the conflict between TRIPS and public health, WTO Members agreed to amend TRIPS with conditional exemptions of some obligations under Article 31, thus providing a permanent decision to the issue concerning patents and public health.[26]

Admittedly, the practical result brought about by the resolution is not as encouraging as expected, because the rights of developing countries to protect public health are strictly limited within the scope of TRIPS.[27] In consideration of the truth

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[24] Estelle Derclaye, 'Should Patent Law Help Cool the Planet? An Inquiry from the Point of View of Environmental Law: Part 1' (2009) 31 (4) European Intellectual Property Review 168, 172. (Though stipulated in TRIPS, it has the same effect as the principle of ratification of environmental damage at source which is regarded as one of principles followed by environmental laws, favoring 'the control of pollution at the point of emission rather than further down the chains'.)

[25] Article 30 and 31 of TRIPS provide that limited exceptions to rights conferred and other use without authorization of the right holders are permitted as long as respects are showed to the requirements under TRIPS.http://www.wto.org/english/docs_e/legal_e/27-trips_01_e.htm.

[26] WTO General Council, Amendment of the TRIPS Agreement Decision of 6 December 2005, WT/L/641 8 December 2005. http://www.wto.org/english/tratop_e/trips_e/wtl641_e.htm. It states that

> '*Noting* the Declaration on the TRIPS Agreement and Public Health (WT/MIN (01)/DEC/2) and, in particular, the instruction of the Ministerial Conference to the Council for TRIPS contained in paragraph 6 of the Declaration to find an expeditious solution to the problem of the difficulties that WTO Members with insufficient or no manufacturing capacities in the pharmaceutical sector could face in making effective use of compulsory licensing under the TRIPS Agreement;'.

[27] Mike Gumbel, 'Is Article 31 Bis Enough? The Need to Promote Economies of Scale in the International Compulsory Licensing System' (2008) 22 No.1TEMPLE INT'L & COMP. L.J.161, 163. (Article 31bis aims at assisting developing countries to obtain needed medicines, but it seems that the Article did not yield satisfactory results due to the shortcomings of the new regulation. It argues that the new regulation makes the scale production in developing countries naught with 'its relationship requirements between countries'.)

that energy crises, food crises and extreme catastrophes triggered by climate change are worse than a simple public health crisis, the historical value of the Doha Declaration would be reduced, if the interpretation of Article 30 and 31 were confined to public health. In the next chapter, compulsory licensing, which is the fundamental implication of Article 31, will be discussed in the comparison of patent rights related to public health and climate change.

Article 66.2 has a special meaning for the transfer of ESTs in the context of climate change, as it clearly provides a legally-binding obligation on developed countries to take the initiative to create a positive stimulus for advancing technology transfer.[28] It is obvious that developing countries are excluded from the list of those whom this provision was designed to assist, and unfortunately quite a lot of developing countries are important GHG emission emitters who are undergoing economic restructure during their prime period of development. This suggests that the implementation of Article 66.2 probably has a rather limited effect on climate change mitigation. Moreover, due to the lack of an effective mechanism to monitor the implementation of Article 66.2, governments of developed countries have discretion when deciding how to provide incentives and which country will be the recipient of technologies.[29] More importantly, the obligation of technology transfer is not laid on governments who formulate regulations and policies, but on 'enterprises and institutions'.[30] Thus in this sense, the functional result of the implementation of

[28] Article 66.2 of TRIPS states that developed countries are obliged to formulate or create stimulus to promote technology transfer from their domestic enterprises and institutions to the least developed countries. http://www.wto.org/english/docs_e/legal_e/27-trips_01_e.htm.

[29] The WHO Report, 'Local Production for Access to Medical Products : Developing a Framework to Improve Public Health' (2011) The Report comes from the Joint Project largely conducted by the World Health Organization, the United Nations Conference on Trade and Development, the International Center for Trade and Sustainable Development on 'Improving Access to medicines in developing countries through technology transfer and local production' <http://www.who.int/phi/publications/local_production_policy_framework/en/> accessed on 21 November 2013. (It was found by some analysts that the incentives provided by the normal business practice model did not engender extra positive results of technology transfer to LDCs, reflecting that there is plenty of space room for developed countries when formulating laws and policies concerning incentives.)

[30] Suerie Moon, 'Meaningful Technology Transfer to the LDCs: A Proposal for a Monitoring Mechanism for TRIPS Article 66.2' (2011) ICTSD Program on Innovation, Technology and Intellectual Property Policy Brief No.9 April 2011, 2 <http://ictsd.org/i/publications/106434/> accessed on 21

Article 66.2 are greatly compromised.

3.1.1.2 The Drawbacks of these Articles of TRIPS as a Whole in the Light of Climate Change

This part discusses whether the above mentioned articles of TRIPS as a whole are effective to reconcile the protection and accessibility of ESTs. It is generally agreed that the birth of TRIPS resulted from some kind of subjective compromise as well as the objective trend of trade globalization, thus reflecting different legislative requirements on IP protection of developed and developing countries at their different stages of development.[31] The protection of IPRs centralized under the jurisdiction of WIPO was incorporated into the world trading system, because the IP system under WIPO could not meet the demands of developed countries. As a result, IP issues were further confined in the trade-related aspect under TRIPS, which means that technology protection and transfer should be dealt with completely under the effect of trade rules.[32] Against this background, it is easy to ignore the characteristic of ESTs as public goods to increase social welfare as IPRs are largely treated as commodities under TRIPS.[33] As such, it could be easily perceived that any amendment of TRIPS

November 2013. (It is believed that entities that actually carry out initiatives of technology transfer are 'enterprises and institutions', which involve not only private sectors but also non-profit sectors and public organizations.)

[31] K.Ravi Srinivas, 'Climate Change,Technology Transfer and Intellectual Property Rights' (2009) Research and Information System for Developing Countries Discussion Paper RIS-DP#153,2009; Graeme B. Dinwoodie, Rochelle C. Dreyfuss, 'Designing a Global Intellectual Property System Responsive to Change: The WTO, WIPO and Beyond' (2009) University of Oxford Legal Research Paper Series Paper No.50/2009, 1. (The TRIPS Agreement is regarded as a result of compromise by which developing countries strengthen legislation and enforcement of IPRs in exchange for access to the markets of developed countries.)

[32] Jörg Reinbothe and Silke von Lewinski, *The WIPO Treaties 1966* (Butterworths 2002) 2. (The result of multilateral negotiations came to a compromise. 'Following a compromise, according to which negotiations would be limited to trade-related aspects of IP, the outcome of 'Dunkel-Text' of December 1991 was slightly amended and then known as TRIPS in 1994, which is a part of the Agreement Establishing the WTO.')

[33] Graeme B. Dinwoodie and Rochelle C. Dreyfuss, 'Designing a Global Intellectual Property System Responsive to Change: The WTO, WIPO and Beyond' (2009) University of Oxford Legal Research Paper Series Paper No.50/2009, 6. (Although it is reasonably understood that IPRs are treated as a kind of commodity under TRIPS, the cultural value of the outcomes of knowledge, viewed as an intangible

for harmonization of patent protection and access to ESTs may fall into the same failure as mentioned in Chapter 2 when the proprietary characteristic of EST-related IPRs is discussed.

The use of flexible provisions in TRIPS is one example of the dynamic development of TRIPS.[34] However, since TRIPS after all is in some senses a compromise between developed and developing countries, repeated bargains, from the minimum standard of IP protection to the mandatory dispute settlement procedures, has led to the result that, within the framework of the existing TRIPS, there is 'a gray zone' in which Members are permitted to interpret the definition of 'public order', 'public health' or 'immoral behavior' from different angles, to meet their own needs in the conversion of TRIPS to domestic application.[35] However, the zone boundary is quite clear, that is, the obligations under TRIPS.[36] Members are entitled to shape the structure of their rights and put it into practice only if the obligations under TRIPS are fulfilled. Therefore, in this context, how to maintain a basic balance between rights and obligations becomes a strategic issue that each Member should take into account, while complying with general rules in the game of international trades.[37]

At the superficial level, TRIPS is a result of concession through which

building closely associated with future development of education and technologies, was underestimated and neglected in the process of drafting TRIPS. In this sense, the object that TRIPS was designed to protect is the goods necessary to improve social welfare.)

[34] Peter K. Yu, 'Are Developing Countries Playing a Better TRIPS Game?' (2011) 16 UCLA J. Int'l L. Foreign Affairs 311. (A complex game is taken as an example by the author to illustrate the dynamic nature of TRIPS with all WTO Members as players.)

[35] Ibid 315-317. (In the process of drafting TRIPS, partly due to the proposal submitted by LDCs, the final text of TRIPS made some modifications in Article1.1, 7, 8, 40, 41.5, 65, 66, 67, but vague and abstract terms are used as a kind of concession in the added flexible provisions and limitation, as well as exceptions of some other articles of TRIPS.)

[36] Mark Van Hoorebeek, William Onzivu, 'The Eco-Patent Commons and Environmental Technology Transfer: Implications for Efforts to Tackle Climate Change' (2010) 1 Carbon & Climate Law Review 13. (The obligations of the developing country Parties under TRIPS are a minimum protection standard, while there is no specific measurable standard for the obligations of the developed country Parties. Rights holders absolutely enjoy this minimum standard. Then as it were, there is a serious imbalance between rights and obligations of TRIPS.)

[37] Laurence R. Helfer, 'Human Rights and Intellectual Property: Conflict or Coexistence?' (2003) 5 Minnesota Intellectual Property Review 47. (Unlike the previous intellectual property agreements, a set of mandatory obligations is stipulated in TRIPS. If they fail to comply these obligations, also referred to as the rules of the game, the Members will be punished by WTODSM in the form of trade sanction.)

developing countries commit themselves to a strong IP protection domestically in exchange for access to the markets of developed countries. However, in the long term, developing countries are placed in a very disadvantageous position, because various regional and bilateral preferential trade agreements hinder them from using IP to achieve their social development goals.[38] Some scholars have further pointed out that TRIPS and post-TRIPS trade agreements are quite possibly intended to realize more benefits for developed countries at the expense of the poor or weak participants, and even in negotiations on the theme of development this tendency is given rise to.[39] It seems that in the trading system, parties to a transaction between developed and developing countries are subjects with equal status, but in the long run it is not in the interest of developing countries to improve their capacity and catch up.

In terms of their origin, most of current domestic patent laws were designed for inventions that emerged in the Industrial Revolution, and so have been unable to meet the development challenges in the modern era and in new industries.[40] TRIPS is not the final solution to coordination of global IP protection and relevant issues, because it is short of a stable legislative basis for the adjustment of IP norms to suit ever-changing needs.[41] Although it is possible to conduct coordination by request, TRIPS appears somewhat lopsided in concerns which should be taken into account

[38] Shadlen (n 20) 14-15.

[39] Jerome H. Reichman and Rochelle Cooper Dryfuss, 'Harmonization without Consensus: Critical Reflections on Drafting a Substantive Patent Law Treaty' (2007) New York University School of Law. Law & Economics Research Paper Series Paper No. 07-43; Duke University School of Law Legal Studies Research Paper Series Paper No.178; Duke Science, Technology and Innovation Research Paper Series Paper No.22.

[40] Matthew Rimmer, 'A Proposal for a Clean Technology Directive: European Patent Law and Climate Change' (2011) 3 Renewable Energy Law & Policy Review 195. (From the historical perspective, the UK Patent Law under the *Statute Monopolies* 1623 provides exclusive monopoly rights for the inventions based on independent labor or new manufacturing methods, in exchange for the dissemination of invention information. This legal system could never be separated with the Industrial Revolution, providing incentives for inventions from plants. However, Derclaye argues that the role of patent laws in facilitating those technologies that cause pollution was gradually criticized. Is IP the cause or the culprit of global warming?)

[41] Reichman and Dryfuss (n 39) 127. (It argues in this article that it is crucial to deal with the deficiencies in TRIPS, and to some extent, the dispute settlement mechanism would help TRIPS respond to actual needs. The Doha Declaration would be a typical example to rectify some problems of TRIPS. However, TRIPS is after all not the destination of the deep harmonized global patent law because of lack of 'a solid legislative basis'.)

about rights of producers and users of knowledge. As seen from the wording in TRIPS, the articles associated with accessibility of ESTs are basically principled clauses without enforceable standards, while in contrast, the articles for the protection of technology holders are rather specific.[42] In fact, the purpose of the former has been undermined, as governments have been unable to compel private companies to take active measures to promote the transfer of ESTs.[43] The balance of interests was from the outset heavily in favor of IP right holders, whose duties have been diluted.[44]

A deeper institutional barrier should never be ignored. The jurisdiction of the WTO is established within a broad framework in which various social goals were advanced based on compromise, and thus the WTO is closely monitored as to its enforcement so that its full potential can be realized in promoting its objectives and exerting great impact on trading practices among the Member States.[45] Nevertheless, a compromise among various social objectives within the field of trade would not have a rapid and positive response to climate change, because the public goal of mitigation and adaptation of climate change has not been placed in the position of equal or nearly equal importance to that of the protection of private rights in the

[42] Ebinger and Avasarala (n 1) 8. (It is concluded that Article 7 and 66.2 of TRIPS are widely defined on technology transfer, while Article 27.2 is the only provision in which the term 'environment' could be found in TRIPS.)

[43] Daniel K.N. Johnson and Kristina M. Lybecker, 'Challenges to Technology Transfer: A Literature Review of the Constraints on Environmental Technology Dissemination' (2009) 07 Colorado College Working Paper in the Project Supported by the National Peace Foundation and the United States Chamber of Commerce 1, 12. (It is noted that in addition to lack of technical expertise in developing countries, another particularly crucial point is undeniable that neither the patent law nor compulsory licensing in general obliges right holders to transfer their patented technologies or know-how.)

[44] Gumbel (n 27) 164. (When discussing the historical responsibility of industrialized world, it is believed that they bear 'a humanitarian duty' to provide assistance in food, medical care and other aspects of vital importance to developing countries.)

[45] Ruth L.Okediji, 'WIPO-WTO Relations and the Future of Global IP Norms' (2009) Netherlands Yearbook of International Law, Vol. 39, 2008; Minnesota Legal Studies Research Paper No. 09-07, 1-2 <http://ssrn.com/abstract=1338902> accessed on 23 July 2013. (It is argued by the author that the examination of dominant position of the WTO is usually conducted in the trade-related discussions in which either the jurisdiction of the WTO is described or the political and legal power of the WTO is utilized to promote the norms without institutional support or international structures for States to comply with. 'Because the jurisdictional contour of the WTO is embedded in a broader global framework in which competing social goals must be reconciled, the enforcement power of the WTO in particular has attracted intense scrutiny for its potential to promote objectives and influence state behavior in matters that are ostensibly far removed from the world of transactions in goods and services with which trade rules are to be (at least in theory) preoccupied.')

framework of TRIPS. This implies that it is impossible to find a middle way to balance the protection of patent rights and access to patented technologies under the WTO.

3.1.2 The Relevant International Documents under WIPO and their Implications for Access to ESTs

The international IP system is the most correlated field with the development of technologies, as the history of WIPO can date back to the nineteenth century when a contradiction emerged between a tremendous technological explosion during the Industrial Revolution and the absence of an international framework to protect inventions.[46] International IP protection began to take shape as a coherent system in such a context and experienced a continuously updated process with the development of technologies. A series of treaties and agreements administrated by WIPO were subsequently signed, and the existing versions of many documents were formed based on several revisions.[47] WIPO is the organization which has responded the readiest to change in the IP field by various legislative and administrative measures.[48] Optimistically speaking, this is not a one-way process, but the formulation and management of IP rules in turn promotes technological innovation. The treaties administrated by WIPO cover various subdivisions of IPRs, including copy rights, patents, trademarks and other industrial properties. However, in this part, the

[46] Paul Salmon, 'Cooperation between the World Intellectual Property Organization and the World Trade Organization' (2003) 17 St. John's Journal Legal Comment 429, 430. (The history of the WIPO could be traced back to the Paris Convention in 1883, earlier than that of the United Nations. The explosive technological power and the globalization of literary and artistic works called for an international mechanism, the birth of which was marked by the Paris Convention and Berne Convention.)

[47] The WIPO-Administrated Treaties<http://www.wipo.int/treaties/en/>accessed on 25 November 2013. (WIPO administers 26 Treaties including the Convention establishing the World Intellectual Property Organization. For example, the Madrid Agreement Concerning the International Registration of Marks was signed in 1891 and has been revised seven times since its birth.)

[48] Dinwoodie and Dreyfuss (n 33) 5. (The restructure of its norm development processes enable WIPO to respond quickly to new circumstances through the adoption of soft law instrument, and consequently WIPO is 'not suffering as badly from the lawmaking problems confounding the WTO'.)

discussion focuses on patents which are most relevant to the international protection of ESTs.

3.1.2.1 The Relevant Patent Documents under WIPO

The most relevant document to ESTs under WIPO is the Paris Convention for the Protection of Industrial Property, which is by far one of the most important basic treaty involving technologies.[49] The Paris Convention consists of thirty articles which lay down basic principles and provide facilities for the protection of industrial property among signatory States. In order to avoid the differentiated treatment adopted by countries in national IP protection practices, the Paris Convention specifically provides a 'national treatment' principle in Article 2 whose purpose is to ban discrimination against foreigners legislatively.[50] The right of priority and independence in Article 4 expands the scope of patent protection, while maintaining the discretion of each country to the fullest possible extent.[51] This ensures viability of the international and domestic patent protection in a complete sense.

The principle of compulsory license set out in Article 5 of the Paris Convention provides that, Member States are entitled to take legislative measures to grant compulsory licenses subject to some restrictions so as to prevent the abuse of exclusive rights conferred by patents.[52] The Paris Convention which serves as a classic model for subsequent treaties concerning industrial properties was arguably

[49] Gerald J. Mossinghoff, 'Patent Harmonization through the United Nations: International Progress or Deadlock?' (2004) 86 Journal of the Patent & Trademark Office Society 5. (The Paris Convention, called the ancestor of all subsequent patent treaties, ushered in a new era with a key framework for the following patent treaties.)

[50] Article 2 of The Paris Convention for the Protection of Industrial Property (1883) (Article 2 with the title 'National Treatment for Nationals of Countries of the Union' presents details about the national treatment principle) < http://www.wipo.int/treaties/en/text.jsp?file_id=288514> accessed on 12 October 2013.

[51] Kevin Mcgarry, 'U.S. Patent Reform and International Public Health: Issues of Law and Policy' (2008) 3 Intercultural Human Rights Law Review 299, 319. (The principle of priority provided by the Paris Convention represents the first time to establish a standard to confirm the patent ownership across borders for the first patent application.)

[52] Article 5 A (2) of Paris Convention (1883) < http://www.wipo.int/treaties/en/text.jsp?file_id=288514> accessed on 12 October 2013.

designed to encourage creation and protect the rights of invention owners in addition to stimulating competition and protecting consumers' rights.[53]

The Patent Cooperation Treaty (PCT) was created because the Paris Convention had not fully unified rules on the protection of industrial property among parties. The PCT plays a substantial role in further facilitating patent protection in the international arena, and makes it possible to obtain protection in many countries for one invention of a country.[54] It is worth mentioning that the PCT contributes to the unique position of WIPO in the UN, by providing an adequate amount of financial support for its daily operation.[55]

A new interpretation of the significance and role of the PCT will be provided here in the context of climate change. On the one hand, the PCT promotes EST applications, lending credence to intensified efforts to address climate change; while on the other hand, developing countries have to pay royalty fees for EST patents first granted in developed countries. According to statistics of the OECD, the patent applications of ESTs under the PCT are steadily increasing, and this trend is likely to have been affected by growing concerns about the issue of climate change and increased R&D funds.[56] Simultaneously, this trend is reinforced by national introduction of more environmentally-friendly legislation and incentives, given that a monopoly of patented ESTs represents a strong voice and initiatives in the global economic transformation.[57]

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[53] Kevin Mcgarry, 'U.S. Patent Reform and International Public Health: Issues of Law and Policy' (2008) 3 Intercultural Human Rights Law Review 299, 319. (The ground rules for international patents, for example the first-to-file standard and priority filing for patent protection in different national jurisdictions, were set up by the Paris Convention that is viewed as 'a foundational pillar of the international intellectual property system'.)

[54] The Patent Cooperation Treaty done at Washington on June 19, 1970, amended on September 28, 1979 and modified on February 3, 1984 and October 3, 2001. <http://www.wipo.int/pct/en/texts/articles/atoc.htm>accessed on 10 November 2013.

[55] Salmon (n 46) 430.

[56] OECD Patents by Main Technology and by International Patent Classification (2011) <http://www.oecd-ilibrary.org/science-and-technology/data/oecd-patent-statistics/patents-by-main-technology-and-by-international-patent-classification-ipc_data-00508-en?isPartOf=/content/datacollection/patent-data-en> accessed on 13 November 2013.

[57] Ahmed Abdel Latif, Keith Maskus, Ruth Okediji, Jerome Reichman, Pedro Roffe, 'Overcoming the Impasse on Intellectual Property and Climate Change at the UNFCCC: A Way Forward' (2011) 11 ICTSD Programme on Innovation, Technology and Intellectual Property November 2011 Policy Brief 1,

The PCT purports to free patents from territorial limits, and thus increases traditional patent protection. However, as a treaty that defends the growing patent protection around the world is likely to further increase the difficulty of developing countries getting reasonable and timely access to effective but expensive ESTs, PCT's aim of facilitating dissemination of technical information and access to technologies for developing countries needs to attest in consideration of international obligations to climate change.[58]

3.1.2.2 The Drawbacks of the Documents under WIPO

The rapid development of science and technology has always been the technical factor that promotes the development of international IP system, as many IP treaties and their revisions bear the stamp of technologies. This requires sufficient internal flexibility and inclusiveness of the international IP system in response to changing technology sectors. The foreword of the Convention Establishing the World Intellectual Property Organization states that the establishment of WIPO is 'in order to encourage creative activity, to promote the protection of intellectual property throughout the world', so the flexibility and inclusiveness within the structure internal to WIPO with the primary task to encourage creativeness can be considered to be innate.[59]

However, the existing IP system under WIPO, especially the patent system, is

4. <http: //ictsd.org/i/publications/120254.> accessed on 12 May 2013. (According to the report jointly made by UNEP, EPO and ICTSD, titled as Patents and Clean Energy, Bridging the Gap Between Evidence and Policy, the rate of patent application has greatly increased in clean energy sector by 20% annually since 1997, which is the result that cannot be separated from the efforts of governments in investment and legislation.)

[58] Nandini Kotthapally, 'From World Intellectual Property Organization (WIPO) to World Innovation Promotion Organization (WIPO)? Whither WIPO?' (2011) 2011 WIPO Journal 1, 4. ('An unprecedented decision to integrate the Development Agenda recommendations in the technical discussions on improvements to the PCT system' was agreed by the PCT working group who began to review to what extent the PCT had succeeded in 'in its aim of disseminating technical information and facilitating access to technology for developing countries'.)

[59] The Convention Establishing the World Intellectual Property Organization (1967) (The Convention was signed at Stockholm on July 14, 1967 and as amended on September 28, 1979.) <http://www.wipo.int/treaties/en/convention/> accessed on 27 November 2013.

tailored for inventions of the Industrial Revolution, and can no longer adapt to new developments and challenges of the new era.[60] Especially today, with many emerging concerns such as environmental protection, public health, biodiversity, food security, making full use of public policies integrated in IP systems to promote technological and social development has become a legitimate motive desperately pursued by developing and less developed countries.[61] Drahos notes that, unfortunately, although WIPO surely provides a more friendly IP forum than the WTO, developing and less developed countries, as the majority of the membership of WIPO, failed to fully and effectively use this advantage to express their demands on the WIPO forum, indicating that the combat effectiveness they showed fell far short of what they did in the WTO's TRIPS Council negotiations.[62]

WIPO had been taking IP protection as its primary or even its only task for a long time, which is reflected by the fact that the word 'protection' appeared in the titles of several conventions of vital importance, for example, the Paris Convention for the Protection of Industrial Property, the Berne Convention for the Protection of Literary and Artistic Works and Rome Convention for the Protection of Performers, Producers of Phonograms and Broadcasting Organizations. In the context of globally widespread concern about emerging markets, however, it is inevitable that the credibility of conventions under WIPO has been challenged[63], given the clear influence of

[60] Reichman and Dryfuss (n 39) 92. (In practice, many domestic patent systems primarily reflect the demand of technologies and the concept of innovative sectors which emerged in the Industrial Revolution, but in the post-industrial revolution age, knowledge-intensive inventions come from research institutions and creative entities, from which new participants join in patent protection games.)

[61] Okediji (n 45) 4. (In order to effectively address these challenges, an institutional framework ought to be integral part of a multilateral solution and plus an institutional forum could gradually promote the generation of successful and mutually benefits by providing reasonable political motives.)

[62] Peter Drahos, 'Developing Countries and International Property Standard Setting' (2002) 5(5) The Journal of World Intellectual Property 765. (It is observed that as ideas of developing countries on the WIPO forum are often elaborated by the official representatives from their national IP offices, who without the global strategic vision of the role of IP in the social and economic development are deeply influenced by concepts infused by developed countries.)

[63] Padmashree Gehl Sampath and Pedro Roffe, 'Unpacking the International Technology Transfer Debate: Fifty Years and Beyond' (2012) Working Paper 1, 42 <http://ictsd.org/downloads/2012/07/unpacking-the-international-technology-transfer-debate-fifty-years-and-beyond.pdf> accessed on 3 May 2013. (It is argued by promoters of WIPO Development Agenda that costs of any operation of IP protection should not be greater than benefits they bring about. In

Eurocentric philosophy in the process of drafting conventions[64]. In a sense, WIPO has adhered to a strong IP protection as its own institutional culture since its foundation, which is what triggered the controversy and doubt about the traditional IP doctrine under WIPO's jurisdiction.[65]

Currently, WIPO is facing internal and external 'troubles'. Internally, as a UN agency, WIPO finds itself in an embarrassing situation. On the one hand, WIPO hopes to expedite the adjustment of its development strategy with a focus on the actual needs of LDCs.[66] On the other hand, WIPO is driven by its well-known institutional culture to actively oversee and participate in discussions or actions taken by other UN development-friendly organizations.[67] Externally, the 'orthodox' position of WIPO in the IP rules-making has been shaken by the challenge of TRIPS, and it is even suggested by some scholar that the WTO should be the future IP substantive rule-making centre, particularly in the areas concerning the supply of global public

other words, there is no doubt that the credibility of the IP system under WIPO would be weakened if WIPO neglects the public policy concerns when promoting IP protection.); Henning Grosse Ruse-Khan, 'Sustainable Development in International Intellectual Property Law – New Approaches from EU Economic Partnership Agreements?' (2010) 29 ICTSD Programme on IPRs and Sustainable Development 1, 16. (If WIPO wishes to maintain the credibility of the international IP system, it cannot be silent on the issues of global concerns. The transfer of green technology should be viewed and conducted from the perspective of ensuring IP as a support behind public policy objectives.)

[64] Okediji (n 45) 7. (The author holds the view that under the administration of the United International Bureau for the Protection of Intellectual Property, the predecessor of WIPO, the harmonization between IP and sustainable development is greatly affected by Eurocentric ideology, which represents the interests of main European developed countries.)

[65] Jeremy de Beer and Chidi Oguamanam, 'Intellectual Property Training and Education: A Development Perspective' (2010) Issue Paper No. 31 ICTSD's Programme on IPRs and Sustainable Development. (The authors believe that any proposal that contributes to capacity building should not be separated from the IP norm making under WIPO, because the formulation of IP rules, the implementation of IP policies, and the enforcement of IP laws goes on everywhere in real life. The basic understanding of the relationship between IP and public policies and relevant development issues is as important as that of IP norms and legal philosophy for creating a well-balanced IP system.)

[66] Kotthapally (n 58) 5. (The Development Agenda has big implication on the core area of WIPO where the fundamental paradigm shift has been witnessed from 'the substitution of the conventional term 'enforcement of IP' with the development-friendly concept of 'building respect for IP''. Specifically, 'the conventional approach based on the limited perspective of criminal-judicial enforcement has been replaced by a more balanced and holistic approach aimed at fostering respect for IP that takes into account the socio-economic and developmental dimensions of complex challenges such as counterfeiting and piracy.')

[67] Debora J. Halbert, 'The World Intellectual Property Organization: Past, Present and Future' (2006) 54 Journal, Copyright Society of the USA 253, 270. (Once founded and set upon its course, the primary objective of WIPO, 'to expand legal protection of intellectual property and educate people throughout the world regarding the value of this regime' fell into place.)

goods.[68]

Undeniably, there is a clear, inherent disadvantage of conventions and treaties administered by WIPO. Although in great numbers, they lack the weight of necessary enforcement measures and a dispute settlement mechanism as a strong support behind them.[69] This is also the objective, underlying cause of the power to formulate international IP rules gradually shifting from WIPO to the WTO. In addition, some developed countries have transferred over to the WTO those tasks that were difficult to deal with under WIPO.[70] Under the influence of various factors, turning to WTO for solutions has become a frequently-used method for timely managing conflicts among countries.[71] However, as a specialized organization in charge of IP and other closely related issues, the institutional structure of WIPO should create an environment of great inclusiveness for the real challenge of climate change, rather than be unable to deal with the issue, or worse be sidelined in the efforts to resolve it.

3.1.3 The Analysis of EST Transfer under the UNFCCC

The transfer and dissemination of ESTs has become a key element under the UNFCCC. These concern the international rules, principles and consensus reached by the Conferences of the Parties since the UNFCCC entered into force in 1994 and the

[68] Okediji (n 45) 3. (It is proposed by the author in this article that the WTO 'should be promoted as the future locus of substantive international IP regulation, particularly with respect to the creation of IP norms affecting the regulation and supply of global public goods such as health, education, scientific data and the environment.')

[69] Paul Salmon, 'Cooperation between the World Intellectual Property Organization and the World Trade Organization' (2003) 17 St. John's Journal Legal Comment 429. (Global protection of IP under WIPO is realized on the basis of national cooperation and largely by moral persuasion to force the Member States to fulfill their obligations, due to lack of a formal enforcement and a dispute settlement mechanism.)

[70] Thomas Cottier and Marina Foltea, 'Global Governance in Intellectual Property Protection: Does the Decision-making Forum Matter?' (2012) 3 (2) The WIPO Journal 139, 157. (Given WIPO's weakness in its enforcement of IPRs, the United States and European Community favored the regime-shifting from WIPO to WTO, which is called a game actors play in the IP chessboard.)

[71] Frederic M. Abbott, 'Distributed Governance at the WTO-WIPO: an Evolving Model for Open-Architecture Integrated Governance' (2000) 3 Journal of International Economic Law 63, 66-69. (TRIPS is now considered as the most important agreement in the field of IP protection and will continue to play a leading role in this area.)

Meetings of the Parties since the Kyoto Protocol took effect in 2005, as well as the relevant resolutions passed by the Subsidiary Body for Scientific and Technological Advice of UNFCCC (SBSTA)[72] and the reports from the Expert Group on Technology Transfer (EGTT)[73]. The following discuss will focus on the arrangements that have crucial significance.

3.1.3.1 The Arrangements concerning ESTs under the UNFCCC

The UNFCCC, which was adopted by the UN Intergovernmental Negotiating Committee on Climate Change on 4 June 1992 and entered into force in 1994, laid a legal foundation for cooperation between countries within an authoritative, universal and comprehensive international framework to address climate change.[74] The UNFCCC aims to reduce GHG emissions, decrease hazards engendered by anthropogenic activities, enhance ecosystem resilience to climate change and ensure food production and sustainable economic development.[75] To achieve this, the Convention established five basic principles, of which the most famous one is the principle of 'common but differentiated' responsibilities that requires developed

[72] The Subsidiary Body for Scientific and Technological Advice is one of the two permanent subsidiary bodies, the other one of which is the Subsidiary Body for Implementation. The SBSTA, established based on Article 9 of the Convention and Article 15 of the Kyoto Protocol, serves the COP to the Convention and the MOP to the Kyoto Protocol with the timely and professional information and advice.< http://unfccc.int/bodies/body/6399.php> accessed on 4 November 2013.

[73] In order to promote the implementation of Article 4, Paragraph 5 of the Convention, the Expert Group on Technology Transfer was established to 'analyze and identify ways to facilitate and advance technology transfer activities and making recommendations to the Subsidiary Body for Scientific and Technological Advice' in accordance with Decision 4/CP.7 issued by the Seventh session of the Conference of the Parties to the Convention.< http://unfccc.int/resource/docs/cop7/13a01.pdf#page=22> accessed on 6 November 2013.

[74] Margaret A. Young, 'Climate Change Law and Regime Interaction' (2011) 2 Carbon & Climate Law Review 147. (The UNFCCC is created as a central legal regime with almost universal ratification by 195 States so far and within the UNFCCC, a broad objective is set out to stabilize the level of greenhouse gas concentration.)

[75] A lofty but specific goal of the UNFCCC is set up to stabilize greenhouse gas concentrations 'at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system.' It states that 'such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner'. < http://unfccc.int/essential_background/convention/items/6036.php> accessed on 19 November 2013.

countries to take the first steps to address climate change.[76] The other four include the principles of concrete analysis of concrete conditions[77], combining prevention and management[78], sovereignty and cooperation[79].

Agenda 21 of the UN Sustainable Development is the first international document that highlights the term 'ESTs'. It defines ESTs as a fast-growing emerging technological industry which mainly focuses on natural resource protection, pollution reduction, and use of recycling wastes and products in a more sustainable and effective way than alternative technologies.[80] The obligation expressed unequivocally in the UNFCCC is that all Parties shall promote exchanges and cooperation of ESTs with a strong emphasis on the obligation of the developed country Parties to actively transfer ESTs to the developing country Parties. The transfer of ESTs is mentioned in seven of ten commitments in Article 4 of the UNFCCC, among which the most important one is that

> 'The developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing

[76] The principle of common but differentiated responsibilities which occurs three times in the UNFCCC comes first of the list of principles provided in the Convention, indicating its significance to addressing climate change. <http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf> accessed on 19 November 2013.

[77] This principle is mainly aimed at the developing country Parties by taking their special needs and specific circumstances into full account. <http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf> accessed on 19 November 2013.

[78] The principle of combining prevention and management requires that the Parties shall take necessary measures to anticipate, prevent and reduce factors causing climate change.

[79] Paragraph 5 of Article 3 of the UNFCCC <http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf> accessed on 19 November 2013. (The principle of cooperation helps remove barriers to international trades by strengthening international cooperation to address climate change.)

[80] The United Nations Conference on Environment & Development Rio de Janerio, Brazil, 3 to 14 June 1992, Article 34 of Agenda 21. < http://sustainabledevelopment.un.org/content/documents/Agenda21.pdf> accessed on 1 December 2013; Elizabeth Burleson, 'Energy Policy, Intellectual Property and Technology Transfer to Address Climate Change' (2009) Climate Change and Human Rights Symposium 18 University of Iowa Transnational Law and Contemporary Problems, 69.

country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties. Other Parties and organizations in a position to do so may also assist in facilitating the transfer of such technologies.'[81]

This Article on obligations of the developed country Parties is a consensus reasonably based on the contradiction between the bounden duty of all Parties to address the common concerns and the glaring discrepancy in their ability to perform their respective commitments, because, in reality, developing countries with relatively backward economic and technical strength face higher costs in the performance of their obligations under the UNFCCC.[82] If developed countries only consider circumstances under their own jurisdictions without caring about practical difficulties of the remaining Parties, solutions will be rendered ineffective. No matter whether or not the obligations of the developed country Parties are strictly legally-binding, there should not be an excuse to refuse to provide necessary assistance.

As a supplement to the UNFCCC, Article 10 and 11 of the Kyoto Protocol further clarify that the developed country Parties are obligated to transfer ESTs to the developing countries on concessional terms and provide appropriate financial support.[83] The measures and mechanisms set out in the Kyoto Protocol have some degree of operability and actuality, and so it is more influential than the UNFCCC in

[81] Paragraph 5 of Article 4 of the UNFCCC <http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf> accessed on19 November 2013.

[82] Bernice Lee, Ilian Iliev and Felix Preston, 'Who Owns Our Low Carbon Future?' (2009) A Chatham House Report on Intellectual Property and Energy Technologies <http://www.chathamhouse.org/sites/default/files/public/Research/Energy%20Environment%20and%20Development/r0909_lowcarbonfuture.pdf> accessed on 3 May 2013. (Given that they have to take responsibility for three-quarters of historical emissions, it is fair that developed countries take the leading role in global emission reduction actions. But nowadays, global emissions are not concentrated in some region, the developed countries, including those ones with technological leadership in ESTs, are not willing to undertake emission reduction tasks alone.)

[83] The Kyoto Protocol to the UNFCCC, Conference of the Parties, 3d Sess. U.N. Doc. FCCC/CP/1997/L.7/Add.1 (Dec. 11, 1997) <http://unfccc.int/essential_background/kyoto_protocol/items/6034.php.> accessed 20 November 2013.

terms of binding force.[84]

3.1.3.2 The Drawbacks of these Arrangements under the UNFCCC

The arrangements on EST transfer under the UNFCCC are largely understood as a sort of political stance or consensus, as a result of which there has been a slow and inadequate implementation of the relevant international obligations and a fundamentally unchanged situation in technology transfer.[85] In other words, the UNFCCC has set a basic framework for the international transfer of ESTs, but most of the terms and principles are not very flexible. Therefore, a specific legal mechanism, such as particular provisions of an IP system or another multilateral treaty, is necessary to promote and achieve a qualitative rather quantitative leap in the engagement of EST transfer.

Although there are clauses in the Kyoto Protocol that directly impose an obligation of EST transfer on developed countries, a considerable discretionary space is left for the Parties due to vague language. Moreover, the effect of the articles that stipulate the implementation of technology transfer is greatly reduced, due to a lack of performance and responsibility binding mechanisms in the Kyoto Protocol.[86]

There are some observable drawbacks in the three famous mechanisms in the Kyoto Protocol. As the technical levels and the supply of funds are highly variable from country to country, the disparity between the two sides of cooperation has led to the fact that the efficiency of the CDM largely depends on the will of developed

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[84] The Kyoto Protocol requires developed countries and some countries with economies in transition to reduce total greenhouse gas emissions by 5.2% in the 2008-2012 and to practice the requirement of technology transfer by means of encouraging and facilitating incremental use of ESTs. <http://unfccc.int/resource/docs/convkp/kpeng.pdf> accessed 20 November 2013.

[85] Ebinger and Avasarala (n 1) 20. (Although the consequences of climate change are well known, the fruitless debates and the excessive emphasis on ‘inclusivity’ under the UNFCCC result in no encouraging progress of international climate change negotiations.)

[86] Ibid 21. (It is believed by the authors that the Kyoto Protocol sets a frustrating precedent for the future of the climate change negotiations. The authors also agree Mckibbin and Wilcoxen's view that apparently the Kyoto Protocol seems strong but in fact fails to help reducing emission due to lack of an effective enforcement mechanism.)

countries and their private sectors.[87] Although the IET is in favor of avoiding greater global GHG emissions in the short term, in the long run, the relative reduction in the transaction mode may not help to lower emission reductions in absolute volume but instead greatly dampens initiatives and enthusiasms of certain countries to reduce emissions, thus indirectly impeding the use and transfer of new ESTs.[88] When it comes to the JI, its positive role in promoting EST transfer is limited in the cooperation model that is dominated by the energy sector and greatly influenced by geopolitics.

3.2 The Interaction of Existing Coordination Arrangements concerning Patents and Climate Protection

The arrangements under the UNFCCC and international IP system mentioned above seem independent in harmony, but unfortunately in recent years there are some discordant notes arising from in-depth discussions about climate change. Given this, can the two systems cooperate effectively with each other? The answer is surely yes. As a matter of fact, each of the two systems respectively plays an irreplaceable role in addressing climate change with broad-based cooperation.

3.2.1 The Conflicts between these Arrangements

There are some potential conflicts between the relevant provisions of TRIPS and

[87] Jason Obold, Mattew Burns and Caroline Baker, 'Notes & Comments Impressions from Durban: COP-17 and Current Climate Change Policies' (2012) 22 Colo. J. Int'l Envtl. L. & Pol'y. 389.

[88] H-Holger Rogner, Dadi Zhou, Rick Bradley, Philipp Crabbé, Ottmar Edenhofer, Bill Hare, Lambert Kuijper, Mitsutsune Yanaguchi (2007) Chapter 1 Introduction in B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds), *Climate Change 2007: Mitigation of Climate Change* (Cambridge University Press 2007), 108-109. (Emission reduction in term of absolute amount is challenging, which 'presupposes a reduction of energy and carbon intensities at a faster rate than income and population growth taken together'.)

the arrangements concerning EST transfer under the UNFCCC.[89] No formal mechanism on the interoperability of rules has been established between the UNFCCC and TRIPS. Although the multilateral negotiations under the UNFCCC have paid more and more attention in recent years to the relationship of EST transfer and IPRs, and the development goals of public health and environment are also given due consideration by TRIPS, the two systems have not reached a consensus on the issue of whether the flexible terms in TRIPS could be applied to mitigation and adaptation of climate change as required by the UNFCCC.[90] The discussion about the applicability of compulsory license to EST transfer has been driven to an impasse within the framework of TRIPS.[91] Many developing countries call for use of compulsory licensing in ESTs based on similarities between ESTs and pharmaceutical industry, but this is strongly opposed by developed countries which insist that there is too much difference between the two industries so compulsory licensing is not applicable.[92] The divergence in attitudes between the two sides surely stifles any possible cooperation.

The international IP system may hinder the implementation of the principle of common but differentiated responsibilities, in accordance with which developed countries are required to take more responsibilities of mitigation and adaptation of climate change and assist developing countries as much as possible in access to

[89] Cameron Hutchison, 'Does TRIPS Facilitate or Impede Climate Change Technology Transfer into Developing Countries?' (2006) 3 (2) UOLTJ 517, 527. (It is noted by Hutchison that there is no sufficient funding mechanism to support technology transfer in UNFCCC or specific commitments in Kyoto Protocol, so at the superficial level, the EST-related arrangements under UNFCCC do not conflict with TRIPS because they do not substantially touch the sensitive nerve of TRIPS.)

[90] Frederick M Abbott, 'Trends in Local Production of Medicines and Related Technology Transfer' (2011) <http://www.who.int/phi/publications/local_production_trends/en/> accessed on 7 January 2014 (In the literature review on technology transfer and climate change in this report of Abbott, according to Maskus, TRIPS is flexible enough for any access to new technologies, so he opposes reform of TRIPS, believing that particular changes in patent rules would not be more effective in innovation and diffusion of ESTs to combat climate change.)

[91] Cynthia Cannady, 'Access to Climate Change Technology by Developing Countries: A Practical Strategy' (2009) ICTSD's Programme on IPRs and Sustainable Development, Issue Paper No. 25, 4. ('Compulsory licensing is to IP law what eminent domain is to real property law: it is generally acknowledged as an essential legal doctrine, but no one wants to be the subject of its exercise'.)

[92] Robert Fair, 'Does Climate Change Justify Compulsory Licensing of Green Technology' (2009) 6 International Law & Management Review 21.

ESTs.[93] The TRIPS minimum standard serves as a reasonable and cogent excuse held by relevant Member States to refuse to perform or shrink from their due responsibilities.[94] On the issue of EST transfer, developed countries always claim that they cannot force private holders to transfer their ESTs that are lawfully protected by domestic IP laws. However, when it comes to the fulfillment of emission reduction obligations, developed countries do not allow developing countries to resort to their domestic IP regimes, which is a typical case of double standard.

As a system that is fundamentally in place to encourage innovation by legally recognized proprietary rights, it is difficult for TRIPS to make concessions to the common issue of global concern in the UNFCCC.[95] Consequently, the subject who must fulfill obligations required by the principle of common but differentiated responsibilities is not at liberty to decide most of EST transfer and licensing, but instead must protect and even has to strengthen the jus disponendi of right holders. Furthermore, the principles of national treatment and most-favored-nation treatment place technology recipients in a passive position from the beginning of negotiations.

From an operational level, there is another point worthy of being mentioned. The guideline on putting prevention first and combining prevention and control is established, and precautionary measures are suggested to be taken in advance within the framework of the UNFCCC. This ensures that current uncertainties on climate

[93] Kalpana Murari, 'Transfer of Technology in A Post-Kyoto Framework' (2010) Working Papers Series 2010, 1 <http://ssrn.com/abstract=1909468 or http://dx.doi.org/10.2139/ssrn.1909468> accessed on 20 April 2013. (There are two fundamental elements in the principle of common but differentiated responsibilities advocated by UNFCCC: 'the common responsibility of countries for the protection of the environment at the national, regional and global levels; and the need to take into account each country's contribution to a particular problem and its ability to and control the threat'.)

[94] Sampath and Roffe (n 63) 39. (For a considerable number of countries, TRIPS is just a flash in the pan, leaving more of a disappointment. The reason is that many countries have gradually felt squeezed in policy space in the use of parallel importation and compulsory licensing. What makes it worse is that developed countries are unwilling to fulfill their due commitments under TRIPS, which has always been considered as an outstanding issue in discussions about TRIPS.)

[95] Kalpana Murari, 'Transfer of Technology in A Post-Kyoto Framework' (2010) Working Papers Series 2010, 8 <http://ssrn.com/abstract=1909468 or http://dx.doi.org/10.2139/ssrn.1909468> accessed on 20 April 2013. (The gate is closed by TRIPS for access to ESTs through compulsory licensing 'on the pretext that climate change effects tantamount to national emergency', which is an argument that has been refuted by most of the nations.)

change shall not be used as an excuse to refuse national emission reduction.[96] As for the more specific and realistic international IP system, any exception or compulsory measure must be applied based on convinced scientific evidence, which here mainly refers to scientific data related to climate change, actual result of EST application, and risks and benefits thereof.[97] From this point of view, the key to successfully promote EST transfer lies in how to provide scientific demonstrations for the validity of any use of exceptions to IPRs. Nevertheless, even if scientific argument could be provided, breadth and depth of international EST transfer primarily depends on geopolitical and systemic factors.[98] Thus the international EST transfer under the IP system is so complex that it is difficult to achieve the mandatory requirements stipulated in the UNFCCC.

3.2.2 The Integration between these Arrangements

Given the nature and dual characteristics of ESTs, conflicts between these arrangements could be avoided through integration. It appears incontrovertible that, due to the public goods nature of ESTs based on their proprietary property, the formulation of international EST-related IP rules has a direct link with international arrangements in response to climate change. This means EST-related IP rule-making

[96] Albert Mumma and David Hodas, 'Designing a Global Post-Kyoto Climate Change Protocol that Advances Human Development' (2008) 20 The Georgetown International Environmental Law Review 619, 624. (The UNFCCC requires all member states must undertake emission reduction obligations, including the creation of a detailed record of emission reduction, the implementation of domestic emission reduction projects, and the consideration of climatic factor in developing national development policies. However, under the Kyoto Protocol, currently only Annex I countries are obliged to fulfill emission reduction obligations, which makes an excuse to refuse national GHG emissions for other developed countries, the first one of which is the United States.)

[97] Maskus (n 21) 13. (Further to say, there is a great number of uncertainties about the international and domestic costs and benefits of investment in ESTs, as well as the impact of climate change on each country.)

[98] Meir Perez Pugatch, 'Mitigating Climate Change through the Promotion of Technology Transfer and the Use of Environmentally Sound Technologies: The Role of Intellectual Property Rights' (2010) 4 European Journal of Risk Regulation 408, 409. (This article points out that geopolitical factor mainly refers to the political will to establish a viable binding action framework in respect of EST transfer among countries with different interests. Systemic factors refer to economic, legal, social and technological development level of technology importing countries.)

not only just relates to mitigation and adaptation to climate change, but also primarily aims at dealing with conflicts triggered by the lack of a unified coordination mechanism to achieve the triple goals of addressing climate change, promoting fair trade and protecting IP.[99]

The international IP system is to EST-related arrangements under the UNFCCC what generality is to particularity. The international IP system builds up a fundamental framework for innovation and dissemination of ESTs, so the application of ESTs should follow the relevant provisions of international IP conventions. The EST-related arrangement under UNFCCC externalizes international IPRs in the context of climate change. The current international EST-related IPRs and arrangements under the UNFCCC are complementary to each other, and both essential for addressing climate change.[100]

In addition, the international IP issue is an unavoidable topic in a number of alternatives to achieve emission reductions. The international EST-related IP arrangements and international environmental system essentially share the same the ultimate goal.[101] Although mechanisms and arrangements under the UNFCCC, which are presented as political statements with a positive attitude, are in terms of legally binding effect inferior to those under the WTO or WIPO, the external, positive influence of the UNFCCC has been widely recognized in the international arena.

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[99] Alexander Adam, 'Technology Transfer to Combat Climate Change: Opportunities and Obligations under TRIPS and Kyoto Protocol' (2009) 4 Journal of High Technology Law 1, 16. (In the author's view, 'since there is no such waiver for any other products and no overlap between ESTs and pharmaceutical products, a country trying to set up a compulsory license to export an environmental good or service to a developing country currently cannot do without violating WTO rules.')

[100] Laurence R. Helfer, 'Mediating Interaction in an Expanding International Intellectual Property Regime' (2004) 36 Case Western Reserve Journal of International Law 123, 133<http://ssrn.com/abstract=578121> accessed on 8 January 2014. (By the introduction of 2001 Sub-Commission IP Solution and High Commissioner Report to highlight the human rights implication of TRIPS, the UN human rights bodies urged WTO to consider the establishment of the close interaction between the promotion of human rights and TRIPS, but WTO is not obliged to respond favorably to this requirement.)

[101] Article 2 of UNFCCC states its ultimate objective: to achieve stabilization of GHG concentration at a level that should be achieved within a time frame 'sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner'. Article 7 of TRIPS state the objective of IP protection shoule be to contribute to technological innovation and transfer from both producer- and user- friendly perspective and in a manner that is conducive to economic and social welfare.

Therefore, the key consideration is how to transform this external influence into realistic institutional arrangements based upon the international IP system.

In order to maintain consistency of international mitigation actions, the recognition that ESTs themselves are not in conflict with mitigation measures is necessary for the international community which has to acknowledge that developed countries evade their obligations under the UNFCCC by claiming that ESTs are legally protected by patents.[102] Accordingly, the integration between these arrangements should show respect to both the existing international IPRs and reasonable demands of needed technologies based on the right to subsistence in the process of converting eloquent words to specific actions, during which the latter should take precedence over the former.[103]

3.3 Assessing Possible Ways to Reconcile Patents and Climate Protection

Given the lack of an international countermeasure to dissolve the discord between patents and climate protection, different voices are heard on the form or way to relieve the discord. There are several possible ways to solve EST-related IP issues in the

[102] In the climate talks about technologies, IP or patents are a polarizing topic. There is a different voice from international community that insists that it is the UNFCCC that includes some proposals that weak or evade patent rights. See Padmashree Gehl Sampath, John Mugabe and John Barton, 'Realizing the potential of the UNFCCC Technology Mechanism: Perspectives on the Way Forward' (2012) Issue Paper No. 35 ICTSD Programme on Innovation, Technology and Intellectual Property May 2012, 1.

[103] Daniel Bodansky, 'Climate Change and Human Right: Unpacking the Issues' (2010) 38 (3) Georgia Journal of International and Comparative Law 511, 518. (Climate change is said to likely 'affect the realization and enjoyment of a variety of widely recognized human rights, such as the right to life, the right to adequate food and water, the right to health, the right to self-determination, among others'.); Sanjit Kr. Chakraborty, 'Intellectual Property Rights (IPRs) over Agricultural Biotechnology and Environment: Human Rights Perspective in India' (2011) 2 (2) India Human Rights Law Review 1, 14 < SSRN: http://ssrn.com/abstract=1996443> accessed on 2 January 2014. (The case study of India pinpoints that two human rights, the right to attain basic needs and the right to a sound environment, are involved in the challenge facing the country like India that 'how to provide economic development with a healthy and diverse environment'. It is believed that 'attempts to resolve these two paradoxical rights have taken the form of the concept of sustainable development'.)

context of climate change. The first proposal is to completely preclude IP issues from international climate change negotiations, which is primarily supported by representatives from certain industrial countries. Obviously, this idea is irrational. The second is to make some modifications under TRIPS in order to meet the challenges of climate change. The third proposal is to establish an effective framework to harmonize the extreme divergence on IP issues under the UNFCCC. The fourth possible solution is to design a special EST-related IP architecture under WIPO, which is advocated in this thesis. This section will focus on all proposals except the first.

Another possibility, which will not be repeated in the following discussion, is the establishment of a cooperation mechanism outside WIPO, WTO and UNFCCC. According to the present situation, representatives from the U.S. argue that conditions for cooperation in certain region or based on the existing sound relationship between certain countries are available for this proposal, although developed countries do not explicitly express the willingness to participate in negotiations on EST-related IP issues.[104] In case of no consensus reached under the current framework, a cooperative mechanism among developed countries, for example the three-part cooperation on IP between EPO, USPTO and JPO, is likely to exert a subtle influence on negotiations of EST-related IP issues by recruiting new countries to a new multilateralism.[105]

3.3.1. The Possible Pathway under the WTO

The second proposal is a relatively 'conservative' program. Namely, without relaxing the minimum standard of IP protection, concreteness could be lent to the

[104] Ebinger and Avasarala (n 1) 20. (Representatives from the U.S. put forward a suggestion that global problems can be better solved in a small range than by plenary sessions in the UNFCCC, by lauding the benefits of smaller negotiating forums and highlighting the historic inability of the UNFCCC and its 192 member nations to reach concrete agreements. It is stated in their proposal that 'just as you cannot run a company through plenary meeting of the shareholders, you cannot manage crucial global issues that way either.')

[105] Ibid. (The authors of this article propose E-10 cooperation model among ten countries that are great emitters accounting for three quarters of global emission, including EU, the United States, China, India, Japan, Russia, Canada, South Africa, Australia and Brazil. If it is possible, this cooperative model would have a significant impact on global emission control.)

flexible provisions of TRIPS in the innovation and application of ESTs, so that the enforceability of these clauses could be enhanced to cope with the transfer of ESTs.[106] More specifically, it sounds like a solution similar to the Doha Declaration on TRIPS and Public Health through negotiations under the WTO framework.[107] The Doha Declaration opened up the exchange between the closed trade-related IP system and the outside world by limited modification of TRIPS Article 31, and thus the incessantly expanding rift between patent protection and access to drugs, trade and other development-related issues, although not completely or substantially bridged, has been more or less narrowed.[108]

In the context of climate change, the use of TRIPS flexibilities mainly refers to measures taken by a Member by placing an actual limitation on EST-related exclusive rights, in order to to prevent or stop damage caused by climate change to public health and survival. For example, further explanation of 'a national emergency' or 'other circumstances of extreme urgency' in accordance with the provision of Article 31 of TRIPS could be elaborated.[109] In addition, in order to mitigate and adapt to climate

[106] Ujjwal Kacker, 'Technology Transfer and Financing: Issues for Long Term Climate Policy in Developing Countries' (2009) 3 Carbon & Climate Law Review 292, 294 < http://heinonline.org/HOL/Page?handle=hein.journals/cclr3&div=51&g_sent=1&collection=journals#310> accessed on 8 January 2014. (As a representative of developing countries, Brazilian Foreign Minister delivered in his speech to UNFCCC COP in Bali 2007 that a Doha-type model should be used in climate negotiations. The reason is that, according to Martin Khor, being afraid of be revenged by other countries, especially developed countries, for direct use of flexible terms in TRIPS, developing countries choose to resort to a formal statement similar to the Doha Declaration so that 'when they exercise the rights, they are protected politically, which adds to their confidence of exercising the already existing law.')

[107] John Whalley, Sean Walsh, 'Post-Copenhagen Negotiation Issues and the North-South Divide' (2009) 8 Seattle Journal for Social Justice 773 <http://digitalcommons.law.seattleu.edu/sjsj/vol8/iss2/12/> accessed on 8 January 2014. (Climate negotiations could be dragged for years without a result that generally satisfies most participants. The process of climate negotiations is similar to the Doha negotiations in the WTO, but what is different from trade negotiations is that, if the worst effects of climate change can be avoided, climate negotiations may close that relatively definite charted map of climate mitigation and adaptation. Therefore, the establishment of the Doha-style agreement in climate negotiations is very dangerous.)

[108] Henning Grosse Ruse-Khan, 'Sustainable Development in International Intellectual Property Law – New Approaches from EU Economic Partnership Agreements?' (2010) 29 ICTSD Programme on IPRs and Sustainable Development 1, 2. (By confirming its objective to promote sustainable development and thereof the obligation of WTO Members, the Doha Declaration is viewed as a good opportunity to launch a new round of trade negotiations about development issues.)

[109] Moustapha Kamal Gueye, 'Technologies for Climate Change and Intellectual Property: Issues for Small Developing Countries' (2009) ICTSD Information Note 12 2009, 6 <

change, a Member could be granted an exemption from the obligation of patent protection, as is provided in Article 27.2 that inventions may be excluded from patentability to avoid 'serious prejudice to the environment'.[110]

From a legal perspective, this proposal is put forward for most part based on the following four reasons. The first is that the ultimate goal of TRIPS is to improve the living standards of humanity with the promotion of technology innovation and diffusion as its core objective. However, some scholars are against it on the ground that the discussion about what form should be adopted to change legislation under the WTO so as to meet new challenges is inconclusive; the objective of the WTO to increase social welfare through free trade is not directly linked with the values embraced in promoting access to patented ESTs to address climate change.[111]

The second reason for this proposal is that the flexible terms in TRIPS provide a reasonable basis for necessary measures taken by national governments in the name of public interests.[112] The objection is given based on the reason that although the Member States are apparently granted plenty of room, the dispute settlement

http://ictsd.org/i/publications/57611/> accessed on 8 January 2014. (It is suggested by the author that climate mitigation and adaptation provides a well founded argument for compulsory license and could be furthered recognized as essential part of public interests. Interestingly, it finds that the use of compulsory licensing in the case of national emergency or other extreme circumstances could be a useful way of multiplying the effectiveness of the efforts made by developing countries in mitigating and adapting climate change by obtaining key ESTs.)

[110] Scott Taylor, 'Where are the Green Machines? : Using the Patent System to Encourage Green Invention and Technology Transfer' (2011) 23 The Georgetown International Environmental Law Review 577, 596. (Article 27.2 allows Members to exclude inventions from patentability to maintain necessary public order or mortality, including avoidance of serious damage to the environment. However, the definition of 'serious prejudice of the environment' is not accurate, and so far how to interpret this Article is unknown due to no precedence for the use of the terms. It is optimistically believed by the author that Article 27.2 could be broadly defined, if one Member could provide the evidence that assess to green technologies is difficult because of the granted patents or the lack of such technology would be devoted to serious environmental deterioration. In this sense, Article 27.2 can be identified as a reasonable ground for the exclusion of green technologies from patentability.)

[111] Dinwoodie and Dreyfuss (n 33) 2-3. (It is observed that the target of WTO to enhance the welfare of humanity through trade liberalization is not enough to justify its reform as respond to new challenges.)

[112] Van Smith, 'Enabling Environments or Enabling Discord: Intellectual Property Rights, Public-private Partnerships, and the Quest for Green Technology Transfer' (2011) 42 Georgetown Journal of International Law 817, 833. (It argues that the flexibilities offered by TRIPS is an attempt to 'strike a balance between the long term social objective of providing incentives for future inventions and creation, and the short term objective of allowing people to use existing inventions and creations'.)

mechanism is vague about the terms and conditions of flexibilities. As a result, the Member States are at a loss as to how to modify national legislations. Ostensible freedom is not actual freedom. What is more, the Doha Declaration essentially places restrictive immunity on part of the obligations under Article 31 of TRIPS, without giving an account of how WTO members could apply Article 30 more flexibly or giving the green light to other products, which indicates that the use of a compulsory licensing system is strictly confined in certain individual cases.[113]

The third reason is that TRIPS could force governments to take positive actions to strengthen IP protection through the dispute settlement mechanism in the framework of multilateral trades. The WTO's concern about conflict rules under a trade environment reflects that the establishment of the dispute settlement system is not aimed at distinguishing right from wrong, but at finding a mutually acceptable solution to restore the balance between rights and obligations.[114]

However, due to the special nature of ESTs in international trades, under such circumstance some fresh problems emerge before the application of TRIPS' flexible terms can occur.[115] For example, how to define the purpose of use these flexibilities in the context of climate change? Could these flexibilities be integrated into domestic laws or does the application of TRIPS flexibilities just specifically refer to the effectiveness of addressing climate change? In addition, an issue worthy of consideration is that the settlement of institutional disputes seems pointless under DSM, because decisions made by dispute settlement panels do not change or reduce TRIPS rights or obligations.[116]

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[113] Adam (n 99) 1. (Although compulsory license is primarily associated with the pharmaceutical industry, it is argued by the author that compulsory license can be used for patented technologies in any other field.)

[114] ICTSD, 'Dispute Settlement at the WTO: The Developing Countries Experience' (2012) ICTSD International Trade Law Programme Information Note, April 2012.

[115] Roger E. Schechter and John R. Thomas, *The Principles of Patent Law* (Zhongru Yu tr, 2nd edn, Intellectual Property Publishing House 2016) 62. (The popular belief is that patent system is not an appropriate carrier to judge the moral value of new technologies. However, whether the environment protection characteristic can be defined as the moral value of ESTs is questionable.)

[116] Dinwoodie and Dreyfuss (n 33) 3. (Although it could make up for unmentioned issues in the Ministerial Conference and the General Assembly, after all, the judgment mechanism of WTO is not a well-functioning legislative body. Unlike an international agreement with top-down solution to

Throughout the history of international IP negotiations, trade benefits are regularly the most important consideration, if any proposal is accepted within the WTO framework.[117] More importantly, it is optimistically believed that developing countries could receive additional compensation for the high cost of protecting IPRs.[118] Admittedly, this additional compensation in a cross-protocol manner could greatly enhance the unity of coordination, but for developing countries this is more of a short-term comfort. In the long run, developed countries will try to replicate the strategy that shifts the international IP protection from bilateral to multilateral, and then from multilateral to bilateral or regionally-multilateral, continuously enhancing protection standards in a spiraling way.[119] As a result, regardless of whether developing countries oppose it or not, or seek to maximize their chips in negotiations, they have to pay for the cost of strong IP protection.

Given the above analysis, it can be seen that access to ESTs through the use of flexibilities in TRIPS can be affected by many uncertain factors. A consensus on remedies from international trading system as a main way to increase access to ESTs is not easy to reach, due to their unknown effect.[120] As a rather strict or even rigid IP protection and awareness has been formed in those developed countries that hold monopoly benefits of IP under the TRIPS umbrella, it is foreseeable that developed

substantive issues, decisions made by the dispute settlement committee is not able to reduce obligations or rights provided in already achieved agreements. The institutional obstacle is a sort of restriction that is not easy to ignore in judicial practices.)

[117] Sampath and Roffe (n 63) 38. ('The rise of IP provisions within regional agreements shows how developing countries, who often initiate such agreements in an effort to find mutually agreeable terms of trade, are enticed to accept a gradual proliferation of stronger IPR standards and stringent enforcement rules in their domestic regimes in return for favorable access conditions to developed country markets')

[118] Reichman and Dryfuss (n 39) 100.

[119] Sampath and Roffe (n 63) 41. (In different forms, preferential trade agreements have been created and signed in recent years across the world. Although these agreements aim at expanding trade liberalization in goods and services and improving market access, most of them focus on trade rules concerning investment, government procurement, and IP. With respect to IPRs, the minimum standard of TRIPS is further explained and enhanced by these agreements.)

[120] Mark Van Hoorebeek and William Onzivu, 'The Eco-Patent Commons and Environmental Technology Transfer: Implications for Efforts to Tackle Climate Change' (2010) 1 Carbon & Climate Law Review 13. (In conventional trade context, how much IP contributes to promoting technology transfer is not confirmed, and the responsibility of developing countries expected to assume in TRIPS is hard to measure.)

countries will not give up the private attribution of ESTs for the sake of the other attribution of ESTs as public goods. Hence, it is a difficult task to resolve problems raised by the conflict between IPRs and other development issues in the trading area, in which the value orientation of technology transfer is essentially different from that of technology transfer advocated as an important way to address climate change by the UNFCCC.[121]

3.3.2. The Proposal under the UNFCCC

The situation that continues to occur in climate negotiations is similar to that in the Uruguay Round negotiations in which the discussion about whether GATT was an appropriate forum to achieve a substantive IP system set off a heated debate. In climate negotiations, the parties are split on their view about whether the UNFCCC is the right place to solve IP issues. In the Uruguay Round negotiations, developed countries insisted that IP issues should be resolved within trade domain given the deadlocked negotiation for a higher standard protection of IP under WIPO, while in the context of climate negotiations they avoid discussion of IP issues.[122]

The R&D and application of advanced ESTs is the key and ultimate solution to climate change, which has been recognized by common consent across the world, and thus particularly emphasized in the UNFCCC, so it is theoretically possible to create an EST-related IP framework under the UNFCCC. The public goods nature of ESTs is

[121] Joshua D. Sarnoff, 'The Patent System and Climate Change' (2011) 16 (02) Virginal Journal of Law and Technology 302, 317. (Five characteristics in the process of traditional technology transfer are summarized as follows: 'relative advantage, compatibility [with user values], complexity, triability [to overcome user uncertainty], and observability [of benefits … and] a number of [diffusion and adoption] factors [i.e.,] cost‐effectiveness ... [and] access to investment capital [for capital intensive technologies having size and scale economies and] salvage values for the displaced technology across firms, as well as distinct abilities to assess the risks and rewards associated with the innovation…'.)

[122] Dongwook Chun, 'Justifying Patent Harmonization' (2012) 12 Asper Review of International Business & Trade Law 99, 110-113. (It argues that developing countries can gain compensation when IP protection issues are related with free trade, which is always beneficial to domestic economic welfare of each individual state with their own comparative advantages. However, the harmonization of patents should be examined from the perspective of patent theory or utilitarianism, according to which 'the patent system was originally designed to maximize social utility'.)

the most fundamental reason for the establishment of international EST-related IP framework, the goal of which is to overcome excessive IP protection by stressing the prominent role of IPRs in promoting sustainable development as well as in encouraging innovation and transfer of ESTs in the context of climate change. It is strongly believed that only when a new IP agreement is reached in climate negotiations could IP owners' interests and various global interests be fully taken into account as much as possible.[123] Moreover, as climate negotiations deepen, this potential IP agreement may eventually become one of the implementation mechanisms of the UNFCCC.

The most obvious feature of this proposal is that the hypothesis has the moral high-ground. This has both a positive and negative effect on the global response to climate change. The positive effect chiefly means that a wide range of countries are willing to participate in climate change negotiations whatever their respective purposes are and thus a broad consensus on the importance of emission reduction obligations and the transfer and application of ESTs could be achieved. The negative impact is that it is quite hard for one country or a group of countries to influence or change positions or practices of other countries by taking the moral high-ground when the focus of following negotiations is on how to implement the results of preliminary negotiations, especially in the face of IP issues, because the duality of ESTs deprives it of an adequate and convincing reason to support the recommendation.[124]

In other words, the transfer of ESTs mentioned in the special IP framework under the UNFCCC should largely be understood as EST sharing, which is meaningless

[123] Manuel A.J. Teehankee, Ingrid Jegou, Rafael Jacques Rodrigues, 'Multilateral Negotiations at the Intersection of Trade and Climate Change --An overview of Developing Countries' Priorities in UNCSD,UNFCCC and WTO Processes' (2012) 2 ICTSD Programme on Global Economic Policy and Institution May 2012, 5. (A warning is given in the negotiation on how to make contribution to climate change actions from the perspective of trade that developing countries, not a homogeneous or static, 'have specific interests and distinct domestic dynamics which have to be taken in account at different fora and at different times.')

[124] Chun (n 122) 113.(When substantive harmonization is involved in the negotiations, participants have to strike a balance between welfare gains and welfare loss, indicating that compensation is meaningful rather than empty talk if harmonization entails welfare loss in some countries.)

without the support of the Green Fund based on the UN contribution levels.[125] In the absence of a substantive and procedural guarantee, repeatedly pointing to the historical responsibilities of developed countries can in no way help to properly solve EST-related IP issues within the UNFCCC. Arrangements under the UNFCCC are even considered expensive but have little effect, producing instead more political bickering than expected constructive solutions.[126] This proposal seems ineffective mostly because the UNFCCC is a negotiating body not in a legal but in a political sense, which can be seen from the endless bargaining without positive results in certain important conferences of the UNFCCC.

It seems pointless to design an IP system under the UNFCCC that could surpass the influence of TRIPS at a time when current international climate negotiations are faltering, because an innocent EST-related IP system is likely to become a means to attack each other if placed in a political environment.[127] Although trade links have more extensive influence than political negotiations, in the exceptional circumstance of climate change, international negotiations are of great historical significance which can be seen from the considerable progress made over their course, from a deep understanding of the impact of climate change to active efforts of mitigation and adaptation.

[125] Elizabeth Burleson, 'Energy Policy, Intellectual Property and Technology Transfer to Address Climate Change' (2009) Climate Change and Human Rights Symposium 18 University of Iowa Transnational Law and Contemporary Problems, 69. (In accordance with the 2007/2008 Human Development Report under the UN Development Program, it is reaffirmed by the author that 'multilateral climate protection architecture will be left on an insecure foundation if it is not rooted in financial commitments'.)

[126] Ebinger and Avasarala (n 1) 20. (The most obvious disadvantage of the UNFCCC is its inefficiency. The main reason for this is that international agreements under the UNFCCC are mostly presented in the form of Convention and Protocol, the biggest feature of which is to encourage a long negotiation process with procrastination.)

[127] Chun (n 122) 104. (The harmonization of patent rights under political pressure would result in 'a growing belief among developing countries that the international patent system and patent harmonization is a coerced agreement that should be resisted rather than embraced'.)

3.3.3. The Proposed Framework under WIPO

In view of the difficulties encountered in the WTO and UNFCCC, the EST-related IP issue may be introduced into the discussion under the auspice of WIPO. It is advocated in this thesis to establish an EST-related patent regime under WIPO so that the arrangements relating to ESTs under the UNFCCC could be internalized into the special IP system of WIPO as a carrier. From the perspective of its institutional characteristics, WIPO is believed to be able to make its contribution to tackling climate change as the most suitable organization of primary responsibility for the development of a specific EST-related patent system.[128] Salmon describes the functions of WIPO to include being responsible for conclusion of a new treaty, providing global IP protection services and assistance to developing countries, and doing professional research in the field of IPRs.[129] All these confirm the feasibility of a special regime designed in this thesis.

The main purpose of the establishment of WIPO was to serve as a holistic framework for international cooperation in the field of IP and harmonize national IP law.[130] WIPO is intended primarily as a forum for conclusion of new treaties or modification of existing documents under its jurisdiction, to promote the implementation of a unified international IP protection standard by cross-border and cross-sector coordination.[131] Given the importance and urgency of efforts to address climate change and as no satisfactory results have yet been achieved, it is necessary to

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[128] Dinwoodie and Dreyfuss (n 33) 5. (As legislative activities within the WTO have been basically stagnant, IP issues again return to the WIPO system. The institutional structure of WIPO involves greater diversity and flexibility than that of WTO, so it argues that the IP system under WIPO could better respond to complex practical problems.)

[129] Paul Salmon, 'Cooperation between the World Intellectual Property Organization and the World Trade Organization' (2003) 17 St. John's Journal Legal Comment 429.

[130] Frederick M. Abbot, 'The Future of the Multilateral Trading System in the Context of TRIPS' (1996) 20 Hastings Int'l & Comp. L. Rev. 661 < http://heinonline.org/HOL/Page?handle=hein.journals/hasint20&div=34&g_sent=1&collection=journals#681 > accessed on 12 November 2013.

[131] Salmon (n 46) 433. (It is observed by Paul Salmon that since the last revision of the Paris Convention in 1967, over the next 25 years, IP rule making within WIPO system had failed to achieve substantial progress, indicating that WIPO lacks the ability of cross sector coordination. This weakness is fatally flawed to trade markets that require a higher standard of IP protection.)

seek conclusion and implementation of a new international document during the process of which WIPO is supposed to be principally responsible for agendas of meetings, negotiations and drafts of a new agreement, a final summary required by the establishment of a new system, as well as supervision and coordination of the operation of a new system. Optimistically, this proposal can be used as an intermediate solution to break the deadlock in negotiations on substantive patent law treaty, and thus if carried out could be taken as good news for WIPO's development goal to build a global integrated patent system.[132]

Through the treaties and agreements under its jurisdiction, WIPO provides services and advices for applicants from all over the world. This service revenue is the main source of funding for WIPO. As the international applications of ESTs increase, services offered by WIPO in this area have expanded.[133] While improving services, WIPO can collect as much as possible and analyze EST-related patent information, accelerate the application process and reduce service costs for those applicants who hold the ESTs urgently needed by developing countries and have the intention to transfer their ESTs to developing countries, which is more conducive to the exchange of information and diffusion of ESTs.

WIPO is committed to providing technical and legal assistance to developing countries and LDCs by focusing on the impact of IP protection on the development of those countries. Although results of the early efforts made by WIPO in this issue were not encouraging, WIPO has updated its development agenda and begun to handle the issue of excessive protection in North countries.[134] As is known, traditional

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[132] Mohammed K El Said, *Public health related TRIPS-plus Provisions in Bilateral Trade Agreements: a policy guide for negotiators and implementers in the Eastern Mediterranean Region* (World Health Organization *Regional Office for the Eastern Mediterranean and ICTSD* 2011) 107. (The Substantive Patent Law Treaty is considered aggressive, because 'it seeks to limit exceptions from patentability and harmonize the definition of "prior art" within patent examination, which if adopted would lead to the erosion of TRIPS flexibilities and the policy space available to developing countries'.)

[133] Cannady (n 91) 5. (Here the service mainly refers to patent information and databases which is strongly suggested as 'a quasi-technology transfer to provide access to climate change technology'. Given its active role in advocacy of patent information since 1975, WIPO aggregates PCT patent data from almost the world which is described as 'a goldmine of technology guidance to developing countries', by fully taking use of internet to update its service in this respect.)

[134] Kotthapally (n 58) 2-7. (Given its failure to reach a satisfactory result of traditional norm setting,

knowledge, folklore and genetic resources, which constitute an extremely important part of the wealth that developing countries are proud of, are not covered by TRIPS but in fact by WIPO which is committed to the worldwide protection of IP with greater flexibility.[135]

The proposed patent system under WIPO is a system that takes ESTs as an example to guide Member States on how to use patent systems in a more effective way which will not reduce the incentive effect of patent protection but assist developing countries to better digest it with a sound legal infrastructure.[136] In addition, there is a dedicated Global Challenges Division under WIPO to deal with the issues that arise between IPRs and highly-relevant global challenges.[137] Compared with the WTO, it is argued that the governance structure of WIPO means it enjoys more diversity and flexibility to readjust its IP rules in the development process.[138]

As a specialized agency of the UN, WIPO has acquired beneficial things in human rights law and paid attention to the development of developing and less developed countries in time-honored fashion.[139] What WIPO has done to acquire beneficial things in human rights law and to pay much attention to the development of developing countries and less developed countries can be considered interrelated. On the one hand, a plenty of provisions of conventions administered by WIPO are consistent with the man-centered concept fostered by human rights law in which IPRs

WIPO introduced a development agenda 'as a revolutionary revolutionary soft norm that was antithetical to the conventional IP paradigm'. The Development Agenda has a significant impact on the functioning of WIPO in many aspects which include conceptual paradigm shift, norm-setting, substantive work in WIPO committees, and institutional changes.)

[135] Dinwoodie and Dreyfuss (n 33) 1.

[136] Reichman and Dryfuss (n 39) 98.

[137] Ahmed Abdel Latif, 'Change and Continuity in the International Intellectual Property System: A Turbulent Decade in Perspective' (2011) 3 (1) WIPO Journal 36, 36-37. ('A Global Challenges Division was established to address public policy issues as part of the strategic realignment process led by Francis Gurry', the WIPO Director General who commented on this move that 'in the past, WIPO has not engaged in these issues, so we want to move from isolationism to engagement.')

[138] Okediji (n 45) 9. (In line with its tradition of system coordination, WIPO is able to respond to modification of IP rules and various challenges which are contrary to IP orthodox system.)

[139] Ibid 6. (From the beginning of its reconstruction initiatives, to ensure economic development of developing and less developed countries has been considered to be part of legitimacy of the International Bureau system. Although the initial purpose is simple to seek the exclusive privilege of making global IP rules, its responsibilities for global development in the field of IP is objectively enhanced.)

are regarded as an integral part of human rights.[140] For example, in the Berne Convention the two-track protection of authors' economic rights and moral rights is presented.[141] On the other hand, the assistance provided by WIPO for developing and less developed countries indicates that the human rights nature of IPRs might conflict with the right to life and health which is a basic part of human rights.[142] It is the important theoretical basis for special handling of patent rights associated with ESTs that the human rights attribute of IPRs must not become an obstacle against the right to life and health.[143]

History has taught us that any attempt to reduce standards of IPR protection designed largely to protect the interests of developed countries would inevitably meet strong resistance.[144] Therefore, at a time when humanity is faced with common challenges and increasing global concerns about climate change, it is of great significance that WIPO as a coordinator and administrator should continue to maintain its time-honored tradition by treating the human rights attribute of IP in a

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[140] Estelle Derclaye, 'Intellectual Property Rights and Global Warming' (2008) 12 Marquette Intellectual Property Law Review 263, 290-291<http://ssrn.com/abstract=1016864> accessed on 24 October 2013. (The argument that IPRs are human rights, 'either as such or within the right to the respect of one's property' is well recognized in the Universal Declaration of Human Rights in which the moral and material interests of authors and inventors are protected as human rights.)

[141] The Berne Convention for the Protection of Literary and Artistic Works, adopted in 1886, deals with the protection of works and the rights of their authors. Here the rights of authors contain 'economic rights' as well as 'moral rights. The moral rights include 'the right to claim authorship of the work and the right to object to any mutilation, deformation or other modification of, or other derogatory action in relation to, the work that would be prejudicial to the author's honor or reputation'. <http://www.wipo.int/treaties/en/ip/berne/summary_berne.html> accessed on 14 May 2016.

[142] Ibid. (It is noted that so far there is no confirmation of the right to a clean and healthy environment in any international law nor any enforceable right like that.)

[143] Sanjit Kr. Chakraborty, 'Intellectual Property Rights (IPRs) over Agricultural Biotechnology and Environment: Human Rights Perspective in India' (2011) 2 (2) India Human Rights Law Review 1, 4 < SSRN: http://ssrn.com/abstract=1996443> accessed on 2 January 2014.(Under the influence of the trend of thought in favor of freedom and human dignity, the Indian Supreme Court began to reexamine the meaning of social justice by expanding the outreach of the fundamental rights provided in the third part of the Constitution. It is recognized by the Court 'various unarticulated rights' as enforceable ones, such as the recognition of 'a right to wholesome environment' as an integral part of the right to life under the Constitution.)

[144] Gerald J. Mossinghoff, 'Patent Harmonization through the United Nations: International Progress or Deadlock?' (2004) 86 Journal of the Patent & Trademark Office Society 5, 9-10. (The diplomatic effort to amend the Paris Convention ended with failure in 1980s. It was the first attempt in the development history of the Paris Convention to reduce global patent standards rather than to increase patent protection substantially and procedurally.)

rational way, to avoid falling into the old trap.[145]

3.4 Conclusion

Although the decision to discuss and resolve IP issues related to climate change is a very complex and difficult issue, urgency of environmental problems caused by climate change has forces the international community to seek a suitable forum and opportunity to do so. For developed countries, it is beneficial to participate in discussions about specific demands of developing countries, while the relatively sound IP system in developed countries also provides a valuable point of reference for future development of IP law of developing countries.

The existing arrangements under the UNFCCC and the use of TRIPS flexibilities under the WTO both have considerable difficulties in reconciling IPRs and climate protection. It finds that the solution under the UNFCCC is a flawed vision, and the flexible terms in TRIPS are not as adaptable to changes as expected, so a more eclectic approach is required to manage the EST-related IP issues under WIPO. This means that IPRs need be re-examined in the context of climate change, to examine a solution which will both avoid the prevailing over-emphasis on the inviolability of private rights in the world trading system, while simultaneously seeking a solution which will overcome the shortcomings of being devoid of legally binding arrangements under the UNFCCC.

As discussed above, the current exploration of an appropriate regime to address patent protection and access to ESTs has accumulated valuable experiences for the development of the global IP system. By making full use of these resources, WIPO is supposed to take the responsibility for negotiations over EST-related IP issues and intensify efforts to build a more practical, effective and sustainable patent system

[145] Susan K. Sell, 'The Quest for Global Governance in Intellectual Property and Public Health: Structural, Discursive, and Institutional Dimensions' (2004) 77 Temple Law Review 363, 388. (Given the human right implication of IP protection, human right organizations recast IP as 'a social product with a social function and not primarily as an economic relationship'.)

which must be built upon the characteristics of ESTs.

Crisis of public health and climate change visibly highlights the discord between exclusive rights of patents and interests of users of protected drugs and ESTs. The heated debate on public health and access to drugs can provide some lessons for harmonization of patent rights in the context of climate change. Therefore, before establishing such a patent regime, it is of great significance to conduct comparison between drug and ESTs, which will be analyzed in the next chapter.

Chapter 4 Lessons from Reconciliation of Patent Rights and Access to Pharmaceuticals

Global public health crisis mirrors the conflict between pharmaceutical patents and human right to life, providing an opportunity for global attention spotlighted on public interests. Similarly, both faced by the double dilemma of climate change and energy crisis, owners of ESTs defend the stringent patent protection, while EST importing countries hope to obtain technologies at relatively low cost. By full use of the benefits of the international reconciliation between pharmaceutical patents and public health, the objective of this chapter is to provide some lessons for consideration of the harmonization between international patent protection and access to ESTs.

Since the WTO Doha Ministerial Conference in 2001[1], the response to the international health crisis under the WTO provides legal clarity for the balance between pharmaceutical patents and public health, a real inspiration for solutions to potential conflicts between IPRs and other areas. Further speaking, through comparison, it finds that ESTs and pharmaceuticals both belong to imperfect public goods, i.e. ones with some characteristics of public goods. Beneficial nutrients could be absorbed from the outcomes of the coordination of public health and drug patents.[2] Due to the differences between pharmaceuticals and ESTs, the refusal to make any response to the discord between EST-related patents and climate mitigation should be alerted, and efforts on the development of an appropriate patent system based on the uniqueness of ESTs are worthwhile.

[1] The Fourth WTO Ministerial Conference, held in Doha, Qatar from 9 to 14 November 2001 with the outcome of the famous Declaration on the TRIPS Agreement and Public Health <http://www.wto.org/english/thewto_e/minist_e/min01_e/min01_e.htm> accessed on 6 June 2014.

[2] Bronwyn H. Hall and Christian Helmers, 'The Role of Patent Protection in (Clean/Green) Technology Transfer' (2010) No.16323 National Bureau of Economic Research Working Paper 1.

4.1 The Comparison between Pharmaceuticals and ESTs

Before any lessons could be learned from the reconciliation between patents and access to pharmaceuticals, it is essential to make a comparison between pharmaceuticals and ESTs. From an economic point of view, pharmaceuticals and ESTs can be defined as imperfect public goods with positive externalities that determine their characteristic of realizing public interest goals, which will be analyzed later. Unfortunately, inefficiency of patent rights may hinder the achievement of these goals, thus governments and legislatures are required to get involved.[3] From the legislators' point of view, social benefit and costs arising from the implementation of any specific legal system must be roughly equal, if not more benefit at less cost.[4]

4.1.1 Similarities and Differences between Pharmaceuticals and ESTs

4.1.1.1 Pharmaceuticals and ESTs Defined as Imperfect Public Goods

Drugs and ESTs could not be simply classified as public goods or private goods. According to Samuelson, public goods are 'ones whose benefits are indivisibly spread among the entire community, whether or not individuals desire to purchase the public goods', while private goods, by contrast, 'are ones that can be divided up and provided separately to different individuals, with no external benefits or costs to others'.[5] Nonetheless, there is not always a clear-cut boundary between public and

[3] Daniel R. Cahoy, 'Breaking Patents' (2011) 32 Michigan Journal of International Law 461, 466. (According to Joseph E. Stiglitz, 'intellectual property rights circumscribe the use of knowledge and thus, almost necessarily, cause inefficiency'.); see also WTO, The Report of the Panel on Canada-Patent Production of Pharmaceutical Products (2000) WT/DS114/R, 26. (In the context of facilitating access to pharmaceuticals, the patent monopoly that is 'inherently economically inefficient', if not limited, would mean 'the quantity of drugs available to society would be less than optimal, due to sales at prices considerably higher than marginal cost'.)

[4] Ahmed Abdel Latif, 'Change and Continuity in the International Intellectual Property System: A Turbulent Decade in Perspective' (2011) 3 (1) WIPO Journal 36, 43. (It is noteworthy that 'intellectual property protection is a policy instrument the operation of which may, in actual practice, produce benefits as well as costs, which may vary in accordance with a country's level of development.')

[5] Paul A Samuelson and William D. Nordhaus, *Economics* (Chen Xiao tr, 18th edn, McGraw-Hill

private goods, the distinction of which largely depends on legal systems, especially IP legislation.

Drugs and ESTs with attributes of both public and private goods belong to imperfect public goods, in which some elements of public goods are involved. These products, which are not naturally occurring or inexhaustible resources, are created by a small group of people with complex, costly and time-consuming production processes, which are determinants of provision. Human-induced crisis in public health and climate change arouses increasing concerns, because no effective market or political mechanisms are currently available to efficiently allocate drugs or ESTs.[6] This is viewed as the worst example of market failure in the supply of global public goods.[7]

Therefore, in order to safeguard their provision, the IP system renders certain public goods as commodities of scarcity, which economists contend as a basic fact of life.[8] A particular group of people depend on the inventions or technologies of right holders, such as patients' demand for drugs and the demand from the energy sector for energy-saving technologies. Patent rights restrict access to those public goods. Accordingly, the consumption of protected drugs and ESTs under patent systems is characterized by rivalry, with extra benefits given to others.[9] It is in this sense that both drugs and ESTs are regarded as imperfect public goods. The level of balance between the supply of and the demand for these two particular products will never be

Education 2005) 370.

[6] Frederick M. Abbott, 'Innovation and Technology Transfer to Address Climate Change: Lessons from the Global Debate on Intellectual Property and Public Health' (2009) ICTSD's Programme on IPRs and Sustainable Development, Issue Paper No. 24, June 2009, 18. (Abbott emphasizes the importance of concrete mechanisms for technology transfer, and suggests that the establishment of public-private partnership may effectively allocate future distribution market along geographic lines by giving the example of this partnership on the Drugs for Neglected Disease Initiative.)

[7] Samuelson and Nordhaus (n 5) 370. (The provision of global public goods is the typical example of market failure, as individuals do not have enough incentives for production and governments could not obtain corresponding benefits from large investment in development of global public goods.)

[8] Ibid.4. (It is believed by economists that 'no society has reached a utopia of limitless possibilities'. So scarcity is the normal state of the world, and efficiency is critical to social development.)

[9] Once special drugs are used in the treatment of infectious diseases, it is naturally beneficial to other people who could be relieved from the threat of those infectious diseases. Similarly, the benefits of the use of ESTs will extend to other people who do not actually make a direct payment for it.

ignored. Their scarcity and the tense situation between supply and demand will continue to exist for a long time, implying that countries with sound competitiveness in medical and EST-related industries have advantages in market monopoly.

4.1.1.2 The Obviously Positive Externality of Pharmaceuticals and ESTs

The concept of an externality from an economic perspective is 'an activity that imposes involuntary costs or benefits on others, or an activity whose effects are not completely reflected in prices and market transaction'.[10] Pharmaceuticals and ESTs both show positive externality because their application imposes benefits on others outside the marketplace. The discussion then proceeds into the externality of pharmaceuticals and ESTs.

The reputation of drugs most lies in their contribution to global public health, especially in the control of infectious diseases.[11] According to the 2001 report of the WHO, the number of those who die of infectious diseases each year is up to fourteen million, of which over ninety percent in Africa, Asia and South America where the treatment of infectious diseases is principally dependent on pharmaceutical industries in the U.S., Europe and Japan.[12] Moreover, the spillover of technical information contained in drugs after they are fully developed and marketed can benefit other related industries and individuals, thereby reducing costs of R&D and accelerating the pace of technological progress.[13] The fast proliferation of drug information in the

[10] Samuelson and Nordhaus (n 5) 370.

[11] Here infectious diseases mainly refer to AIDS, malaria, tuberculosis, respiratory infectious diseases and etc.

[12] Meir Perez Pugatch, *The International Political Economy of Intellectual Property Rights* (Edward Elgar, 2004) 78. (According to the survey, the proportion of products made by more than fifty pharmaceutical companies from the United States, Europe and Japan accounts for two thirds of the global drug production and exports. With three fourths of the world's population, developing countries yield just ten percent of the global drug production, and two thirds of the total production in developing countries is from several countries like India, China, Brazil and Mexico.)

[13] Jeanne C. Fromer, 'Patent Disclosure' (2009) 94 Iowa Law Review 539, 556. (Spillovers of privately held information about patented inventions from one entity to another begin to appear in particular industries, for example the chemical process industry, which demonstrates the cumulative nature of innovation in this industry.)

public domain will ultimately increase the aggregate social wealth.

The externality of ESTs is not only reflected in their positive effect on the environment but also in the far-reaching significance to the sustainable development of the future world. National governments are increasingly aware of the fact that international competitiveness of one country relies on its capacity for energy conservation and the efficiency of energy use.[14] This cannot be achieved without the development of ESTs. Advanced ESTs in a certain field will consciously or unconsciously become the global standard of technologies in that area.[15] For example, the U.S., Japan and Germany take a dominant position in patent applications of technologies in the fields of wind, biomass, solar cells, clean coal technologies and carbon capture and storage.[16]

The positive externality of drugs and ESTs endows them with the characteristics to achieve the public interest objective. It is worth considering just how many private and social benefits would be brought about by this kind of externality. Frankly speaking, it is commercial benefit, not the extra positive externality that provokes innovation and application of drugs and ESTs. As is shown in Figure 1, in an unregulated market, individuals will determine their profitable investment levels in the development and application of ESTs and drugs, on the basis of rational pursuit of

[14] Keith E. Maskus and Ruth L. Okediji, 'Intellectual Property Rights and International Technology Transfer to Address Climate Change: Risks, Opportunities and Policy Options' (2010) 32 ICTSD's Programme on IPRs and Sustainable Development Issue Paper 2010 International Centre for Trade and Sustainable Development, Geneva, Switzerland 1, 8-9. (A positive correlation is found across US manufacturing industries between national efforts in energy conservation and efficiency improvement and the number of patent grants to ESTs. In addition, the more international competitive the industry is, the more it invests in environment-related research.)

[15] Environmentally Sound Technologies for Sustainable Development, International Environmental Technology Centre, Division of Technology, Industry and Economics United Nations Environment Program, May 21, 2003, p.7. (On account of spillover effect of technologies, innovative technologies of one industry in some country will always become a global standard of that industry and the potential of technologies depends on the specific economic, political and social environment.)

[16] Miranda Schreurs, Congcong Wang, 'Leadership Competition on Clean Energy and Green Technologies' (2012) 03 Green Leaves 85. (As indicated in the report from Chatham House on IPRs and technology transfer, since the middle of the 20th century, there is a sharp increase of patent applications for clean energy technologies, including wind power generation, biomass energy, solar cells, efficient solar energy, clean coal, carbon capture and storage, which are firmly hold by companies from the U.S., Japan and Germany. There are other important participants including China, Britain, France, Canada, Korea, Italy and Russia.)

commercial profits, by equating marginal private benefit with marginal private cost, which generates the equilibrium at E' in the graph below.[17] From the perspective of social welfare, the marginal social benefit is equal to the marginal cost in the best of circumstances, which is represented as E* in the graph.[18]

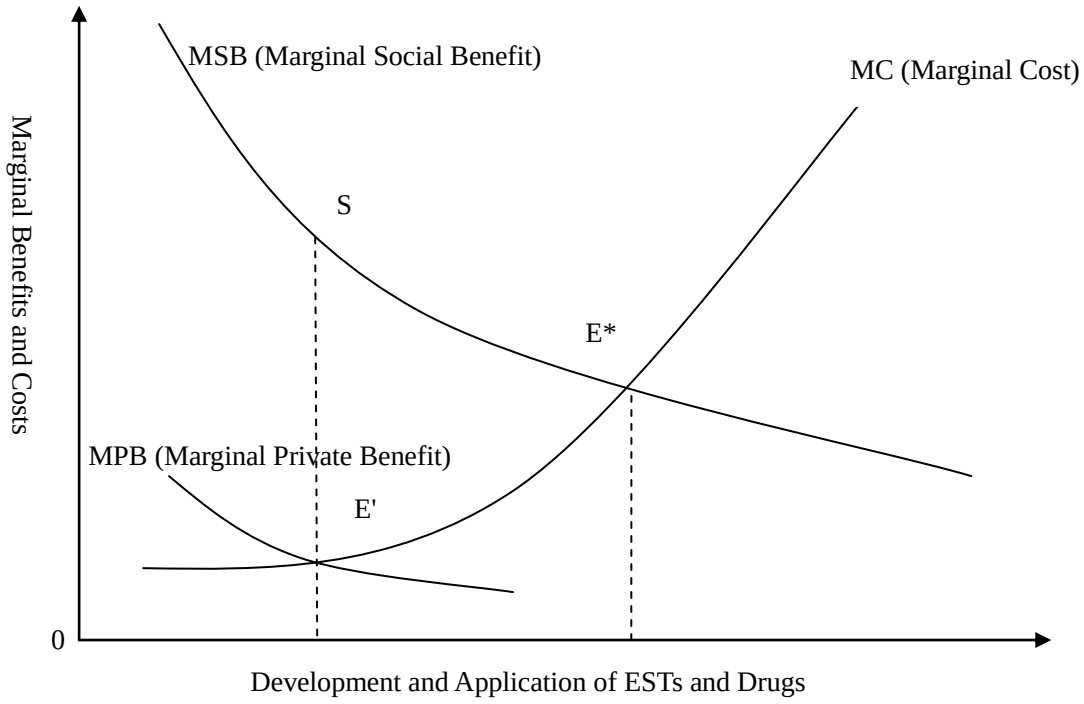

Figure 1 Market Failure with Externality of Imperfect Public Goods

It is obviously impossible and wasteful from an economic point of view to obtain a result of zero discharge or no threat of diseases.[19] The levels of development and application of ESTs and drugs are supposed to represent their sufficiently positive

[17] Samuelson and Nordhaus (n 5) 371-372. (Being a rational individual or a sound profit-maximizing enterprise, it is necessary for an individual or enterprise to know the point where the benefits from additional development, namely, marginal private benefits, are equal to the extra cost, namely, marginal cost of abatement.)

[18] Ibid. (The overall impact of development and application of ESTs and drugs, including 'improved health and increased property values in neighboring regions' is definitely greater than the impact affecting only single enterprise. The excluded benefits are external to the enterprise and have on effect on its profits.)

[19] Ibid. (According to the cost-benefits analysis, it finds that, as in many cases, the most efficient outcome is reached by equating marginal cost and marginal benefit of an activity. Zero discharge or no threat of diseases would generally 'impose astronomically high cleanup costs, while the marginal benefits thereof may be quite modest.' So 'no-risk or zero-discharge policy' would be very wasteful from the economic perspective.)

externality to others. This assumes to a certain degree that the risk of climate change could be reduced toward zero, or that human suffering from infectious or other severe diseases could be almost completely avoided. At this point, the marginal social benefit generated from the development and application of these imperfect public goods tends to be infinitely small.

When the externality of imperfect public goods has great significance, less efficient development of imperfect public goods and more private benefit relative to an optimal circumstance where marginal social benefit is equal to marginal cost will be generated by the private equilibrium in an unregulated environment.[20] The efficient level of development of imperfect public goods comes at point E*, thus the gains represented by the area SE'E* could be achieved as much as possible by a regulated market solution, which means the involvement of public policies and legislations.

4.1.1.3 The Differences between Pharmaceuticals and ESTs

Although pharmaceuticals and ESTs are categorized as imperfect public goods, several differences exist between the two. Each has its own characteristics in terms of concepts, technological development and market demands. First, the concept of ESTs is much more complex than pharmaceuticals. So far, there is no universally accepted or unified concept of ESTs. According to the definition of ESTs made in United Nations Commission on the Environment and Development, ESTs refer not only to non-continuous products and processes but also environmental technology systems and demonstration.[21] According to IPCC 2007 Government Report, the concept of

[20] Benjamin K. Sovacool, 'The Best of Both Worlds: Environmental Federalism and the Need for Federal Action on Renewable Energy and Climate Change' (2008) 27 Stanford Environmental Law Journal 397. (Compared with the cost of implementing ESTs, if unregulated, the relatively low price of fossil fuel would depress 'the incentive to enact energy efficiency and conservation measures, and discourage the adoption of alternative fuels for vehicles and renewable energy technologies'. In order to keep the green house gas emission in a regulated state, reducing the price of ESTs and holding up the price of carbon-intense products are both indispensable.)

[21] The United Nations Conference on Environment and Development, Agenda 21 (1992)

ESTs contains a very coherent system, covering every aspect of the life cycle of technologies and soft environment in which ESTs perform their functions.[22] In this regard, ESTs refer to entities with little or no discharge of waste and are also viewed as a total system including technical methods, processes, products, services, equipment, and managerial processes, leading a technological revolution in environment protection.

Furthermore, ESTs could be interpreted as technologies that support the world's sustainable development by protecting environment and reducing poverty and human sufferings.[23] As climate mitigation and adaption has a substantial sectoral coverage, encompassing almost all industrial sectors and areas of life that intensify efforts in abatement measures, it is a quite difficult to draw a defined boundary of ESTs, the application of which is largely dependent on the time and space they adapt to.[24] ESTs, which are applicable in a country or a region, are probably no longer considered as friendly in other countries or regions after a certain period of time. All of the above definitions of ESTs in the context of climate change lead to the most fundamental concept: technologies upgraded in emission control techniques with higher efficiency of traditional energy, and those invented and developed to use alternative energy and renewable energy.

Second, in terms of the positive externality of the two products, the impact of

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<http://sustainabledevelopment.un.org/content/documents/Agenda21.pdf> accessed on 20 June 2014 (According to Chapter 34 of Agenda 21, ESTs are not just individual technologies. They can also be defined as total systems that include know-how, procedures, goods and services, and equipment, as well as organizational and managerial procedures for promoting environmental sustainability.)

[22] IPCC Government Report (2007), the Third Working Group, Chapter 2 Framework page 148. ('The essentially systemic nature of ESTs refers to the complex set of knowledge and technologies necessary to combat climate change and the broad set of stakeholders impacted by protection and consumption of ESTs.')

[23] Hari M. Osofsky, 'Technology Transfer and Climate Change' (2011) in Lidgard, Atik & Nguyen (eds), *Sustainable Technology Transfer-A Guide to Global Aid and Trade Development* (Kluwer 2011). (The transfer of ESTs from developed countries to developing countries, as part of strategy for addressing climate change, allows developing countries to focus on economic growth and poverty eradication goals in an environmentally friendly fashion, which is absolutely different from emission-intensive development mode developed countries have adopted.)

[24] Environmentally Sound Technologies for Sustainable Development, International Environmental Technology Centre, Division of Technology, Industry and Economics United Nations Environment Program, May 21, 2003, 16-24.

EST utilization is wider reaching than pharmaceuticals. Almost all regions have suffered or are suffering from environmental or climatic challenges, the influence of which stretches steadily outward until finally connected together as a whole. There is no alternative, except mandatory consumption within different national economies challenged by climate change, the effect of which extends beyond borders and over times, so that climate mitigation and adaption is required to develop extensively and intensively.

In respect of breadth, not only is world-wide coverage of ESTs necessary, but also its wide application in the energy sectors, transportation, construction, infrastructure and aspects of social life.[25] In respect of depth, ESTs require a long-term and deep cover operation to integrate the environmental philosophy into all aspects of economic, legal and social development.[26] In this sense, the gradual enhancement of patent protection over ESTs is conducive to achieving the long-term goal, if properly controlled. It should be specially noted that the vulnerability to climate change shown by developing countries is prominent, thus the application of ESTs has a deeper significance for developing countries, whose economic development is more dependent on natural environment and resources than for developed countries.[27]

In the medical industry, the concept of essential medicines was introduced and they become part of the public domain,[28] and thus even the poorest countries could

[25] Van Smith, 'Enabling Environments or Enabling Discord: Intellectual Property Rights, Public-private Partnerships, and the Quest for Green Technology Transfer' (2011) 42 Georgetown Journal of International Law 817, 826-827. (The global cooperation and coordination presents all countries with unprecedented challenges in terms of the transfer of ESTs, whether from the perspective of breadth, depth or urgency. No single set of technologies is able to provide a sector with an effective emission reduction, which is only part of a national mitigation target with the support of various technologies in need, so what expected is a broad spread of application of ESTs.)

[26] Ibid 827. (ESTs include but are not restricted to those necessary for the modernization of infrastructure, the improvement of measuring and monitoring capabilities and the support for climate adaption. The transfer of ESTs is not only concentrated on several key technologies to address climate change, but also expanded to modernization and development of the whole energy industries.)

[27] Charles K. Ebinger and Govinda V. Avasarala, 'Transferring Environmentally Sound Technologies in an Intellectual Property Friendly Framework' (2009) Energy Security Initiative Policy Brief 09-08 by the Brookings Institution.

[28] Abbott, 'Innovation and Technology Transfer to Address Climate Change: Lessons from the Global Debate on Intellectual Property and Public Health' (n 6) 24. (It is believed by Abbott that the concept of 'essential medicines' is one of the most important programs initiated by the WHO. The concept of

obtain relatively inexpensive essential medicines against common diseases from some big developing countries.[29] Medicinal corporations' high returns are practically earned from patented drugs for high-risk infectious diseases that largely occur in developing countries where access to basic health care is impossible or R&D capabilities are lacking.[30] As seen, drug patents have an impact on the irregular distribution in global public health with improved access to essential medicines and the accessibility of ESTs needs to be well facilitated.

Thirdly, there is something special about ESTs and pharmaceuticals in respect of competition within the market. The diversity of ESTs and their great significance in climate protection mean that ESTs face severe competition, not only with each other but also with fossil fuel energy technologies in the long term, so patents may not provide patent holders of ESTs with as much monopoly power as they do in the medical industry.[31] As a technical industry entering into its prime, the patent protection of ESTs is the top priority for owners and exerts an overwhelming impact on the respond to climate change. There is a tendency that patent protection of ESTs is strengthened both internationally and domestically, as a result of misappropriation of the term 'harmonization of IP law' by countries that have a leading role in innovation.[32]

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essential drugs develops as part of public domain and 'calls upon public health authorities to assure the availability of a relatively low number of medicines that will address the preponderance of public health issues at affordable prices'. However, certain important medicines or treatment for severe infectious diseases are exceptions.)

[29] Frederick M Abbott, 'Trends in Local Production of Medicines and Related Technology Transfer' (2011) <http://www.who.int/phi/publications/local_production_trends/en/> accessed on 7 January 2014, 111. (According to the Europe Economics 2001, over ninety percent of molecules on the WHO Essential Drug List are out of patent. 'These can be supplied by whichever producers can deliver the right quality at the most competitive price; this is likely to be achieved in future through international trade rather than local production.')

[30] WHO Fact Sheets: Infectious Diseases< http://www.who.int/topics/infectious_diseases/factsheets/en/> accessed on 10 July 2014 (Since 1973, about 25 types of new infectious diseases, including AIDS which is world-wide spread and others like malaria and cholera mainly occurring in developing countries, have been discovered.)

[31] Ahmed Abdel Latif, 'Intellectual Property Rights and Green Technologies from Rio to Rio: An Impossible Dialogue?' (2012) 14 International Center for Trade and Sustainable Development Programme on Innovation, Technology and Intellectual Property July 2012 Policy Brief 1, 6.

[32] Latif, 'Change and Continuity in the International Intellectual Property System: A Turbulent Decade in Perspective' (n 4) 44. (A more balanced IP system is elaborated by some leading developed countries

In the pharmaceutical industry, competition between innovative drugs and their substitution is the contradiction of great concern, which is largely reflected by the disparity in affordability of innovative and generic drugs.[33] Patent holders are most concerned about how to maximize the use of their patents to develop the market of their products. In the pharmaceutical industry, creative enterprises endeavor resolutely to possess exclusively innovative drugs with high level of risks and profits but relatively low imitation costs, while generic drug producers also rush to obtain market approval for their own products through experiments and tests.[34]

4.1.2 Substantive Requirements of Patent Grants on Pharmaceuticals and ESTs

The substantive requirements of patent grants refer to a series of standards used to evaluate whether an invention is patentable or not. Although the standard of patentability has great flexibility, varying slightly depending on national laws and policies, a generally unified standard is set out in TRIPS: novelty, inventiveness and utility.[35] Under Article 27 of TRIPS, a patent could be granted to any invention in all technological fields, provided that it is new, it involves an inventive step and is capable of industrial use.[36] The dominant form of patentability for ESTs and

as a reward system for innovation and creativity, which is opposed to the original meaning of harmonization put forward by developing countries.)

[33] WTO, The Report of the Panel on Canada-Patent Production of Pharmaceutical Products (2000) WT/DS114/R, 114. (Although competition in pharmaceutical sector depends almost exclusively on the quality of products, the high expensive advertising reduces affordability of innovative drugs and generic durgs are believed to play an important role in global provision of drugs.)

[34] Ibid 135. (It may take several years of generic drug producers to carry out experiments and tests for market approval. If 'these tests were not allowed during the patent term, the term of effective patent protection of a drug would be much longer and, thus, would extend the period of restricted competition beyond the point at which two equally justified policy objectives met in a well- balanced manner, i.e. the internalization of positive externality and the cost-effective protection of public health'.)

[35] In the footnote of Article 27 of TRIPS Agreement, 'an inventive step' and 'capable of industrial application' are synonymous with 'non-obvious' and 'useful' respectively.

[36] In Article 27.1 of TRIPS, it states that 'patents shall be available for any inventions, whether products or processes, in all fields of technology, provided that they are new, involve an inventive step and are capable of industrial application'.

pharmaceuticals is discerned in this section through analysis of the substantive elements of their respective patent grants.

4.1.2.1 Novelty

The standard of novelty in modern patent laws is built upon the evaluation of prior art.[37] Novelty relates to the differences between a new invention and the patents preceding its filling date, which are determined by technical comparisons. A detailed definition or full explanation of the standard of novelty is a necessary condition of patent grants and is absent in TRIPS, which allows Member States to implement the standard of novelty in a creative way.[38] Common practice is that if an invention is the same as the prior art, or the elements contained in the disclosure have already been found in prior art, the invention is not of novelty. The key to the outcome of the novelty examination lies in the mastery of information by patent authorities and a full disclosure of information by applicants.[39]

Information disclosure, a necessary condition for patent grants, is directly related to the extent of patent protection described in the claims. The scope of patent protection is generally not wider than the range of information disclosure. In the case

[37] Daniele Archibugi and Andrea Filippetti, 'The Globalization of Intellectual Property Rights: Four Learnt Lessons and Four Theses' (2009) Working Paper Available at SSRN: <http://ssrn.com/abstract=1486071 or http://dx.doi.org/10.2139/ssrn.1486071> accessed on 4 May 2012. (The patent law in modern sense assigned its origin to Venetian Republic and novelty as one of the two requirements, the other of which is usefulness, has been widely recognized by States so far on the basis of objective assessment.)

[38] Mohammed K El Said, *Public health related TRIPS-plus Provisions in Bilateral Trade Agreements: a policy guide for negotiators and implementers in the Eastern Mediterranean Region* (World Health Organization *Regional Office for the Eastern Mediterranean and ICTSD* 2011) 90. (It is argued by the author that in accordance with Article 1.1 of TRIPS, concepts related to patentability such as novelty and inventiveness are also included in the 'creative implementation' of TRIPS, in which only certain standards rather than definitions are provided.)

[39] Paragraph 1 Article 29 of TRIPS, 'Members shall require that an application for a patent shall disclose the invention in a manner sufficiently clear and complete for the invention to be carried out by a person skilled in the art and may require the applicant to indicate the best mode for carrying out the invention known to the inventor at the filing date or, where priority is claimed, at the priority date of the application'. Paragraph 2 Article 29, 'Members may require an applicant for a patent to provide information concerning the applicant's corresponding foreign applications and grants'.

where information is fully mastered, inventions that meet the standard of novelty will be granted patents. In reality, however, neither applicants at the time of application nor patent authorities reviewing patent applications are likely to be able to exhaust the information that has been disclosed in one technological field, especially those within fields of complex technologies.

In accordance with the EU international standard industry classification based on the distinction of intensity in the manufacturing sector, the pharmaceutical industry that belongs to the high-tech sector and provides powerful treatment for various diseases via mass drug production, is primarily divided into 'synthetic organic chemistry-based' and 'biological' pharmaceutical products.[40] The former category is dominated by low molecular compounds which can be imitated by controlling chemical formulas to produce products of similar structure without much effort. The latter is developed by using substantially different types of materials and production processes from the former which is viewed as traditional pharmaceuticals.[41] In the pharmaceutical industry, the standard of novelty is normally examined by testing active pharmaceutical ingredients rather than all chemicals contained in a new drug. In the diagnostics areas, chemical, mechanical and electrical technologies with separate patents may be involved, complicating the detailed disclosure of active ingredients.[42] Moreover, patent holders may not be so proactive to disclose active

[40] European Commission, European Classification of Economic Activities NACE; see also Frederick M Abbott, 'Trends in Local Production of Medicines and Related Technology Transfer' (2011) <http://www.who.int/phi/publications/local_production_trends/en/> accessed on 7 January 2014, 14-16. (The production of pharmaceuticals principally involves 'synthesizing active ingredients that perform therapeutic functions of the end products and combining active ingredients with inactive materials that facilitate delivery in the human body by creating tablets, capsules, liquids or other forms of drug delivery'.)

[41] Ibid. (it is in the past decade that biological pharmaceutical products become significant in the production sector. Biological pharmaceuticals cover a wide range of products, including 'vaccines, blood and blood components, allergenics, somatic cells, gene therapy, tissues, and recombinant therapeutic proteins that are isolated from a variety of natural sources, human, animal, or microorganism'.)

[42] The WHO Report, 'Local Production for Access to Medical Products : Developing a Framework to Improve Public Health' (2011) The Report comes from the Joint Project largely conducted by the World Health Organization (WHO), the United Nations Conference on Trade and Development (UNCTAD), the International Centre for Trade and Sustainable Development (ICTSD) on 'Improving access to medicines in developing countries through technology transfer and local production'

ingredients in order to protect information from rivals. All of the above could reflect the difficulties in extensively disclosing technical information.

Comparatively, although an international patent classification based on the particular area of technology has been introduced, no clear classification system could be used to group ESTs distinguishable by an extensive range of industries.[43] The result of this is that such ESTs could not be easily and effectively filtered or searched for using the existing classification standard. ESTs and closely-related projects are run as a complex industrial system that is formed by complicated processes involving environmental engineering and a great number of general purpose equipment as well.

An example of this is the flue gas desulfurization (FGD) system. A FGD unit with 300MW is comprised of a milling system, boost fan, upright refluxing spray absorber, a high velocity horizontal flow spray absorber, etc. Correspondingly, within an FDG unit a group of patents are held respectively by different patent owners, adding difficulty in information disclosure. More importantly, there are practical difficulties in carrying out a systematic and exhaustive search of the prior art within a specific field of ESTs. For example, carbon capture technologies are not classified under IPC or USPC, as such not all related carbon dioxide technologies can be retrieved from the existing patent database, because those technologies involve not only chemical and biological purification technologies, but also other common separation technologies.[44] In addition, carbon oxide captured here generally refers to carbon dioxide but with no

<http://www.who.int/phi/publications/local_production_policy_framework/en/> accessed on 21 November 2013, 28.

[43] European Patent Office, Search for Patents: Patent Classification: Classification Schemes-the International Patent Classification and the Cooperative Patent Classification < http://www.epo.org/searching/essentials/classification.html> accessed on 21 December 2014; EPO, Patenting Issues: Classification: Climate Change Mitigation Technologies <http://www.epo.org/news-issues/issues/classification/classification.html> accessed on 21 December 2014;
USPTO, Patent Classification: Environmentally Sound Technology Concordance <http://www.uspto.gov/web/patents/classification/international/est_concordance.htm> accessed on 21 December 2014.

[44] USPTO, Patent Classification: Environmentally Sound Technology Concordance <http://www.uspto.gov/web/patents/classification/international/est_concordance.htm> accessed on 21 December 2014; WIPO, International Patent Classification Green Inventory < http://www.wipo.int/classifications/ipc/en/est/> accessed on 21 December 2014.

discrimination against carbon monoxide, therefore certain patents related to carbon monoxide separation technologies within the chemicals field may be retrieved as opposed to patents on carbon dioxide capture technologies.

Even with the assistance of the most comprehensive EST patent classification, all relevant patent documents could not be exhausted, which indicates that imperfect information increases difficulty for patent authorities to deal with the standard of novelty. Trade-offs have to be made by patent authorities between the cost of reducing errors and the benefit brought by free competition. A suck cost and monopoly cost will be produced if errors occur, while many new factors of uncertainty in the market certainly affect the objective assessment of benefits from open competition.[45] As a result, given the use of prior art as a crucial reference to determine difference between filings and prior art, the establishment of a reasonable standard of novelty that is based on strict disclosure is necessary to reduce the cost of monopoly from imperfect information.

The standard of novelty, which ensures patents will not be grant to inventions already in the public's possession, is closely tied to the progress of relevant technology fields and industrial sectors.[46] It is also inextricably bound to the scope of patent protection, which determines benefits that patent owners can recoup through

[45] H-Holger Rogner, Dadi Zhou, Rick Bradley, Philipp Crabbé, Ottmar Edenhofer, Bill Hare, Lambert Kuijper, Mitsutsune Yanaguchi (2007) Chapter 1 Introduction in B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds), *Climate Change 2007: Mitigation of Climate Change* (Cambridge University Press 2007) 102. (Apart from irreversibility of climate change response to human activities over time, adoption of new ESTs, and mitigation and adaption measures involve huge irreversible costs. Therefore, decision-makers must take the irreversibility of environment, social economic and the investment in the development of ESTs into account, when deciding the timing and scale of actions to address climate change.)

[46] Sean B. Seymore, 'Rethinking Novelty in Patent Law' (2011) 60 Duke Law Journal 919, 922-924. (The standard of novelty is set upon the a comparison of a claimed invention with the prior art that refers to 'preexisting knowledge and technology already available to the public', including common sources of prior art such as patents and printed publications, as well as a prior art reference that must satisfy three conditions under U.S. jurisdiction: 'it must predate the applicant's invention or have existed more than one year before the applicant's filing date; it must identically disclose or describe every element of the claimed invention in as complete detail as contained in the patent claim; it must disclose the subject matter in sufficient detail to enable a person having ordinary skill in the art to make it without undue experimentation'.)

the duration of their patents.[47] In spite of the fact that a strict standard of novelty is beneficial for initial researchers, in the pharmaceutical industry, where a large amount of money and time has been spent on basic research, competitive extravagance may occur, resulting in under-investment in the subsequent stages.[48] According to Schtchmer and Green, lenient review of novelty is conducive to timely disclosure that has a strongly positive externality, and thus brings more benefits to highly-related industries.[49] However, Spence stands firmly in the opposition, holding that the strong externality of information will be followed by free-riding problems and a weakened incentive of patent systems to private innovation, though reducing the production cost of competitors and the cost of industry-wide R&D as well.[50]

4.1.2.2 Inventiveness

Inventiveness is the most valuable part of an invention. It mandates a higher demand for technological upgrading than novelty, which instead focuses on the distinctions between patent filings and prior art.[51] In the light of the interpretation under TRIPS, the term 'inventive' is a synonym for 'non-obvious'. This explanation can be extended to say that through comparison with the prior art, the invention has made 'substantial' and 'significant' progress.[52] The key to effective protection of

[47] Richard Gilbert and Carl Shapiro, 'Optimal Patent Length and Breadth' (1990) 21 (1) RAND Journal of Economics 106.

[48] In the medicine areas, it may take ten years from R&D to marketing, spending hundreds of million dollars during one pharmaceutical process where the clinical trials consisting of three phases most cost money.

[49] Jerry R. Green and Suzanne Scotchmer, 'On the Division of Profit in Sequential Innovation' (1995) 26 (1) *RAND Journal of Economics 20.*

[50] Andrew M. Spence, 'Cost Reduction, Competition, and Industry Performance' (1984) 52 (1) Econometric Society 101. (The inefficiency of market in the provision of new technologies is analyzed in this article.)

[51] Eric L. Lane, 'Chapter 1: Clean Tech IP Is for Real' (2011) *Clean Tech Intellectual Property: Eco-Marks, Green Patents, and Green Innovation* (Oxford University Press 2011) 9. (The standard of non-obviousness is applied as a way of measuring the real level of inventions, implying that those inventions that are different from the prior art but obvious to ordinary technicians in that technical field are not eligible.)

[52] Ibid. (It argues that the inventive standard makes certain that patents are granted to 'real' and 'truely' innovative inventions that are distinct from 'the inventions that differ the prior art in the way obvious to

technological innovation lies in the level of standard of inventiveness, which varies inversely with the possibility of patent grants. Due to the imbalance in the levels technological development within various areas of technology, industrial sectors and national states, opportunities and possibilities for technological innovation show marked difference.[53] Accordingly, the standard of inventiveness cannot be set in the same way; the level of intensity relies on dynamic competition in specific circumstances.[54]

According to the subgroups of technologies based on the growth rate of application under the PCT and the standard of global patent share issued by WIPO, pharmaceutical technologies belong to the matured technology group, the application of which adds limited value to products at the maturation stage.[55] Objectively speaking, a relatively high standard of inventiveness is applicable to the mature technology group. Under the same grouping criteria, ESTs are grouped as new and emerging technologies, which corresponds to products at the growth period of the life circle and the application of which will greatly impact the value chain, facilitating the rapid development of new related products.[56] Furthermore, according to the study of von Graevenitz, Wagner and Harhoff, ESTs are classified as complex technologies, indicating additional difficulties in the imitation of ESTs that could lead to adverse impact on their diffusion rate.[57]

Standards of inventiveness vary between industrial sectors that technologies

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some skilled in the technical field of involved inventions'.)

[53] Stefano Breschi, Franco Malerba and Luigi Orsenigo. 'Technological Regimes and Schumpeterian Patterns of Innovation' (2000) 110 (463) The Economic Journal 388.

[54] John F. Duffy, 'Harmony and Diversity in Global Patent Law' (2002) 17 Berkeley Technology Law Journal 685. (According to Professors Dreyfuss and Lawenfeld, the standard of patent protection depends on intellectual and industrial development of one country and the types of innovative activities.)

[55] H. Grupp, D. Fornahl, C. A. Tran, J. Stohr, T. Schubert, F. Malerba, F. Montobbio, L. Cusmano, E. Bacchiocchi, and F. Puzone, 'National Specialization and Innovation Performance' (2010) Task 4: Horizontal Report 1 of Europe INNOVA Sectoral Innovation Watch for DG Enterprise and Industry European Commission 2011.

[56] Ibid.

[57] Georg von Graevenitz, Stefan Wagner and Dietmar Harhoff, 'Incidence and Growth of Patent Thickets: the Impact of Technological Opportunities and Complexity' (2013) 61 (3) The Journal of Industrial Economics 521.

belong to. Under the New International Patent Classification and Technology Concordance Table issued by WIPO, both drugs and ESTs belong to subareas of chemistry, which itself is one of five main areas.[58] Based on the proportion of scientific citation in patent statements, drugs belong to the basic scientific technology subarea, the innovation of which depends heavily on breakthroughs of scientific research and is comprised of primitive and fundamental technologies for industrial development.[59]

In the pharmaceutical field, innovative compounds generally have a close relationship with known compounds in terms of structure.[60] A compound with a new structure is composed of a group of molecules with common structures or similar properties and uses; the inventiveness of an improved compound requires a more stringent review in comparison with those that precede it, in order to determine the degree of structural difference and the changing effects thereof.[61] Where there are substantial structural differences, a compound could be considered inventive. Differences in effect shall be taken into account where the structure is similar to the prior art. For example, for patent grants to drugs in China, where a new compound is found to have a similar structure when compared with previous compounds, it must be assessed against the standard of inventiveness, by testing the claimed positive effect resulting from its new functions.[62]

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[58] Ulrich Schmoch, 'Concept of a Technology Classification for Country Comparisons' (2008) Fraunhofer Institute for Systems and Innovation Research, Final Report to WIPO <http://www.wipo.int/edocs/mdocs/classifications/en/ipc_ce_41/ipc_ce_41_5-annex1.pdf> accessed on 24 December 2014. (In 2008, in order to fully reflect the new development of global science and technologies, WIPO issued a new international patent classification and technology concordance on the basis of the 1993 FHG / OST / INPI IPC and Technology Concordance Table in cooperation with Fraunhofer Institute for Systems and Innovation Research.)

[59] Bart Van Looy, E. Zimerman, Reinhilde Veugelers, Arnold Verbeek, Johanna Mello and Koenraad Debackere, 'Do Science-Technology Interactions Pay off When Developing Technology? An Exploratory Investigation of 10 Science-Intensive Technology Domains' (2003) 57 (3) Scientometrics 355.

[60] Abbott, 'Innovation and Technology Transfer to Address Climate Change: Lessons from the Global Debate on Intellectual Property and Public Health' (n 6) 9.

[61] Ibid.

[62] China, Decision of the State Intellectual Property Office Amending the Guidelines for Patent Examination (promulgated by order No. 68 of March 12, 2014, of the State Intellectual Property Office) < http://www.wipo.int/wipolex/en/details.jsp?id=14761> accessed on 7 September 2014.

As the starting point for the research and development of drugs, pathologic diagnosis is the most creative and uncertain stage that requires a comparatively long period of time, as the specific embodiment of areas of basic scientific technology.[63] For resource-intensive drugs with difficulties in research and development, the standard of inventiveness is stringently high. Nevertheless, as far as the pharmaceutical industry is concerned, the standard of inventiveness is increasingly declining, evident from the fact that almost all new discoveries, including new uses, new dose forms, new combinations, and even new packages and colors, are able to be patented.[64]

The innovation of ESTs primarily includes the creation of design patterns, integrated systems and key equipment.[65] The innovation of design patterns refers to the successful simulation of working conditions with scientific quantitative approaches, putting emphasis on different types of data and operations of objects with the assistance of modern design tools, to achieve the maximum of GHG emission reduction during the design process.[66] The innovation of integrated systems relates to new systematic technology innovation and the process innovation of subsystems. Moreover, the innovation of key equipment principally refers to the research and development of new facilities and the optimization of equipment selection parameters.

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[63] Andrew Beckerman-Rodau, 'The Problem with Intellectual Property Rights: Subject Matter Expansion' (2010) 13 Yale Journal of Law & Tech. 35, 59-60. (Though pathologic diagnosis is a very challenging process full of important advance, it is worth mentioning that a diagnostic medical test that covers 'naturally occurring correlation' itself is not patentable, as naturally occurring correlation between substances is 'an important basic scientific finding that no one should own'.)

[64] Marcia Angell, *The Truth about the Drug Companies* (Random House Group 2005) 128. (Taking America as an example, from 1998 to 2000, four hundred and fifteen new drugs are approved by Food and Drug Administration, only 14% of which can be truly called innovative, 9% are the improvements of old drugs, and the rest 77% are generics. In the sight of FDA, however, these new drugs are significant enough to improve therapeutic treatments.)

[65] Keqin Sun, Kai Shen, Haitao Xu, Changcheng Chou, Yanzhong Xu, 'The Study on Emission Reduction during the Innovative Process of ESTs' (The Fourth China's International Forum on Environment and Development, Beijing China, October 2008).

[66] Ibid; see also Benjamin K. Sovacool, Janet L. Sawin, 'Creating Technological Momentum: Lessons from American and Danish Wind Energy Research' (2010) 11 The Whitehead Journal of Diplomacy and International Relations 43. (Through the comparisons of American and Danish wind energy research, it is concluded that reliability built upon the successful simulation of working conditions should be the top priority of technology design. Designs that are created to satisfy the ideals which were desirable in theory are incompatible with the existing social environment.)

Function plays a chief role in setting standards of EST innovation, as the nature of ESTs is made evident by their functions of reducing emission and improving energy efficiency. The function of ESTs set out in this thesis is demonstrated by technical solutions to climatic issues. For example, the gas desulfurization technique aims to solve air pollution by removing sulfur from gas emission. Theoretically, a function-based standard of inventiveness is generally not accepted, save for some exceptional cases where functional characteristics could be viewed as the main determinant for inventiveness, without which there is no other way to describe the inventions.[67] Admittedly, functional characteristics should not be wildly used on the basis that once a specific function claimed in a technical solution for which patent protection is sought is recognized, other technical solutions with similar functions will no longer be protected, which may hinder innovation.[68] Similarly, effects are also limited as a standard of inventiveness; however, it is function rather than effects that constitutes one part of claims.[69]

Nevertheless, as one of the elements used to compare against prior art, effects have still become an important element for inventiveness reviews. The introduction of effect-based standards poses special significance on inventiveness reviews of drugs and ESTs. When it comes to technical solutions of drugs that differ slightly from the prior art, the inventiveness of a new drug is determined primarily by its non-obvious progress or efficacy, which are not easily derived from structures or compositions of known drugs.[70] In addition, whether the supposed efficacy could be produced will

[67] Beckerman-Rodau (n 63) 35. (As far as subject matters are concerned, innovations that are functional are the most common things under patent protection. However, the doctrine of functionality has limitations on IP protection. The function features of a patented subject matter would have an effect on the patentability of other things with similar function, if function-based standard is adopted. The functional aspect is often used to distinguish utility patents and design patents and the non-functionality is an element of patentability of design models.)

[68] Jeanne C. Fromer, 'The Layers of Obviousness in Patent Law' (2008) 22 Harvard Journal of Law & Technology 75, 84. (It argues that as 'function is already part of the analysis of the utility an invention implements, there is no need to examine it separately. Moreover, very few inventions have a non-obvious function, providing another reason not to analyze function much further. Therefore, the obviousness of an invention's function should be given little, if any, weight.')

[69] Ibid 82.

[70] Jerome H. Reichman and Frederick M. Abbott, 'The Doha Round's Public Health Legacy: Strategies for the Production and Diffusion of Patented Medicines under the Amended TRIPS

greatly influence findings of patent infringement.

The innovation process of ESTs is comprised of the design, implementation and debug stages.[71] At the traditional initial stage of innovation, where the main innovative part of ESTs is designed, energy-saving targets are just regarded as design constraints. Under the influence of the current international consensus on mandatory emission reduction targets, energy saving and emission reduction have changed from constraints to objectives, which are equally important as economic goals.[72] The actual effect of ESTs on energy saving and emission reduction is therefore another important element in determining the inventiveness of ESTs.[73]

4.1.2.3 Utility

The standard of novelty keeps a close watch on technical distinctions in comparison with prior art, and the focus of inventiveness review is placed on the substantive contribution of inventions to solving specific technical problems. As one of three substantive requirements, utility refers to practical use that could enable ordinary technicians in relevant fields to implement technologies with beneficial results.[74] As contrasted with being theoretical, utility emphasizes that inventions are

Provisions' (2007) 10 (4) Journal of International Economic Law 921. (The efficacy of claimed drugs has been taken seriously in national patent legislations. For instance, an efficacy test has been applied by the USPTO to claimed drugs prior to the decision by the Federal Circuit in In re Brana, 51F.3d 1560. Section 3(d) of the Amended India Patents Act 'denies patentability for claims of modifications to previously known pharmaceutical substances that do not demonstrate significant enhancement in 'efficacy'.')

[71] Sun, Shen, Xu, Chou and Xu (n 65).

[72] Michael A. Gollin, 'Using Intellectual Property to Improve Environmental Protection' (1991) 4 Harvard Journal of Law & Technology 193, 226. (It is strongly believed that 'technology-forcing environmental statutes and regulations create a market for environmental technology' and economic and environmental goals can be combined well. In this regard, regulations that set the performance-based standard would be more effective to stimulate the innovation of ESTs.)

[73] Naoki Yoshida, David Albagli, 'The Fastest Routes for Green Patents-Japan' (2012) 222 Managing Intell. Prop. 60. (It is argued by the authors that green technologies are viewed as not only those that have effect of reducing energy consumption or GHG emission but also those that are reasonably demonstrated to make contribution to the environment in all fields. According to the definition, the JPO holds the doctrine that 'the main factor for accepting requests under this category is linking the invention to an effect on the environment rather than the technical field to which it belongs.')

[74] In Article 27 of TRIPS the utility is defined as 'are capable of industrial application' or 'useful'

not purely theoretical but repeatedly operational. Broadly speaking, utility could be interpreted as being beneficial to production and living standards. Under patent examination practices, filings are less likely to be turned down because of a lack of utility as opposed to a failure in novelty or inventiveness reviews.[75]

Given the particularity of the pharmaceutical industry, a lenient standard of utility is evident from the practice that a lot of chemical and biological compounds are patented in clinical trials, even though their industrial applicability remains under review.[76] In addition to the applicable standard of utility in other technology fields, safety and reliability are covered by the utility of a new drug or therapy.[77] In the U.S., the utility of new drugs and therapies is based on therapeutic, prophylactic and pathological findings. Following pre-clinical animal testing and cell cultivation, the drug enters into clinical trials during which the utility is critically determined to find whether it is approved for human use.[78]

ESTs under patent protection may range from operable machinery, an application process that is used as guidance or controls devices to perform particular function, or a method, which is a series of specific steps taken in technical devices. The utility of patented ESTs is tested through complete simulations of possible operating conditions

which means being available for industrial use.

[75] European Patent Office, Guidelines for Examination in the European Patent Office (Amended 2014) < http://www.epo.org/law-practice/legal-texts/guidelines.html> accessed on 12 December 2014. (It is explained in Part C Guidelines for Procedure Aspects of Substantive Examination Chapter IV 4.1 Reasoned Objections of *Guidelines for Examination in the European Patent Office* that a patent application is rarely stroked down as lack of utility, however, if the claimed product or method is manufactured or operate in a manner that is obviously in contradiction with the accepted laws of nature, it could be excluded from patentability as devoid of utility.)

[76] Jerome. H. Reichman, 'Rethinking the Role of Clinical Trial Data in International Intellectual Property Law: the Case for Public Good Approach' (2009) 13 (1) Marquette Intellectual Property Law Review 1, 23. (Some critics point out that public health utility will be low, if pharmaceutical developers are not able to patent any given pharmaceutical.)

[77] Mohammed K El Said (n 38) 133. (Due to the characteristics of drugs, an independent drug regulatory authority is set up in most countries, to ensure that drugs are safe and in conformity to quality standards, unlike the duty of patent administration offices that are merely responsible for the review of the three requirements of patent application.)

[78] Sean B. Seymore, 'Making Patents Useful' (2014) 98 Minnesota Law Review 1046, 1057-1058. (The utility of new drugs is not an issue about credibility but safety-related concerns, the basic principle of which uphold by Justice Story must 'be around morals, the health or the good order of society'. In the US, applicants for therapeutic patents must 'supply proof of safety and effectiveness of the claimed composition in man'.)

in a relatively short time, in order to truthfully reflect the technical character of ESTs.[79] It is then officially implemented through commissioning.

Fundamental to the utility of ESTs is the positive impact they exert on the environment. Patent claims about ESTs should cover a technically viable solution to particular environmental issues and these technologies can be widely used in manufacturing or in everyday life.[80] In view of patent application data published by OECD, the environmental problems associated with climate change which ESTs seek to address are intensively about air pollution, energy generation from renewable and non-fossil sources, and energy efficiency of fossil fuels.[81]

It is submitted, however, the review of EST utility is a matter of presence and absence, rather than a matter of the strength or degree of technical usefulness in relation to environmental issues.[82] It should be particularly noted that the technical usefulness mentioned here is different from the technical effect, the latter of which is exhibited through evaluation of the implementation of ESTs. Technical usefulness, on the other hand, is reflected in the design of ESTs. Despite formal commissioning, there is some discrepancy between expected technical effects and actual results of operation.

Benefits of industrial use can be expressed as useless or profitless, such as inventions that are inconsistent with accepted laws of nature, those that cause serious environmental pollution and resource idleness, and those with serious deviation from

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[79] It is hold by the EPO Boards of Appeal that industrial application assumes technical character of inventions, which could be introduced to teach ordinary technicians in that field to solve a particular technical problem by specific means.

[80] Mohammed K El Said (n 38) 171. (In respect of industrial application, it argues that patent claims should 'contain, as a minimum, a technically viable solution and not merely an unresolved problem or a speculative or intended result'.)

[81] OECD Patent Statistics ISSN: 2077-7809 DOI: 10.1787/data-00508-en. (According to the dataset of statistic on patents issued by OECD, technologies specific to climate change mitigation, as one of environmentally sound technologies, mainly refer to capture, storage, sequestration or disposal of green house gases including CO_2 and other gases such as N_2O, CH_4, PFC, HFC, SF_6, energy generation from renewable and non-fossil sources and the improvement of technologies with potential or indirect contribution to emission mitigation by using fossil fuels, biomass, waste.)

[82] Michelle L. Johnson, 'In re Brana and the Utility Examination Guideline: A Light at the End of the Tunnel?' (1996) 49 Rutgers Law Review 285. (The level of utility is not placed in the scope of patent examination, as the famous interpretation of utility made by Judge Story that even a tiny beneficial use is enough for utility review as long as the invention is not prohibited by sound ethics or policies.)

social development.[83] Unfortunately, there are also numerous technologies that are harmful to the environment but also have full industrial applicability.[84] Out of industrial policies and economic development, a lot of technologies with adverse impact on the environment are patented and extensively applied in industrial production. When practical benefit brought about by the use of patented technologies is less than the cost spent on the environmental reconstruction, the standard of utility goes counter to public interests.[85] With the overwhelming patent applications, the combination of utility and public interests should be upheld as the bottom line of patent law.[86] As patent property carries with a set of rights essentially denoting the rights and obligations of patent owners, the next part will focus on the measures that may be useful to promote access to drugs and ESTs.

4.2 The Measures Available for Enhancing Access to Pharmaceuticals and ESTs

The function of patent law is more than just providing an incentive to innovation; and it is to ensure that patent owners and users remain in harmony without prejudice

[83] Sean B. Seymore, 'Making Patents Useful' (2014) 98 Minnesota Law Review 1046, 1049. (Not as usually viewed as 'a low bar to patentability or a non-existent patentability of requirement', the threshold of utility is decided biased for favored and disfavored categories. The negative requirement can be traced to the English Statute of Monopolies of 1623.)

[84] Beckerman-Rodau (n 63) 42. (It is believed that 'existence and recognition of property is a fundamental aspect of a free market economy'. Although this may lead to generation of products without any discrimination, it is the marketplace that determines which one is useful or which one should be eliminated.)

[85] Gollin (n 72) 194-195. (IP regime can effectively promote the innovation of ESTs but has limits on the control of the development of those technologies that do harm to the environment. On the other hand, the environmental regime can be used to restrict the use of or eliminate non-environmentally friendly technologies. So it is necessary to consider the environmental impact of technologies in patent examination.)

[86] Joshua D. Sarnoff, 'The Patent System and Climate Change' (2011) 16 (02) Virginal Journal of Law and Technology 302, 336. (It is put forward by William Robinson in his book *The Law of Patents for Useful Inventions* that '[t]o benefit by the discoveries of his fellow-men is thus not only a natural right, it is also the natural duty which every man owes to himself and to society; and the mutual universal progress thence resulting is the fulfillment of the earthly destiny of the human race.')

to their respective rights.[87] The two sides should be able to obtain maximum benefit in a relatively relaxed environment, which is the essence of patent law, with the fulfillment of public interests as the ultimate objective.[88]

A seesaw struggle is witnessed between holders and users. With limited patent coverage and a short time span, inventors are unable to recover their investment, which inevitably weakens the incentive for innovation. On the contrary, where the scope of patent protection is excessively wide and the duration is longer than it should be, social cost is greater than social benefit, and eventually the loss is transferred to the public.

As the public sphere is gradually eroded and alienated, the imbalance between public and private interests has grown all the more obvious.[89] This is reflected in a tendency to extend the scope and duration of patent protection. The substantive elements of drugs are examined in a more liberal manner and more pharmaceutical substances are protected. Similarly, green channels and other preferences are especially applicable to ESTs, effectively extending the actual duration of patents. The two cases indicate that a fulcrum point is approaching in respect of the protection of private rights. As a result, public health is likely heading into a crisis caused by increasingly difficult access to patented drugs, and global efforts against climate change would be less effective without improved access to ESTs.

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[87] Jeremy de Beer, Chidi Oguamanam, 'Intellectual Property Training and Education: A Development Perspective' (2010) 31 ICTSD Programme on IPRs and Sustainable Development 2010. (In most cases, IP is too often presented as a tool in the hand of creators and owners for against users, who are deemed as making no contribution to innovations, and correspondingly public interests and development objectives that are important concerns about users are hardly mentioned.)

[88] Henning Grosse Ruse-Khan, 'Sustainable Development in International Intellectual Property Law – New Approaches from EU Economic Partnership Agreements?' (2010) 29 ICTSD Programme on IPRs and Sustainable Development 1, 17. (Public interests are recognized by a three-step test as provided in TRIPS. Special cases refer to 'those which address public interests recognized in Article 8.1 or the concept of sustainable development'. 'Exploitation could be considered 'normal' only if it does not significantly interfere'. Any prejudice caused by good faith measures or believed necessary to 'protect those objectives may be understood as not being 'unreasonable' and 'legitimate' interests of right holders may only be those which sufficiently reconcile the public interests recognized in the WTO/ TRIPS objectives'.)

[89] Debora J. Halbert, 'The World Intellectual Property Organization: Past, Present and Future' (2006) 54 Journal, Copyright Society of the USA 253, 271. (As privatization continues to erode the public's ability to 'exchange creative work freely', resistance is becoming strong, especially when the issue of access to knowledge is involved, seen from a development agenda for WIPO.)

As a branch of private laws that deals with the relationship between individuals in an organized society, patents protection created for innovative results inevitably restrains access to patented drugs and ESTs. With occurrence of global public health crises and environmental problems, the importance of integrating public interests into patent laws is increasingly highlighted by the challenges the patent system has to face.[90] Efforts are thus intensified, both at an international and domestic level, to strengthen the degree of consideration of public interests through measures such as examination of patentability, compulsory licensing, parallel imports and exceptions to exclusive rights, all of which clearly show characteristics of public laws has been incorporated into patent legislation.[91]

4.2.1 Compulsory Licensing

4.2.1.1 Justification of Compulsory Licensing in Drugs and ESTs

First appearing in the Paris Convention, the provision of compulsory licensing has been further developed and refined in TRIPS, in which the implementation conditions and scope were deliberately extended and the restraints on the use of compulsory licensing were strongly emphasized.[92] Adequate remuneration is a

[90] Matthew Rimmer, 'Patents for Humanity' (2012) 3 (2) the World Intellectual Property Organization Journal 198. (Professor Brad has noted that the patent system is not designed as a regulatory instrument just for economic goals. Although no one could dispute that the patent system takes an important position in macroeconomic policies, no argument is supportive on exclusion of external factors such as the impact of technologies on the environment or public health from the core of the patent system. It cannot be taken for granted that practices, rules or concepts in the past few centuries are convincing strongly enough to insist in believing that the patent system functions merely as an economic incentive. On the contrary, the patent system has occasionally played a non-economic role.)

[91] Jerome H. Reichman, 'Intellectual Property in the 21st Century: Will the Developing Countries lead or Follow?' (2009) 46 (4) Houst Law Review 1115, 1152. (WIPO's Development Agenda encourages more than talks and developing countries make efforts in 'implementing model TRIPS-compliant flexibilities in their own domestic laws'. For example, China interpreted the 'public order' exceptions to patentability in Article 27.2 of TRIPS in its third version of Patent Law: 'any invention-creation that is contrary to the laws of the State or social morality or that is detrimental to the public interest'. Based on this provision, China regulated for the first time access to genetic resources.)

[92] Paragraph 2, 3 and 4 in Article 5 (A) of the Paris Convention provide conditions and restrictions for compulsory license and in Article 31 of TRIPS the term of 'other use without authorization of the right

crucial manner of compensating non-voluntary licenses provided for in TRIPS, but in many cases, the public interest reflected in compulsory licenses clearly outweighs the importance of the particular economic benefits to related industries.[93]

According the TRIPS, the hypothesis that the public interest is in danger or that patent rights are abused is the primary consideration for the use of compulsory licensing. It is viewed as an elaborate defensive barrier, though public interests or abuses of patent rights could be construed differently.[94] It is provided in Paragraph 4 Article 271 (d) Consolidated Patent Law of the United States of America that failure to work, insufficient working, or failure to sell patent products at the lowest price possible to customers is not a cause for compulsory licenses.[95] From practical needs to responses to continually emerging circumstances such as national defense security, environmental protection, and treatment of sudden sickness and infectious diseases, compulsory license has become an important tool in dealing with national emergencies or public security crises.[96]

It is highly controversial whether climate change or public health crises in certain poor countries could justify the implementation of compulsory licensing for access to ESTs and drugs. Despite being characterized as public goods, the externality of ESTs and drugs is different in certain respects from that of other public goods, such as road

holder' is used to replace 'compulsory license' and such use is subject to a series of specific provisions.

[93] Nitya Nanda, Nidhi Srivastava, 'Clean Technology Transfer and Intellectual Property Rights' (2009) 9 (3) Sustainable Development Law & Policy Spring 2009 42.(It is confirmed by the Doha Declaration that the use of compulsory license in the name of public interests shall be respected and relevant provisions of TRIPS shall provide more input in issues of public health.)

[94] The defensive function of compulsory license is explicitly illustrated in TRIPS Agreement Article 31 (b) 'such use may only be permitted if, prior to such use, the proposed user has made efforts to obtain authorization from the right holder on reasonable commercial terms and conditions and that such efforts have not been successfully within a reasonable period of time'.

[95] The United States of America, *Consolidated Patent Laws*, enters into force in July 19 1952, revised in May 2014 < http://www.wipo.int/wipolex/en/details.jsp?id=14870> accessed on 12 December 2014.

[96] Carlos M. Correa, 'Intellectual Property Rights and the Use of Compulsory Licenses: Options for Developing Countries' (1999) Trade-related Agenda, Development and Equity Working Paper, South Centre, 1999 <http://www.iatp.org/files/Intellectual_Property_Rights_and_the_Use_of_Co.pdf> accessed on 10 October 2014. (The role of compulsory license has been considerably stressed in lessening the adverse impact of exclusive monopolies and the danger of conflicts between right holders and the public in terms of dissemination and accessibility of knowledge, innovation and affordability to cost of innovation.)

lamps, which can be kept under control relatively easily due to high scarcity.[97] In the most extreme case, a veil is drawn over ESTs and drugs under the protection of trade secrets, which certainly adverse to the diffusion and application of technologies. Patents have long been accepted as an effective means of curbing externalities and guaranteeing continuous innovation.[98]

According to the prior analysis, however, the positive externality of drugs and ESTs is urgently needed for the control of diseases and environmental degradation by means of patent disclosure, technical exchange and reverse engineering besides patent licenses, which is the most effective albeit a costly way to access patented products.[99] As Thomas Webster stated in 1864, just like the requisition of land for the purpose of public interest, compulsory licensing is applicable for public demands, and thus should be regarded as a reasonable interference in the externality of drugs and ESTs.[100]

4.2.1.2. Discrepancy in Legislation and Practice of Compulsory Licenses concerning Drugs and ESTs

In the face of major public health issues affecting pharmaceuticals, a compulsory license specially for drugs has been formulated in both developed and developing countries, despite glaring discrepancies in legislation and practice. Compulsory

[97] Samuelson and Nordhaus (n 5) 37. (According to the definition, the road lamp is a typical example of a public good with a positive externality. Its adequate private production will not occur because 'the benefits are so widely dispersed across the population that no single firm or consumer has an economic incentive to provide the service and capture the returns'. Therefore, the road lamp is a good with high scarcity and can only be provided by governments.)

[98] Copenhagen Economic A/S and the IPR Company APS, 'Are IPR A Barrier to the Transfer of Climate Change Technology' (2009) Report Commissioned by the European Commission DG Trade <http://www.copenhageneconomics.com/Website/Publications/Energy---Climate.aspx> accessed on 9 October 2014. (It is concluded in this report that a high level of patent protection can stimulate domestic innovation and technology transfer for emerging countries which will gain profits from sufficient market competition.)

[99] Padmashree Gehl Sampath, John Mugabe and John Barton, 'Realizing the potential of the UNFCCC Technology Mechanism: Perspectives on the Way Forward' (2012) Issue Paper No. 35 ICTSD Programme on Innovation, Technology and Intellectual Property May 2012.

[100] Edith Elura Tilton Penrose, *The Economics of the International Patent System* (Baltimore, The Johns Hopkins Press 1951 ISBN 0-8371-6653-5) 164.

license has undergone an appreciable change within the field of medicine, from extensive use to cautious and flexible application as a form of powerful deterrence. Such use can be seen in the practice of governments reaching price-reducing agreements with drug patent holders within a short period, through use of a compulsory license as a bargaining chip when responding to national emergencies. One famous example is that the German pharmaceutical company Bayer signed and concluded such an agreement respectively with the U. S. and Canada on Cipro, a kind of drugs for anthrax treatment, before the two governments officially issuing a compulsory license and announcing the suspension of the Cipro patent.[101]

In contrast, though compulsory licenses are provided for in detail in the patent law of many developing countries, actual use of compulsory licensing suffers great restrictions from home and abroad, playing an ineffective role as an anointed dog catcher.[102] In addition to a viable legal basis and administrative procedure, the level of local technological development and production capacity is an essential foundation for the implementation of compulsory licenses. The compulsory license in the pharmaceutical industry, which is supported by the Indian government, could be counted as an example of successful implementation of TRIPS flexible terms.

Compulsory licenses occupy a special place in the Indian patent system. The 2002 Patent Law Amendment includes the reasons that may justify the grant of compulsory licenses, such as non-commercial use for public purposes, misuse of monopoly in technology transfer, failure to work by patent holders, patented products

[101] James Thuo Gathii, 'The Legal Status of the Doha Declaration on TRIPS and Public Health under the Vienna Convention on the Law of Treaties' (2002) 15 (2) Harvard Journal of Law & Technology 292. (It is recommended in the Doha Declaration that each provision of TRIPS shall be interpreted in the context of the objective and principles set up in TRIPS, which is the gospel for the Members that may have the similar experience with the United States and Canada who decided to override Cipro patents when met with the threat of the anthrax.)

[102] Kalpana Murari, 'Transfer of Technology in A Post-Kyoto Framework' (2010) Working Papers Series 2010, 8 <http://ssrn.com/abstract=1909468 or http://dx.doi.org/10.2139/ssrn.1909468> accessed on 20 April 2013. (The treatment of ESTs is not contained in TRIPS which just excludes technologies from patentability, and State Members are allowed to resort to compulsory license for enhancing access to ESTs only if 'climate change effects tantamount to national emergency, an argument that has been refuted by most of nations', indicating that compulsory licensing is not reliable on the issue of accessibility of ESTs.)

at unaffordable prices, the protection of public health and nutrition, insufficient working, national emergencies and other urgent circumstances, failure to satisfy reasonable public demand for patented products, and the development of Indian core technology sectors.[103] Further, in the 2005 Amendment, the Indian patent system opened its door to agricultural and pharmaceutical products, and the use of compulsory licensing is extended to the supply of other regional markets or countries without drug production capability, as long as these regions or countries agree to accept such imported products in the form of an official written document.[104]

Unfortunately, given the interests of patent holders in developed countries, it is inevitable that the use of compulsory licensing authorized in developing countries will meet with opposition and retaliation. The provisions concerned compulsory licenses in South African Medicines and Related Substances Amendment Act[105] was vigorously opposed by the U.S. government and many international pharmaceutical companies.[106] With the same experience, Brazil showed a public expression of indignation and disappointment at the defamation that Brazil was described as 'a piracy-lenient countries' for its flexible use of compulsory license subject to WTO rules.[107]

As far as ESTs are concerned, justification of compulsory licensing is still in

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[103] Article 84 of *India Patents (Amendment) Act (2002)*. *The Patents (Amendment) Act of 2002* is the second amendment to the Patent Act of 1970, viewed as an effort to ensure that the patent regime of India meets the requirement of TRIPS.

[104] The new Article 92 (A) 'Compulsory licensee for export of patented pharmaceutica1 products in certain exceptional circumstances' was added in *India's Patent (Amendment) Act 2005*.

[105] South Africa, the Medicine and Related Substances Amendment Act (Act No. 59 of 2002) < http://www.wipo.int/wipolex/en/details.jsp?id=13099> accessed on 10 October 2014.

[106] James Thuo Gathii, 'The Legal Status of the Doha Declaration on TRIPS and Public Health under the Vienna Convention on the Law of Treaties' (2002) 15 (2) Harvard Journal of Law & Technology 292.

[107] Latif, 'Change and Continuity in the International Intellectual Property System: A Turbulent Decade in Perspective' (n 4) 38. (In the WIPO Standing Committee on Patents of 2010, Brazil offered an expression of its experience in using compulsory licensing in its proposal:

> 'During the post WTO period, after a long period of negotiations, the government of Brazil decided in May 2007 to sanction the compulsory licensing of an antiretroviral drug in order to address urgent public health problems. Our country then suffered an intense discredit campaign led by some international actors, as if it was ignoring the rules agreed by all WTO Members, with which we fully complied. The defamatory process cast on Brazil an inconvenient image of a piracy-lenient country. Is this what we should expect from the supporters of the current system? '.)

debate. Even if it is approved, an attitude towards undifferentiated use is adopted in majority of developing countries. For example in China's Patent Law, no special provisions of compulsory licenses are formulated for other fields except drugs and semi-conductor technologies. As such, the use of compulsory licensing in patented ESTs is generally permitted on the basis of prevention of patent abuse, public interests or earlier patents.[108]

By contrast, the EU, the U.S. and some other developed countries and organizations combine the protection of ESTs with environmental law or special laws and regulations concerning climate change, creating applicable conditions for use of compulsory licenses in the field of ESTs. It is clearly provided in the USA Clean Air Act that the party involved may request the court to issue compulsory licenses with sufficient reason that the use of certain patented EST could help to meet mandatory reduction targets set up by the Environmental Protection Agency, if the exhaustion of any other reasonable possibility has failed to get patent licensed.[109] This demonstrates that compulsory licensing is incorporated into environmental or climate-related bills and administrative regulations, though it has not been explicitly recognized in the

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[108] China, Patent Law of the People's Republic of China (as amended up to the Decision of December 27, 2008, regarding the Revision of the Patent Law of the People's Republic of China) Chapter 6 Compulsory License for Exploitation of a Patent < http://www.wipo.int/wipolex/en/details.jsp?id=5484> accessed on 12 December 2014. (As for the ground of earlier patents, it is regulated in Article 51 as follows:

> 'If an invention or utility model, for which the patent right has been obtained, represents a major technological advancement of remarkable economic significance, compared with an earlier invention or utility model for which the patent right has already been obtained, and exploitation of the former relies on exploitation of the latter, the patent administration department under the State Council may, upon application made by the latter, grant it a compulsory license to exploit the earlier invention or utility model.')

[109] The United States Environmental Protection Agency, the Clean Air Act 1970 < http://www.epw.senate.gov/envlaws/cleanair.pdf> accessed on 23 December 2014 (As Amended through P.L. 108–201 in February 24, 2004, Section 308 of the Clean Air Act stipulates the terms and conditions for mandatory licensing, which must meets the standard that:

> ' (1) (A) in the implementation of the requirements of section 111, 112, or 202 of this Act, a right under any United States letters patent, which is being used or intended for public or commercial use and not otherwise reasonably available, is necessary to enable any person required to comply with such limitation to so comply, and (B) there are no reasonable alternative methods to accomplish such purpose, and (2) that the unavailability of such right may result in a substantial lessening of competition or tendency to create a monopoly in any line of commerce in any section of the country.')

USA Patent Law.[110] It finds that such a legislative model cleverly circumvents restrictions on the use of compulsory licensing in TRIPS, and relaxes the growing acute conflict between compulsory licensing and patent protection.[111]

From its use as a remedy against patent revocation to recognition of its important role in preventing or inhibiting abuse of a patentee's legal monopoly, compulsory licensing is not as vilified within the internal EU market as it is in international climate negotiations.[112] A consensus has been reached among EU member states that compulsory licensing can be authorized for public interests, or a failure to work, where such failure or insufficient working is justified by legitimate legal, technological or commercial causes.[113] On the issue of climate change, the EU, relying on its advantages in advanced patented ESTs, plays a positive role in promoting the international climate negotiations and has made a promise to provide financial assistance to developing countries.[114] EU representatives have reiterated on the international stage that IPRs will never be an obstacle to addressing climate change; only through adequate protection of ESTs can effective technology transfer be facilitated. Such statements indicate that the local grant of compulsory licenses is undesirable as it is opposed to local market access of ESTs that are controlled by the

[110] Deborah Behles, 'The New Race: Speeding up Climate Change Innovation' (2009) 11 (1) North Carolina Journal of Law & Technology 1, 31. (In addition to *the Clean Air Act*, there are regulations on the exercise of policies and procedures made by EPA for the issuance of mandatory licensing that meets all the necessary conditions. Moreover, Section 203 (a) in *35 United States Code* is another provision that authorizes the government to grant licenses for such EST-related patents held by small business and non-profit organizations but funded by governments.)

[111] Ibid 32. (It is noted that because of those stringently-defined conditions and procedures for applying mandatory licensing, it is hardly surprising that it has never been used.)

[112] European Union, *Regulation (EC) 816/2006* < http://www.wipo.int/wipolex/en/details.jsp?id=1454> accessed on 23 December 2014. (Compulsory licenses in the Europe Union evolve from the declare void of patents in the UK Statute of Monopolies 1623 to the unification Regulation Law passed by the European Parliament, and the Council on 17 May 2006 on compulsory licensing of patents concerning the manufacture of pharmaceutical products for exports to countries with public health problems.)

[113] European Patent Office, the Implementation of the TRIPS Agreement (1997) Committee on Patent Law < http://documents.epo.org/projects/babylon/eponet.nsf/0/C4D31B38251E85DFC125728000456427/$File/capl_97003_en.pdf> accessed on 10 September 2014.

[114] Mulugeta Getu, 'Accommodating the Interests of Developing Countries in the Climate Change Regime: Lessons from the Ozone Layer Regime' (2012) 6 (1) Mizan Law Review 1.

EU.[115]

The world leaders in ESTs devote their efforts to patent protection, and at the same time pay much attention to restrictions on patent misuse. This is reflected by the use of compulsory licenses and exceptions of exclusive rights within patent systems, as well as the relevant provisions in national anti-monopoly and competition laws. It is because of the domestic legal systems in which rights are prevented from being abused and various interests are relatively compatible that those countries adopt a tough attitude towards any relaxation of international patent protection, especially in relation to patented drugs and ESTs.[116]

Theoretically speaking, from a domestic perspective, compulsory licenses make it possible that comparative advantages in leading areas are strengthened as a whole.[117] From the international standpoint, compulsory licenses can promote smooth flow of drugs and ESTs from supplier countries to recipient countries, or from subsidiaries of multinational corporations to local businesses, so as to address public health issues and clear away obstacles to solving climate mitigation and adaption. With its obvious domestic and international spillover benefits, use of compulsory licenses is thus of great significance for access to drugs and ESTs.

Nevertheless, the local use of compulsory licensing for ESTs in developing

[115] Matthew Rimmer, 'A Proposal for a Clean Technology Directive: European Patent Law and Climate Change' (2011) 3 Renewable Energy Law & Policy Review 195. (The EU seems to have a love-hate relationship with compulsory licensing. Despite proposing to modify TRIPS to increase access to essential ESTs by the use of compulsory licenses within the strict patent protection framework, the EU treated the proposals on compulsory licensing on EST-related patents in an unfriendly manner and shrank with particular reluctance from any risk of estranging its technical advantages.)

[116] Mohammed K El Said (n 38) 78. (With the shift of their production policy from local production to external orientated export sectors, the industrial countries such as the US and EU intensify efforts to enhance the level of international patent protection 'in order to maintain their technological comparative advantage and to appease their expanding influential local industries', so it is conceivable that any attempt to relax the IP protection must have been strongly disagreed by these countries.)

[117] Henning Grosse Ruse-Khan, 'Sustainable Development in International Intellectual Property Law – New Approaches from EU Economic Partnership Agreements?' (2010) 29 ICTSD Programme on IPRs and Sustainable Development 1, 24. (According to Compare M. Trebilcock & R. Howse, 'whenever the comparative advantage of a country in a specific industry or field of technology lies more in production based on imitation than innovation, trade and economic theory suggest that such a country should adopt an IP regime which allows some extent of imitation.' In this sense, compulsory licensing is a tool to increase access to much needed technologies that can strengthen comparative advantages of local production.)

countries is uncertain, due to the limited technological capabilities, immature legislation and enforcement of IPRs within those areas. As may be gathered from this study, there is also an increasing risk of abuse of EST-related patents.[118] The development of ESTs is one of the main driving forces of the internationalization of patent protection. As such, alongside the expansion of patent protection, the establishment of compulsory licenses for ESTs is both inevitable and necessary to respond to the growing demand for ESTs. No compulsory license can be created 'one size fits all' and applied automatically to each case; accordingly, the flexibility of use in different cases is the future trend in the development of compulsory licenses.[119]

4.2.2 The Parallel Import

4.2.2.1. Analysis of the Justification of Parallel Import in Drugs and ESTs

It is highly controversial whether the parallel import is strictly legal. It is the exclusive import right of patent holders provided in Article 28 of TRIPS, but whether this exclusive right could legally prevent parallel imports depends on the principle of exhaustion of patent rights adopted in that particular country.[120] As for domestic or international exhaustion, no generally unified standard is established in TRIPS. Further detail could be found in the Doha Declaration, which provides that each Member State is free to determine its own system of IPR exhaustion, which shall not

[118] K.Ravi Srinivas, 'Climate Change, Technology Transfer and Intellectual Property Rights' (2009) Research and Information System for Developing Countries Discussion Paper RIS-DP#153,2009. (Even if it is available to guard against abuse of patent rights in developing countries, the application of competition policy might meet with difficulty when conditions that are anti-competitive or have restricting effects on the rights of licensee are included in technology transfer contracts.)

[119] Article 31 (a) of TRIPS permits the authorization of compulsory licensing to 'be considered on its individual merits', meaning that the use of compulsory licensing on a case-by-case basis is not contradictory with the obligations of TRIPS.

[120] A comment is added to the term of 'import' in Paragraph (a) Article 28 that the right of import as granted as the right of use, sale and distribution under this Agreement shall comply with Article 6 which provides that as far as the dispute settlement under this Agreement concerned, any provision of this Agreement shall not be used to deal with the principle of exhaustion of IPRs in compliance with Article 3 and Article 4.

be challenged by the WTO dispute settlement system.[121] Obviously, in TRIPS the issue concerning exhaustion of IPRs is treated separately from parallel import, meaning that each Member State has the right to develop its own parallel import system based on national circumstances, subject to the principle of most favored nation treatment and national treatment.[122]

From the economic angle, differential pricing is the key condition for the implementation of parallel imports, i.e. the import and sale of products patented and protected in both the product's home territory and the country receiving the import, without the authorization of patent owners in the recipient country, at a lower price.[123] As the parallel import involves market share and expected earnings of patented products, a widespread controversy arises. The economic justification of parallel imports is analyzed as follows.

Along with the in-depth development of trade globalization, the application procedure under PCT is widely used so that one innovation could be protected in multiple countries. An assumption is made that while a patented product or technology X is protected in both Country A and Country B, a obtains the license of X by paying license fee F in Country A, and intends to import X from Country A for sale in Country B where a is not granted a license.

According to Table 1, it is known that X is exported by a from Country A at the price P_0 and sold at the price P_1 in Country B, and at the same time b is authorized to sell X at price P_2 by paying the license fee F_1 in Country B. The import of X to Country B is likely to have a real impact on the legal sale of X by b in Country B because of the difference in the respect of license fee and other costs between Country

[121] The Doha Declaration on the TRIPS Agreement and Public Health (hereinafter referred to as the Doha Declaration) adopted by the WTO Ministerial Conference of 2001 in Doha on November 14, 2001 WT/MIN(01)/DEC/2. http://www.wto.org/english/thewto_e/minist_e/min01_e/mindecl_trips_e.htm.

[122] Cameron Hutchison, 'Does TRIPS Facilitate or Impede Climate Change Technology Transfer into Developing Countries?' (2006) 3 (2) UOLTJ 517, 534-535. (It is arguably believed that under TRIPS, a country is allowed to adopt a rule of international exhaustion and thus 'a licensee could theoretically supply an export market without infringement, subject to rules of exhaustion in the export country'.)

[123] Ibid. (Competitive differential pricing is the main force to support parallel import which 'allow developing countries to purchase cheaper imported patented products'.)

A and Country B that makes $P_0 < P_1 < P_2$.

Country	License Fee	Other Cost	Total Cost	Price	Benefit
A	F_0	C_0’	C_0	P_0	$P_0 - C_0$
B	0	C_1	C_1	P_1	$P_1 - P_0 - C_1$
B	F_1	C_2’	C_2	P_2	$P_2 – C_2$

Table 1 (Self-compiled)

When P_1 and P_2 are almost of the same and P_0 plus C_1 is less than C_2, the exported X from Country A to Country B still has a price advantage, indicating that whether the license fee is charged or not does not necessarily have a causal relation to differential prices of the same product in different markets.[124] Generally, the license fee of a patent is associated with numbers produced by licensees or sub-licensees, so in the parallel import trade the license fee paid by manufacturers eventually flows into the pocket of patent holders. When P_1 is greater than P_2, the price advantage of the imported goods to Country B no longer exists, and a will not make an effort to import X from Country A in a rational case.

Products or technologies protected under PCT are undoubtedly important sources of global innovation, but the contribution made by patent holders to the growth of patent applications under PCT will remain unchanged, even if patents are protected in several countries. It is only through study on the market of an individual country that the contribution of innovative results to marginal productivity and innovation efficiency can be expressed.[125] Assuming that the average cost price of a product or

[124] Alireza Naghavi, ‘Strategic Intellectual Property Rights Policy and North-South Technology Transfer’ (2005) 18 The Fondazione Eni Enrico Mattei NOTA DI LAVORO 2005<http://www.feem.it/Feem/Pub/Publications/WPapers/default.htm> accessed on 19 May 2016. (Differential pricing of the same product in different markets is also known as ‘an economically rational way for multinationals to maximize their profits on products that are sold in both low and high income markets’.)

[125] Bhaven N. Sampat, ‘The Bayh-Dole Model in Developing Countries: Reflections on the India Bill

service with a long-term demand from a certain market declines from C to C' thanks to the introduction of new products or technologies, the aggregate license fee of new patented goods is the product of quantity and license fee per unit. Within the patents' validity period, the license fee is determined by patent owners who may be awarded by fixed fee or royalty so as to reach maximum gain.

For technology transferees, the average total cost, equal to the sum of C' and license fee per unit, is necessarily less than C, or else transferees continue to use old technologies rather than new ones.[126] In view of the strategy of maximizing the quantity of patents adopted by leaders in EST innovation to enter the international market, the production cost will be increased quickly within a short period when the transferee is charged for a group of patents separately.[127] Meanwhile, fees charged on the basis of the number of countries that the patented goods flows through apparently increase unit cost, going in the opposite direction of encouraging transfer and diffusion of ESTs.

4.2.2.2 Applicability and Problems of Parallel Import in Drugs and ESTs

In accordance with the growth rate of patent applications and groups of technology based the world standard of patent share under PCT, drugs belong to the mature technology group, and foreign manufacturers can produce alternative drugs of the same quality after the expiration of innovative drug patents.[128] Numerous

on Publicly Funded Intellectual Property' (2009) UNCTAD-ICTSD Project on IPRs and Sustainable Development Policy Brief No.5 2009. (According to the study made by economic historians, the same case exists in both developed and developing countries that getting knowledge and technologies into the public domain is known as one of the main ways publicly-funded innovation activities make contribution to social productivity and innovation efficiency.)

[126] Hall and Helmers, 'The Role of Patent Protection in (Clean/Green) Technology Transfer' (n 2) 4. (It is submitted by the authors that a strong price signal that indicates energy price will remain obstinately high and subsidies that are granted much enough to offset fixed cost will serve as magic keys to successful persuasion for potential users to replace existing technologies with ESTs.)

[127] Knut Blind, Katrin Cremers and Elisabeth Mueller, 'The Influence of Strategic Patenting on Companies' Patent Portfolios' (2008) ZEW Discussion Paper No.07-013 <http://econstor.eu/bitstream/10419/28615/1/611335573.pdf> accessed on 12 December 2014.

[128] Neel Maitra, 'Access to Environmentally Sound Technologies in the Developing World: A

modifications and combinations appear as generics at this point in developing countries. With the standardization of drug manufacture, the role of drug patents is weakened. The mass production of drugs is then transferred into places that have comparative advantages in terms of capital or other non-technical factors of pharmaceutical business, not only for the supply of the domestic market but also for the country where innovative drugs are generated as well as within certain other counties.[129]

The parallel import is regarded as an effective way to enhance access to drugs by ensuring that cheaper drugs are available to countries with small pharmaceutical manufacturing capacity.[130] In other words, the parallel import enables consumers to purchase effective drugs from the global market. It argues, however, that the principle of international exhaustion in the parallel importation clashes with the exclusive right to import and non-discrimination treatment as to the place of invention, which 'do not unreasonably conflict with a normal exploitation of the patent' and 'do not unreasonably prejudice the legitimate interests of the patent owner' provided in

Proposed Alternative to Compulsory Licensing' (2013) 35 (2) Columbia Journal of Environmental Law 408. (In this article, the author has a different conclusion when it comes to comparison of ESTs and pharmaceuticals. Based on the study of three selected sectors of ESTs, solar, bio-fuels and wind energy, it finds that ESTs belong to mature technologies, most of which are entering into the public domain, showing difference from pharmaceuticals whose basic research continues shift rapidly. Obviously, the term of 'mature' here is relative. In some specific industries, there are always mature and emerging technologies or previous and subsequent technologies.)

[129] The WHO Report, 'Local Production for Access to Medical Products : Developing a Framework to Improve Public Health' (2011) The Report comes from the Joint Project largely conducted by the World Health Organization (WHO), the United Nations Conference on Trade and Development (UNCTAD), the International Centre for Trade and Sustainable Development (ICTSD) on 'Improving access to medicines in developing countries through technology transfer and local production' <http://www.who.int/phi/publications/local_production_policy_framework/en/> accessed on November 21, 2013. (It is believed that local production plays an irreplaceable role in the global pharmaceutical supply chain on the ground that 'local firms can offer price-based competition in the market and improve affordability, can produce products for local needs that either are not produced at all by the multinational companies or are in short supply, and can be more adept at creating distribution networks that cater to the needs of poor people in remote areas'.); Mohammed K El Said (n 38) 73. (Mass production of products and reduction of cost is more likely to achieve with the improvement of technologies which makes the duplication and mass reproduction more feasible, or in other words makes more countries become the beneficiaries of positive externality.)

[130] South Africa, South African Medicines and Related Substances Control Amendment Act Article 15 (c) b the Minister of Health is authorized to approve the parallel import to increase the availability of any drugs against national public health crisis subject to some basic conditions provided in the Act.

Article 30 of TRIPS.[131]

The applicability of parallel import to ESTs is quite different from that of drugs. Countries that occupy a position of prominence in the difficult innovation of ESTs, which are grouped as emerging technologies with high-quality patents, take the lead in introducing new ESTs into market. Due to strong market demand, patent holders who have incomparable advantages can make pricing decisions that are most beneficial to their own investment recovery and expected earnings as soon as possible. On the other hand, in the light of demand and supply of patented technologies being key determinants of price, countries plagued by the limitation of technology innovation are incapable of timely absorbing new ESTs; their advantages in non-technical factors have not yet surfaced, resulting in indistinct difference in prices.[132] Even more importantly, the innovation of ESTs involves the development of high-tech clusters that are protected in patents or other forms of IPRs; various technical elements are brought together to form a new patent portfolio in the innovation process of one EST that generally contains a core patent and certain basic patents. In such cases, tort actions are easily triggered in the parallel import of ESTs.[133]

As illustrated, the parallel import may not work as well in improving accessibility of ESTs as it did in the enhancement of accessibility of drugs.[134] Relatively high

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[131] Frederick M. Abbott, 'Discontinuities in the Intellectual Property Regime, The TRIPS-Legality of Measures Taken to Address Public Crises: a Synopsis' (2001) 7 Widener Law Symposium Journal 71.

[132] Daniel K. N. Johnson and Kristina M. Lybecker, 'Financing Environmental Improvements: A Literature Review of the Constrains on Financing Environmental Innovation' (2009) 08 Colorado College Working Paper 2009. (At the different stage of innovation life cycle, demand and supply sides play different roles. In the early stage of innovation, supply side forces are more important and as the innovation matures demand side forces become more important when IP protection may work well. It often happens that both supply and demand side forces may be weak as far as ESTs are concerned.)

[133] Bernice Lee, Ilian Iliev and Felix Preston, 'Who Owns Our Low Carbon Future?' (2009) A Chatham House Report on Intellectual Property and Energy Technologies <http://www.chathamhouse.org/sites/default/files/public/Research/Energy%20Environment%20and%20Development/r0909_lowcarbonfuture.pdf> accessed on 3 May 2013. (The research on patent analysis shows that there are a number of high-profile patent litigations in wind and solar PV sectors where technologies are being developed rapidly. In the cases where 'the enforcement of licensing business model frequently depends on a credible capability to enforce a patent portfolio', litigation rates are likely to increase when different technologies in one system enter into commercial exploitation.)

[134] Maskus and Okediji (n 14) 38. (Although developing countries and least developed countries are

license fees or royalties charged by patent holders result in greater average cost than before the use of new technologies, which is clearly unfavorable for the diffusion of ESTs. Patent holders' interests, on the other hand, could be guaranteed by improved production and partly decreased unit license fees.[135] Accordingly, permission for the parallel import of peripheral patents could be a good way to improve the manufacture and application of ESTs, by making full use of comparative advantages.

4.3 Conclusion: the Lessons from Heated Debate on Pharmaceutical Patents and Public Health

The objective of this chapter is to provide some lessons for the consideration of an appropriate form of patent protection for ESTs, by full use of the benefits of international reconciliation between pharmaceutical patents and public health. The lessons learned from the heated debate on patents and public health has contributed to paving the way by providing a new perspective to deal with patents and access to ESTs in the light of climate change.

Before any conclusion can be made regarding the substantive requirements of EST patents, the comparison between ESTs and drugs is very appropriate. From a user-friendly perspective, it is obvious that ESTs and drugs have dual attributes as public goods and private products. Due to these dual attribute, EST patents and drug patents are endowed with other than economic value, i.e. the non-economic value, and thus the patent protection of ESTs and drugs should be treated differently.[136] The

permitted to 'elaborate and exercise exceptions and limitations to IPRs in their national jurisdictions', it is questionable whether compulsory licensing and parallel importation will be effective as expected to enhance access to ESTs, especially when associated technical data, know-how and other patented information which are integral to the effective utilization or adaptation of ESTs are involved.)

[135] Jean O. Lanjouw, 'A New Global Patent Regime for Diseases: U.S. and International Legal Issues' (2002) 16 (1) Harvard Journal of Law & Technology 85. (Licensing fees or royalty contracts make patent owners charge 'on the size of profits that those who use the tools can obtain on resulting products' or entitle owners to the share of a percentage of the final product sales.)

[136] Estelle Derclaye, 'Patent Law's Role in the Protection of the Environment: Re-assessing Patent Law and its Justification in the 21st Century' (2009) 40 (3) International Review of Intellectual Property and Competition Law 249. (Since the modern patent law already performs a number of non-economic

attribute of imperfect public goods enables ESTs and drugs to monopolize the market. In view of the advancement of technologies, unfortunately, the substantive requirements (especially the requirement of inventiveness) did not pay adequate attention to the role of the positive externalities of both ESTs and drugs, viewed as a kind of critical input in the creation process, in meeting public demands and benefits.[137]

Due to the differences between drugs and ESTs, the refusal to make any response to the conflicts between EST-related patents and climate mitigation should be alerted, and efforts on the development of an appropriate patent protection on the basis of ESTs' own characteristics are worthwhile. Given their respective conceptual characteristics, technological development and market demand, patent grant requirements for ESTs are different to those of drugs. In comparison with the pharmaceutical industry, which heavily relies on fundamental research, there is more emphasis on the social value of investment on developing applications of ESTs, which need complementary research due to their complexity.[138]

At least four lessons could be drawn from reconciliation of patents and access to ESTs. First, it is necessary to introduce a public interest clause into the rules of EST patent protection and substantiate closely-related claims, since the profit-oriented innovation drive will not place public demands as the top priority.[139] The heated

roles, the proposition that 'patent law can be used for other than purely economic ends, for instance, as a tool to regulate the impact of technology on the environment or health', does not sound alien.)

[137] Cristiano Antonelli, 'Compulsory Licensing: the Foundations of an Institutional Innovation' (2013) 157 The WIPO Journal 1. (According to the author, the positive externalities of ESTs and drugs as a kind of technological knowledge are 'at the same time an output and an input of the recombinant generation of new technological knowledge, and external knowledge is an essential, or even indispensable, input. Eventually knowledge enters the production function of all goods; as such, it is a double input: an input into the generation of new technological knowledge and an input into the generation of all the other goods'.)

[138] Robert Cooter and Thomas Ulen, *Law and Economics* (Addison Wesley Pearson 2007 5th edition) 129. (It is generally believed that in order to make patent system work efficiently, a trade-off analysis is necessary. 'If the social value of investment on fundamental research exceeds the social value of investment on developing applications, then patents should be broadened. Conversely, if the social value of investment on developing applications exceeds the social value of investment on fundamental research, then patents should be narrowed.')

[139] Keith E. Maskus, 'Intellectual Property and the Transfer of Green Technologies: an Essay on Economic Perspectives' (2009) WIPO Journal 2009, 1. (Technology transfer mediated by IPRs, though

debate on drug patents and public health indicates that within particular context should public interests be interpreted. Although what ESTs and drugs have most in common is the public interest with public health as the main content in both forms of patent, the specific public demand for access to ESTs and drugs varies in accordance with their differences.[140]

Secondly, differentiated patent protection of ESTs is feasible in light of the great achievements in the pharmaceutical field, where essential drugs and treatment of infectious diseases is not protected anymore, reflecting the social value of drugs with different functions. As such, it is an inevitable choice to realize optimal access to different ESTs.

Thirdly, it may be unwise to rely too much on compulsory licenses to improve access to ESTs. It is in the field of drugs that the compulsory licensing works in a comparatively successful manner.[141] Compulsory licenses used like a shot in the arm for the pharmaceutical industry can solve a domestic emergent public health crisis promptly. Unfortunately, however, its effect on emission reduction remains to be seen, and the subsequent upgrade of ESTs is still a problem, as it may be more difficult to raise ESTs to a higher stage than to manufacture generic drugs. The main drawback of compulsory licensing lies in that it may be hard to realize the transfer of sophisticated technologies and to enhance local innovation capabilities, especially when complex know-how and technological solutions are involved.[142] Since its actual effect in the

regarded as a matter of purely private market, has great implication for the provision of important global public goods, which is primarily improved by access to knowledge and information.)

[140] Ibid 3. (Specific case study is quite important to answer some basic questions about ESTs because 'ESTs are heterogeneous and the demand for them is context-specific'.)

[141] Charles K. Ebinger and Govinda V. Avasarala, 'Transferring Environmentally Sound Technologies in an Intellectual Property Friendly Framework' (2009) Energy Security Initiative Policy Brief 09-08 by Brookings Institution 1, 7. (Given the differences between ESTs and drugs, it may be not workable through compulsory licensing to facilitate access to ESTs by arguing climate change as a national emergency. 'ESTs require many different technological inputs that involve numerous patents held by different firms, while there is generally only one patent per pharmaceutical product; the climate change abatement technology market is relatively substitutable: generally there is only one drug that can provide a particular medical benefit, compared to the abundant competition for similar clean energy products'.)

[142] Jerome De Meeus and Alain Strowel, 'Climate Change and the Debate around Green Technology Transfer and Patent Rules: History, Prospect and Unresolved Issues' (2012) 3 (2) WIPO Journal 178, 187. (It believes that compulsory licensing is not a right solution to access to ESTs, because 'unlike

field of ESTs is controversial and limited, it is not realistic to use compulsory licensing as the main means of improving access to ESTs. In most cases, it exists basically as a tool of deterrence.

Fourthly, the parallel import of basic and peripheral patents may be a good way to improve the manufacture and application of complex ESTs, by making full use of local comparative advantages, although the parallel import may not work as effectively in increasing access to ESTs in the same way it does for drugs. Again, it is quite difficult to truly think it is going to work with restrictions under international trade rules, nevertheless, if it is carried out to serve a certain market at a regional level, parallel importation might run into less implementation difficulty than on a full international scale.[143]

These lessons mean that the similarities between drugs and ESTs make it necessary to treat ESTs preferentially in the context of climate change, and the differences between them indeed serve as a justification for a differentiated patent regime on the basis of ESTs' own characteristics, which is exactly the focus of next chapter.

pharmaceuticals, climate technologies are not a stand-alone product, they are a "bulk product"; contrary to the "single-supply business model" that predominates in the pharmaceutical market where small volume pills may be sent worldwide from one single place of production, climate technology has to be done locally in cooperation with local industries. ESTs generally form part of a larger product or unit of operation such as a car, a power station or even the energy grid which integrates various elements that should best work together. The transfer of ESTs is thus not likely to produce the expected results if the larger product or unit cannot be adequately produced or replicated.')

[143] Sarnoff (n 86) 334. ('The final recommendation is to make greater use of exhaustion (parallel importation) of patented technologies, preferably on a regional rather than a full international level, when patent owners or their licensees voluntarily supply certain some markets at low costs, to achieve wider diffusion of the climate change technologies.')

Chapter 5 A Specially-designed Patent Regime for ESTs on a Quadrilateral Platform

Climate change, one of the major challenges facing mankind in recent decades, has plagued several generations. In line with the IPCC's report, climate change endangers almost every aspect of human health; thankfully ESTs are advancing rapidly to effectively mitigate its impact.[1] It argues in Chapter 3 that the existing international patent legislation relating to ESTs is not sufficient to improve access to ESTs.[2] Recognized as an incentive that promotes innovation, patents rapidly push forward the development of ESTs with good economic return for innovators, but equally create difficulty in the accessibility of ESTs.[3] How to keep a balance between innovation and access is not a uniquely domestic issue, but indeed an international problem that does not necessarily call for the resolution of technical matters but raises the question of advantage distribution.

The focus of the research in this chapter is to establish a special patent system on an appropriate international platform. Though viewed as a factor of little importance among various economic and market barriers to technology acquisition, patents that do play a significant role in the innovation and protection of ESTs could be used to push the accessibility of ESTs to the greatest extent.[4] The fundamental difficulty in

[1] IPCC, Climate Change 2007 Synthesis Report: an Assessment of the Intergovernmental Panel on Climate Change (2007).

[2] Abbe E L Brown, 'Securing Access to Climate Change Technologies: Answers and Questions' (2010) 21 University Edinburgh School of Law Working Paper Series 1, 6-7. (It is suggested by the author that if restrictions on patents, such as the protection scope, duration and exceptions to patents do not satisfy the needed availability of ESTs, more specific legislations are necessary to force patent holders to share their technologies, which has historically legislative origins, for example the UK Patents Act 1977.)

[3] John H. Barton, 'Intellectual Property and Access to Clean Energy Technologies in Developing Countries: An Analysis of Solar PV, Biofuel and Wind Technologies' (2007) ICTSD trade and sustainable energy series, Issue Paper No.2. (Taking the three technologies, solar PV, biofuel and wind technologies as the case study, it is concluded that IP has some implications on these technologies. One of these implications is that IP access limitations might be barriers or cause delays in obtaining technologies under protection or creating complex production systems of the highest quality.)

[4] Jerome De Meeus, Alain Strowel, 'Climate Change and the Debate around Green Technology Transfer and Patent Rules: History, Prospect and Unresolved Issues' (2012) 3 (2) WIPO Journal 178, 185. (The 2006 UNFCCC Report on 'Economic and Market Barriers to Technology Transfer' for

establishing such a system lies in striking the appropriate balance between the succession of and a deliberate break from traditional patent laws. The balance is crystallized in the purpose of the special patent system and a common set of values shared by stakeholders, which is the prerequisite for the establishment of the proposed regime.[5] Although it is prohibited in TRIPS to treat technologies differently, so as to prevent malicious discrimination in patent laws, necessary preference is not foreclosed for the sake of public interests.[6]

Against the backdrop of growing patent protection, international harmonization of EST patent protection could be helpful to avert the contradictions between patent protection and other public areas. IP systems are an increasingly important part of private property, which must work compatibly with other international commitments, or else ultimately leading to difficult enforcement of international IP rules.[7] With a particular regulative object, legal relationship and regulation method, the regime attempts to break through in the relationship between the innovation and accessibility of ESTs, by locating the emission commitments under the UNFCCC and Kyoto Protocol as the contact point on a quadrilateral platform under the WIPO, UNFCCC, WTO and WHO. Based on their respective functions and duties in the field of IPRs, climate change, global trade and public health (all of which are closely related to the application of ESTs), ensuring consistency and continuity of climate change policies through joint efforts in technical support and policy is the reason why such a platform

non–Annex I respondents found that 'IPR is a factor of minimal significance. Other factors, such as a lack of financial resources, high investment costs, subsidies and tariffs were considered greater barriers to accessing technologies'.)

[5] Daniel Bodansky, 'Climate Change and Human Right: Unpacking the Issues' (2010) 38 (3) Georgia Journal of International and Comparative Law 511. (The solution to climate change involves complex trade-off between different values, which cannot be exactly showed in individual cases.)

[6] Article 27.1 of the TRIPS Agreement.

[7] Estelle Derclaye, 'Not Only Innovation but also Collaboration, Funding, Goodwill and Commitment: Which Role for Patent Laws in Post-Copenhagen Climate Change Action' (2010) 9 J. Marshall Rev. Intellectual Property L. (Special Issue) 657.(In some public areas such as climate change, IP-related solutions must work together with non-IP related solutions, emphasizing the unity in individual and collective commitments.); WIPO, Conference on Intellectual Property and Public Policy Issues (July 2009)< http://www.wipo.int/edocs/mdocs/mdocs/en/wipo_ipgc_ge_09/wipo_ip> accessed on 18 September 2015. (In this conference, many topics in close relation to IP have been discussed, in particular, climate change, public health, food security.)

is chosen. These considerations must be taken into account before any proposal is set in motion.

Due to diversity, complexity and industrial relevance of ESTs, the quadrilateral platform under the auspices of WIPO focuses on the thorough research into the differentiated patent protection of ESTs. The refined and differentiated patent system is demonstrated in two senses: a system discouraging non-environmentally sound technologies, which means greening the innovation environment conforms to the general benefits and progress of society, and a system providing value-based protection for different types of ESTs, which is conducive to reconciling the conflict between dynamic, long-term benefits of IPRs and the short-term objectives of public policy.[8] Accordingly, a structure for EST patent rights that includes intensity, length, width, new classification standard and consideration of public interests is proposed. Furthermore, it constitutes a major adjustment of EST patents model; from maximization to optimization.[9]

From the perspective of social welfare, the law and economics analysis is used to explore an appropriate model structure of patent protection specially designed for ESTs. It considers patentability from the perspective of definitional problems and grant standards of ESTs; length and duration; and the scope of patent validity. Different levels of each of the three dimensions have varying incentive effects on the innovation and accessibility of technologies. Based on the quasi-public nature and major components of ESTs, an optimal structure of patent rights is put forward and accordingly, differentiated protection with value-based judgment at its core, is proposed for different types of ESTs, giving priority to the innovation of some ESTs and accessibility of others.

When establishing the special regime, the following questions must be

[8] Jayashree Watal, *Intellectual Property Rights in the WTO and Developing Countries* (Kluwer Law International 2001) 2. ('The protection of IPRs is meant for the general benefit and progress of society. However, sometimes the dynamic, long-term benefits of IPRs could conflict with other short-term public policy objective.' So the scope and duration of IPRs is always limited in order to ensure a balance between the interests of right holders and those of users.)

[9] John Martin Gillroy, *Justice and Nature: Kantian Philosophy, Environmental Policy, and the Law (American Government and Public Policy)* (George Town University Press, Washington D. 2000) 20.

understood and solved.

1. Has probable cause been found to make the specially-designed patent system independent from the existing international patent rules?
2. How many parts make up the regime, and what are they?
3. Which is the right international platform to apply the regime, and what roles should different organizations have?

5.1 Justification of the Specially-Designed Patent Regime in Relation to ESTs

Whether the EST-related patent system could be independent from existing international patent rules depends on its regulative objects, the legal relationship involved and the regulative method. At present, the innovation and accessibility of ESTs is regulated by international IP and trade laws.[10] The international patent system has taken the dominant role, especially after IP issues are aligned with trade matters. As such, as a value judgment, the interests of right holders become the most important consideration in innovation and access to ESTs.[11] The default minimum standard of patent protection provides legal grounds for stronger patent protection in so-called TRIPS-plus bilateral or regional trade agreements, rendering proposals that promote the development and transfer of ESTs based on the preset flexible term of public interests largely irrelevant in the context of climate change.[12]

[10] The international IP and trade laws here mentioned are the IP conventions under both WIPO and WTO and the legislative attempt on the international technology transfer in the United Nations Conference on Trade and Development.

[11] Brown (n 2) 12. (It is because that 'IP owners are highly likely to be private entities, not states with responsibilities under UNFCCC'. Regardless of the role of ESTs that has been repeatedly emphasized in response to climate change, right holders still actually control technologies and have the right to prevent others from using. What is more, the WTO Panel is believed to view the interests of patent owners as more important than other interests, which is incorrect and 'different from the stance taken by decision makers considering very similar provisions in relation to trademarks and copyright'.)

[12] Ibid 9. (Some questions need to be paid attention to, for example, if actions taken by a member state is considered inconsistent with the minimum obligations under TRIPS, such as the use of compulsory licensing in 'a creative approach', a dispute arises under the jurisdiction of WTO.)

To address challenges of climate change, a comprehensive patent management system is essential for the innovation, transfer and application of ESTs by coordinating the legal relationship among purchasers, providers of ESTs and the public to achieve specific aims of energy conservation and emission reduction. On the consensus that the dissemination of ESTs is the key to tackling climate change, the characteristics of ESTs and the legal relationship involved in environmentally sound patents are only partly covered by the existing international patent systems, meaning that the special patent system for ESTs is also a breakthrough of traditional patent laws.[13] In this respect, it is obviously important that a set of special international patent rules should be made and upheld to serve the goal of improving access to ESTs.

5.1.1 The Particular Regulative Object

The particular regulative object arises at the trans-formative period in patent laws, when the invention landscape changes, as a result of dual pressure from environment degradation and energy shortage, from primarily output-oriented inventions to those populated with less waste and energy consumption.[14] The minimum standard of patent protection set in TRIPS looks like a stage designed for all participants. It is

[13] There are different opinions about whether it is necessary to build another set of independent patent system to deal with ESTs. See the representative article written by Frederick M. Abbott, 'Innovation and Technology Transfer to Address Climate Change: Lessons from the Global Debate on Intellectual Property and Public Health' (2009) ICTSD's Programme on IPRs and Sustainable Development, Issue Paper No. 24, June 2009, 3. ('Rather, there may be sufficient scope within existing international IPRs norms to encompass a range of policies with respect to AREs/MTs taken at the national and regional implementation level. It is critical that the time and energy needed to negotiate changes to international IPRs rules be expended only if genuine practical constraints are identified and that negotiated not be initiated based on flawed assumptions.')

[14] Elisa Lanzi, Elena Verdolini, Ivan Haščič, 'Efficiency Improving Fossil Fuel Technologies for Electricity Generation: Data Selection and Trends' (2011) Sustainable Development Series by Foundazione Eni Enrico Mattei 10.2011.('Improving the efficiency of fossil fuel energy is an opportunity to combat climate change, as lower energy intensity translates into lower GHG emissions per unit of production.'); Eric L. Lane, 'Building the Global Green Patent Highway: A Proposal for International Harmonization of Green Technology Fast Track Programs' (2012) 27 Berkeley Technology Law Journal 1119, 1125. (It is believed that the application of 'transformative new green technologies' is more significant than that of older technologies for global greenhouse gas emission control, reducing the cost of stabilizing environmental carbon dioxide levels.)

reinforced and heightened by various bilateral and regional trade agreements, meaning that the likelihood of using exceptions to exclusive rights for accessibility of ESTs is decreased.[15]

From a legal perspective, the regulative object here refers to a patent property regarding a group of technologies with a particular purpose and an evident characteristic of being public goods, distinguishable from conventional manufacture techniques and production technologies.[16] It is patent rights that make holders of ESTs, who expend great labor, desire to market their inventive achievements and contribute to the smooth circulation of ESTs. In other words, legally clear and stable patent property is regarded as reflecting rights and obligations of subjects involved in the legal relationship between the innovation and application process of ESTs. Given the characteristics of ESTs, patentable requirements are provided on a more granular level in the regulative object, with the aim of compensating for the failure of TRIPS to clearly define criteria for patentability.[17]

The dual nature of ESTs is demonstrated in the setting of patent rights, by properly coordinating interests of different subjects. First of all, it is well confirmed that clear property rights are the prerequisite of dynamic trading activities. The patent system acts as an invisible baton, playing a profound role in the evolution of ESTs,

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[15] ICTSD, 'IP and Sustainable Development: Development Agendas in a Changing World' (2010) ICTSD Programme on IPRs and Sustainable Development Information Note No.17, 2. (It points out that 'the emergence of bilateral free trade agreements that are notable for expanding the minimum standards of protection and enforcement beyond that which is laid out in the TRIPS Agreement has added new complexities and challenges for developing countries in their process of IP reform'.); See also Scott Taylor, 'Where are the Green Machines? : Using the Patent System to Encourage Green Invention and Technology Transfer' (2011) 23 The Georgetown International Environmental Law Review 577, 584. (IP protection is strengthened globally under the influence of TRIPS and other bilateral free trade agreements containing IP provisions. As a result, proposals that aim to 'develop and disseminate green technology must thus work within the confines of a strong, protective and global intellectual property system'.)

[16] IPCC, *Methodological and Technological Issues in Technology Transfer*, Special Report of Working Group III of the intergovernmental Panel on Climate Change (Cambridge University Press 2000). (According to this special report, this type of technologies is invented for the particular purpose of mitigating and adapting to climate change.)

[17] The specifically provisions regarding the protection period, non-discriminatory treatment and implement measures could be clearly found in TRIPS, but the most critical part of patentability, the three requirements of patent grants, is missing.

from birth to promotion.[18] Secondly, based on the importance determined by the special purpose and characteristics of ESTs, EST patents are protected by a superior motive: a sense of duty towards environmental protection that reflects the non-economic nature of EST patents and embrace the economic value in the guarantee of healthy exercise of private rights.[19]

5.1.2 The Particular Legal Relationship

It has to be acknowledged that the patent system designed for ESTs is considered to impact not only the individuals on each side of transactions, but also the stakeholders involved in global environmental and climatic issues.[20] As the parties with tangible stakes in global actions against climate change have varying roles and responsibilities, the particular legal relationship discussed here is different to that in traditional patent property law.[21]

Patent rights act as an incentive for the rapid innovation of ESTs, and are in a state of growing expansion due to innovators' notable contributions to environmental protection. Availing themselves of their respective advantages in innovation, private enterprises, scientific research institutes and non-governmental organizations funded by public resources are integral in satisfying the public's diversified and multi-level

[18] Nuno Pires de Carvalho, 'The Primary Function of Patents' (2001) 1 Journal of Law, Technology & Policy 25. (The invisible power of patents always leads human to invest and make research, indicating that as patents promote research, the denial of patentability would dampen the enthusiasm of innovators.)

[19] Brown (n 2) 18. (It is pointed out in the report of the United Nations High Commissioner for Human Rights that excessive emphasis is placed on the interests of companies and the rights of patent owners, rather than on state's responsibility for public interests and social function of patents.)

[20] Aaditya Mattoo and Arvind Subramanian, 'A 'Green-print' for International Cooperation on Climate Change' (2013) Policy Research Working Paper by Trade and Integration Team of The World Bank Development Research Group 6440. (As larger emitters, developing countries believe that technology generation, the key to preventing or mitigating the effects of climate change, 'will be materially affected by' patent protection, and recognize that their stakes in fighting against climate change are higher than those in developed countries who are affected less and easier to adapt.)

[21] Jason Obold, Matthew Burns, and Caroline Baker, 'Impressions from Durban: COP-17 and Current Climate Change Policies' (2012) 23 (2) Colo. J. Int'l Envtl. L. & Pol'y 389, 398. (The philosophy uphold by the International Chamber of Commerce is that 'any movement must balance environmental responsibility and social development with commercial viability'.)

needs.[22] With a wide variety and high coverage of industries, ESTs are highly specialized and of great relevance to environmental protection, ensuring smooth implementation of various measures against climate change. It follows that patent rights of ESTs owned by private enterprises, scientific research institutes and non-governmental organizations funded by public resources have a direct bearing on their vital interests in engaging in the innovation of ESTs.

In theory, with the expansion of patent rights it is becoming easier to access ESTs as more products and services are provided. In practice, however, high transaction costs and limited technical capability of recipients make the accessibility of ESTs an arduous task.[23] It is necessary, therefore, to control the expansion of patent rights in a proper manner. Accessibility of ESTs should be encouraged as a way of validating the objection to expanding patent rights of providers.[24] Additionally, from an economic perspective, the failure of markets and social organizations certainly means that controls on the space of monopoly through external powers are required.

Essentially, whether the use of ESTs could successfully achieve national emission reduction targets is the final and most important step of ESTs transfer; the specific public interests therein justify the supervision of government behaviors and the routes to appeal or remedy available to users.[25] The public interest here is not interpreted in abstract, but a clear manner: the right to environment and health in a specific territory,

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[22] Cristina Tébar Less and Steven McMillan, 'Achieving the Successful Transfer of ESTs: Trade-related Aspects' (2005) OECD Trade and Environment Working Paper No.2005-2, 8 < http://www.oecd.org/trade>accessed on 4 October 2015. (In comparison with other technologies which may rely largely on private funding, the development of ESTs increases the significance of public funding, because R&D of ESTs is mainly located in university, public research institutes and laboratories. It is also found that in the support of structures and incentives, many ESTs are developed and commercialized by SMEs.)

[23] Benjamin K. Sovacool, 'Placing a Glove on the Invisible Hand: How Intellectual Property Rights May Impede Innovation in Energy Research and Development' (2008) 18(2) Albany Law Journal of Science and Technology 381.

[24] ICTSD, 'IP and Sustainable Development: Development Agendas in a Changing World' (2010) ICTSD Programme on IPRs and Sustainable Development Information Note No.17, 2. (The expansion of IPRs makes access and dissemination of knowledge more difficult, invading the public's access to needed technologies.)

[25] Bodansky (n 5) 523. (It is pointed out that the approach of human rights seems unlikely to meet the need of collective actions of climate mitigation and adaptation, indicating that the public interest mentioned here is specific and represented by national emission reduction targets.)

the claim of which is expressed with lucidity under the jurisdiction of a government over its domestic environment, highlighting the role of the government as a manager.[26] Mandatory tasks of emission reduction could only be completed through projects under the leading and supportive role of governments, by extending the legal relationship between providers and consumers to a trilateral relationship between providers, buyers and end-beneficiaries.[27]

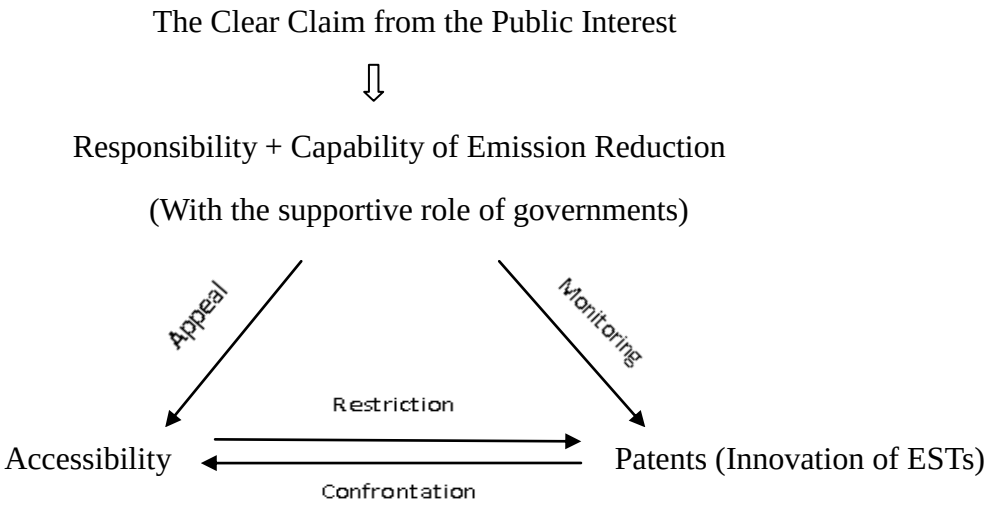

Diagram 1 （Self-compiled)

The responsibility and capacity of emission reduction is reflected in the actively supportive role of governments, who must achieve a balance between innovators and

[26] Frederick M. Abbott, 'Innovation and Technology Transfer to Address Climate Change: Lessons from the Global Debate on Intellectual Property and Public Health' (2009) ICTSD's Programme on IPRs and Sustainable Development, Issue Paper No. 24 June, 2009, 28. (The role of a government in combating climate change is played in such ways that

> '[n]ew government involvement in R&D programs may prove beneficial in the sense that climate change negotiators representing governments should be able to influence the direction of industry. A large-scale infrastructure commitment made by governments with respect to a particular form of energy supply will also pose an impact on the development of ESTs'.)

[27] Vienna Declaration, World Conference on Human Rights, Vienna, 14-25 June 1993, U.N. Doc. A/CONF.157/24 (Part I) at 20 (1993). (Here the concept of end-beneficiaries can got the theoretical support from the Vienna Declaration which saying that '[r]*ecognizing* and affirming that all human rights derive from the dignity and worth inherent in the human person, and that the human person is the central subject of human rights and fundamental freedoms, and consequently should be the principal beneficiary and should participate actively in the realization of these rights and freedoms'.)

users, as innovators are easily frustrated with the emphasis towards the accessibility of ESTs.[28] Accessibility is discouraging if patent rights are overlooked. Unfortunately, weakening the role of governments in current climate negotiations is frequently seen in proposals which attempt to solve issues of innovation and accessibility of ESTs simply through market-based mechanisms.[29] When the role of governments is weakened, there is less opportunity to achieve balance, because governments are constructed as the kernel that essentially promotes innovation and achieves social equality.[30]

From a technical perspective, there are two essential conditions to successfully completing mandatory emission reduction tasks: one is the development of technologies, and the other is that technology resources are reasonably distributed and used. The second condition is a matter of responsibility, while the first involves capability.[31] The development of ESTs could be motivated by private profit or a public desire to solve environmental problems, evident through the main innovators of ESTs that mainly consist of individuals, private enterprises, publicly-funded scientific research institutions, universities or non-governmental organizations. The question of responsibility involves market rules of fairness and morality and as such, it cannot only be solved by market mechanisms.

[28] Aaditya Mattoo and Arvind Subramanian, 'Equity in Climate Change-An Analytical Review' (2010) Policy Research Working Paper by Trade and Integration Team of The World Bank Development Research Group 5383. (From the ethical perspective, it is suggested that 'future allocations of carbon budget are to be inversely related to the ability to pay for emission mitigation' and more specifically, the payment depends on the level of income of countries or individuals.)

[29] Mulugeta Getu, 'Accommodating the Interests of Developing Countries in the Climate Change Regime: Lessons from the Ozone Layer Regime' (2012) 6 (1) Mizan Law Review 1. (It is point out by the author that market-based mechanisms adopted in the Kyoto Protocol used to promote compliance and participation is not as effective as expected due to the lack of effective implementation schemes.)

[30] H-Holger Rogner, Dadi Zhou, Rick Bradley, Philipp Crabbé, Ottmar Edenhofer, Bill Hare, Lambert Kuijper, Mitsutsune Yanaguchi (2007) Chapter 1 Introduction in B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds), *Climate Change 2007: Mitigation of Climate Change* (Cambridge University Press 2007) 112. (In the introduction of this book, the research, development and deployment of ESTs are analyzed. As 'one policy lever that governments have for encouraging a more climate friendly capital, a strengthened publicly funded commitment to technology development could play an important role in altering the trends in GHG emissions'.)

[31] Brown (n 2) 4-5. (It assumes that if ESTs cannot be widely available against climate change, 'the problems arise from is the inability to use technologies because of the stance taken by IP owners, instead of or as well as a lack of capacity to do this because of manufacturing resources or human expertise'.)

Patents, as demonstrated by Diagram 1, represent the maintenance and operation of markets driven by self-interest motives, while accessibility of ESTs, which is less likely to be promoted in the same way, must uphold appeals from the majority of consumers and end-beneficiaries through controls on the expansion of private profits. It is probably considered that the presence of motives for public environmental problems is unfavorable to long-lasting innovation of ESTs.[32] In this chapter, however, it argues that such motives can persist effectively, as long as efforts to solve environmental problems are able to produce positive results as a return to the public.[33] It deserves to be specially noted that the second condition must be satisfied so as to sustain a public motive, otherwise all efforts towards climate mitigation and adaptation could be void.

5.1.3 The Particular Regulative Method

As a pluralized and multi-level benefit body, the patent system for ESTs is designed as a form of benefit coordination mechanism, or a relatively balanced benefit mechanism.[34] From a legal study perspective, the legitimate relationship of interests is embodied in the relationship between rights and obligations. Hegel states that an 'interest' refers to what is actually obtained, while a 'right' is simply a type of permission and ability endowed with new connotations of progress of social

[32] Paul Gormley, 'Compulsory Patent Licenses and Environmental Protection' (1993) 7 Tulane Environmental Law Journal 131. (It is believed that the economic motives are essential for environmental protection and the ethical consideration is not of much use.)

[33] David Popp, 'Lessons from Patents: Using Patents to Measure Technologies Change in Environmental Models' (2005) 54 Ecological Economics 209, 218. (One of lessons learnt from patent data in this study is that, based on the economists' study, social returns to the innovation of ESTs are found higher than private returns, because the knowledge generated by such innovation is a public good.)

[34] Jeremy de Beer and Chidi Oguamanam, 'Intellectual Property Training and Education: A Development Perspective' (2010) 31 ICTSD Programme on IPRs and Sustainable Development 2010. (In the past decade, it is advocated by some organizations like ICTSD to set up 'a more balanced and development-friendly IP system that promotes innovation and creativity while being supportive of public policy and development objectives'.)

civilization.[35] Under the specific historical background, the design of environmentally-sound patent rights ought to be of flexibility and open-endedness, while its implementation is dependent on the specific legal environment.

The formulation of international IP rules is mainly made in two ways, one of which is conducted in a top-down approach by the principal rule makers, WIPO and WTO, to deal with various challenges. The second way is that member states enter into international agreements or conventions that are adopted or modified when opinions are put forward by national legislators based on data and research results provided by the world's major regional and national IP offices, academic research institutions or non-governmental organizations in consideration of local conditions.[36] In a healthy system, the two approaches are needed in order to introduce sound competition and comparison. For the time being, the bottom-up approach seems to be more effective than the top-down approach, as confrontations tend to arise with greater frequency than equal cooperation.

The EST-related patent issue involves several major stakeholders, including governments, private sector bodies, intergovernmental organizations, NGOs etc.[37] Correspondingly, a combination of the two approaches is necessary when the traditional top-down approach offers a new interpretation and breakthrough of IP issues in climate negotiations. This is mainly reflected in the overall characteristics, principles and the target of the proposed system under WIPO, by attaching great importance to the balance of private rights and public interests, and substantiating the flexible terms in the field of ESTs with the assistance to developing countries.[38] On

[35] Georg Wilhelm Friedrich Hegel, *Elements of the Philosophy of Right*, in Allen W. Wood (eds), *Cambridge Texts in the History of Political Thought* (CUPL Press 2003).

[36] Graeme B. Dinwoodie, Rochelle C. Dryfuss, 'Designing a Global Intellectual Property System Responsive to Change: The WTO, WIPO and Beyond' (2009) University of Oxford Legal Research Paper Series Paper No.50/2009, 2-3.

[37] Charles K. Ebinger and Govinda V. Avasarala, 'Transferring Environmentally Sound Technologies in an Intellectual Property Friendly Framework' (2009) Energy Security Initiative Policy Brief 09-08 by the Brookings Institution. (According to the definition of technology transfer made by IPCC, EST-related patent issues involve 'the broad set of processes covering the flows of knowledge, experience, and equipment amongst different stakeholders such as governments, private sector entities, financial institutions, NGOs, and research/educational institutions'.)

[38] Bronwyn H. Hall and Christian Helmers, 'The Role of Patent Protection in (Clean/Green)

the other hand, the bottom-up approach does not entail weakening the role of WIPO but rather emphasizing the supportive role of governments, implying the diversity and selectivity of cooperative ways in related regions as for each state.

For example, compulsory licenses could be applied by states in different technical areas according to their specific claims, i.e., limited application of compulsory licensing. Alongside that, it is noteworthy that the cooperative relationship between private sector bodies and publicly-funded institutions as the main innovators of ESTs is vital in the bottom-up approach, meaning that only when it is well handled can the top-down approach be set firmly on the ground.[39]

5.2 The Principles of the Regime

5.2.1 The Principle of Legitimate Protection and Use

The legal monopoly of patents and accessibility of ESTs in a solid patent system can be balanced by legitimate protection and use of ESTs, which are complementary to one another.[40] In view of aspirations of the negotiators, the establishment of the special patent system could help to coordinate the demands of the parties through cooperation, sharing, and achieving reasonable protection and use of EST-related patents.

Experience has shown that representatives of developed countries are commonly

Technology Transfer' (2010) No.16323 National Bureau of Economic Research Working Paper 1, 20. (The top-down regulatory intervention could be presented in different forms, for example emissions performance standards and climate change mitigation such as reforestation in a local or global scale, and according to the World Bank report of 2010, 'global harmonization of regulations can give rise to scale effects and thus provide multiplier effects'.)

[39] Popp (n 33) 221. (Currently, the points emphasized by the bottom-up approach and the top-down one involving ESTs innovations are different, the former of which covers detailed implementation of policies and specifications of energy systems, while the latter focuses on the links between environmental policies and macroeconomic performance.)

[40] Ibid. ('Technology advance are of little use unless society make use of the innovation', therefore, the availability of ESTs is as important as the innovation, both of which consist of the whole story. Regarding issues of the long-term consequence, such as climate change, it is the diffusion of ESTs that is likely to play a particular significant role.)

skilled in using plausible theory bases, to support their claims in various disputes over IPRs, making developing countries and LDCs powerless in refuting.[41] Developing countries and LDCs tend not to reason the nature and function of IP systems, instead resorting to emotional persuasive displays of their growing dissatisfaction with the systems, to obtain understanding and assistance from developed countries.[42]

A greater degree of wisdom and rationality is becoming imperative in respect of the negotiating strategy surrounding this issue.[43] Consequently, the negotiating tactic of the demanding side needs to be changed, focusing on the reason for dealing with IP-related issues by stressing the justification of IP systems and the human rights characteristics of IPRs, so as to safeguard legitimate interests of both sides. The principle of legitimate protection and use is based on the important principle surrounding the human right attribute: the property nature of IPRs must never be a reason for the violation of the human right to life and health.[44]

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[41] Susan K. Sell, 'The Quest for Global Governance in Intellectual Property and Public Health: Structural, Discursive, and Institutional Dimensions' (2004) 77 Temple Law Review 363, 370. (Accoring to Drahos, 'much of what happens in the agriculture and health sectors of developed and developing countries will end up depending on the bidding or charity of biogopolists as they make strategic commercial decisions on how to use their intellectual property rights'.)

[42] Padmashree Gehl Sampath and Pedro Roffe, 'Unpacking the International Technology Transfer Debate: Fifty Years and Beyond' (2012) Working Paper <http://ictsd.org/downloads/2012/07/unpacking-the-international-technology-transfer-debate-fifty-years-and-beyond.pdf> accessed on 3 May 2013. (In the Doha Ministerial Conference, although developing countries expressed disappointment and dissatisfactory with the failure of fulfillment of promises made by developed countries under TRIPS, insisting that adequate adjustment should be taken in existing IP systems, no concrete results have been produced.)

[43] Debora J. Halbert, 'The World Intellectual Property Organization: Past, Present and Future' (2006) 54 Journal, Copyright Society of the USA 253, 271. (For the global south, it has to be recognized that 'for all the rhetoric international institutions may engage in regarding help for the poor, it remains just that- words. Instead, the trend is towards increasing protection of intellectual property as the emergence of TRIPs under the WTO and TRIPs-plus negotiations on the part of the United States prove so clearly'. Therefore, it is wise and rational to accept that any development should be done 'only under the conditions established by the already overdeveloped countries'.)

[44] Ibid 254. (The important principle surrounding the human right attribute: the property nature of IPRs must never be a reason for the violation of the human right to life and health is advocated by international agreements, such as the Convention on Biological Diversity that claims that 'IPRs should not trump health care, human rights, or environmental protection'.)

5.2.2 The Principle of Risk Distribution and Benefit Sharing

The risk-distribution and benefit-sharing model is distinguishable in the way that investment demand is divided into parts borne by different inventors and optimal products are generated from a team input, with low cost and flexible utilization efficiency to meet a variety of special needs.[45] This model is different from the traditional IP protection, which only takes advantage of the dual role of IP in stimulating innovation and encouraging diffusion to increase social welfare. In an effective reduction mechanism, in which the spread and application of ESTs is the most important part, the necessity of ESTs is widely recognized; what is urgent nowadays is the extensive use in the light of the arduous task of global emission reduction.[46]

Through widespread dissemination of ESTs, opportunities and the burden of emission reduction can be widely distributed. As a result, the more successfully the regional emission reduction becomes, the higher the efficiency of global emission reduction shall be.[47] This issue, however, is considered from a different viewpoint by Maskus who believes that it is difficult to assess the risks and benefits shared by countries, as technical limitations render questionable the prediction of the influence of temperature and climate.[48] A good suggestion comes to mind, that intensified

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[45] Cynthia Cannady, 'Access to Climate Change Technology by Developing Countries: A Practical Strategy' (2009) ICTSD's Programme on IPRs and Sustainable Development, Issue Paper No. 25, 21. (As a practical support of endogenous R&D of ESTs against climate change, form and fund is favorable and necessary for the establishment of regional networks for the development and commercialization of ESTs, by sharing resources and cost in innovation infrastructure and huge research investment.)

[46] Van Smith, 'Enabling Environments or Enabling Discord: Intellectual Property Rights, Public-private Partnerships, and the Quest for Green Technology Transfer' (2011) 42 Georgetown Journal of International Law 817.

[47] Ibid 821. (The wide distribution of ESTs is considered prominent among efficient mechanisms for reducing GHG emission. 'By achieving the transfer of ESTs to large groups of people and countries, opportunities for, and the burdens of, GHG reductions can be shared broadly. By allowing for more reductions in more locations, global GHG reduction can be achieved in the most cost-effective manner possible.')

[48] Keith E. Maskus., 'Differentiated Intellectual Property Regimes for Environmental and Climate Technologies' (2010) Environment Working Paper of Organization for Economic Cooperation and Development No.17 <http://dx.doi.org/10.1787/5kmfwjvc83vk-en> accessed on 12 May 2014.

regional cooperation gradually rises to the cooperation at a global level, highlighting the failure of cooperation caused by regional disparity.

5.2.3 The Principle of Cooperation

The mitigation and adaptation of global climate change relies on a collective sense of responsibility, as opposed to resulting from the pursuit of self interests by any single country, enterprise or individual.[49] Similar to the maintenance of market rules, though still distinguishable, the strength of this shared sense of responsibility is determined by the impact of climate change on participants' respective territories, and is directly related to 'the timeframe over which they are to be experienced'.[50]

Differing widely from region to region, the influence of climate change for some countries is temporary, merely constituting a warning with no substantial effect, whilst for other countries it is a matter of survival.[51] Concerns about climate change, which vary from the acceleration of melting icebergs and frequent extreme weather to a

[49] Bodansky (n 5) 516. (As the international environmental law depends on reciprocity, most international environmental problems, including climate change, require collective effort rather than being addressing by individual state alone.); see also Elizabeth Burleson, 'Energy Policy, Intellectual Property and Technology Transfer to Address Climate Change' (2009) Climate Change and Human Rights Symposium 18 University of Iowa Transnational Law and Contemporary Problems, 69, 93. (Burleson argues that global climate change can only be addressed by meaningful action that 'establishes collective standards with individual country implementation', such as emission reduction targets, financing adaptation and mitigation measures and implementing transfer of ESTs.)

[50] Frederick M. Abbott, 'Innovation and Technology Transfer to Address Climate Change: Lessons from the Global Debate on Intellectual Property and Public Health' (2009) ICTSD's Programme on IPRs and Sustainable Development, Issue Paper No. 24, June 2009, 15. (It is recognized that the degree of impacts of climate change on countries naturally varies considerably. 'A worst-case scenario on climate change may be apocalyptic. A less-worst-case may involve impacts on isolated communities. There is some opinion that certain geographic zones will benefit from climate change in terms of increased arability of land.')

[51] Charles K. Ebinger and Govinda V. Avasarala, 'Transferring Environmentally Sound Technologies in an Intellectual Property Friendly Framework' (2009) the Brookings Institution Energy Security Initiative Policy Brief 09-08, 4. (The disproportionate risks of climate change are facing developing countries, 'particularly in Africa, parts of Latin America and the Caribbean, portions of Southeast Asia, and the Pacific island nations'. The threats 'including rising sea-level, increasing flood, more violent hurricanes and irregular rainfall variation, droughts, fires, and heat waves', are about survival of those vulnerable countries that have contributed very little in harmful emissions.)

matter of life and death, have greatly promoted cooperative initiatives.[52] The lesson here is that the stronger the interests of a community, the more secure the foundation of cooperation. This is also evident from the achievements of the Doha Declaration through its solid foundation of common interests among both developed and developing countries.

5.2.4 The Principle of Efficiency

Historically, human development is observed as a process in which material aspiration is being fulfilled by technological progress. Now, it seems that any idea that contemplates the waiver of patent rights by right holders to achieve social harmony is, though morally noble, like water without a source and a tree without roots.[53] More importantly, from a practical standpoint, such ideas would not improve the accessibility of ESTs, as such an approach increases the chances of certain people 'getting everything for nothing', leading them indulge in wishful thinking to cut corners.[54] Moral unselfishness could never be assumed as the prerequisite of a legal system; the principle of justice is necessary and meaningful only when providers and

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[52] Lisa Heinzerling, 'Climate Change, Human Health and the Post-Cautionary Principle' (2008) 96 Georgetown Law Journal 445. (From the pragmatic perspective, threats from climate change can cause enough concern of the pubic and policy-makers only when it is associated with human health.)

[53] Matthew Rimmer, 'Patents for Humanity' (2012) 3(2) the World Intellectual Property Organization Journal 198. (It is firmly hold by the author that 'shadow solutions' in respect of IP and global issues must be avoided, which is a concept cited from the philosopher Stephen M. Gardiner who made the comment that

> 'In a perfect moral storm, we should expect 'shadow solutions' to the problem at hand that reflect only the limited concerns of those with the power to act. Such 'solutions' are morally problematic. Not only are they typically inadequate as a matter of substance, but they also create the dangerous illusion of real action, and this serves as a distraction through which continued buck-passing can be perpetrated.')

[54] H-Holger Rogner, Dadi Zhou, Rick Bradley, Philipp Crabbé, Ottmar Edenhofer, Bill Hare, Lambert Kuijper, Mitsutsune Yanaguchi (2007) Chapter 1 Introduction in B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds), *Climate Change 2007: Mitigation of Climate Change* (Cambridge University Press 2007) 102. (The efforts made for climate protection is under-provided and the benefits thereof is freely available to all, which is non-exclusive to others who do little contribution to cost of such effort and may 'result in 'free riding', a situation in which mitigation costs are borne by some individuals (nations) while others (the 'free riders') succeed in evading them but still enjoy the benefits of the mitigation commitments of the former'.)

consumers of ESTs are asymmetrically positioned.

The acknowledgement of the legitimacy of patentees to pursue their own interests, thence, is a necessary condition to guarantee EST market development, while the optimal allocation of technical resources can be understood on a deeper level as the maintenance of market rules.[55] When it comes to behaviors driven by public interests, the price mechanism is often seen as insignificant, leading to inefficiency because of losing the important basis of measuring economic returns of those behaviors.[56] Under the background of climate change, the answer to how to define the effective dissemination depends in part on the results of the international emission reduction as a whole.[57] As resources allocated by capital markets are far more efficient than any other form, what national governments need to do is to establish a mechanism to guide the effective allocation and combination of capital and ESTs at both international and domestic level.

[55] Alan Devlin, 'The Misunderstood Function of Disclosure in Patent Law' (2010) 23(2) Harvard Journal of Law & Technology 401. (In a free market, the suboptimal allocation of resources, which 'deprives consumers of valuable information goods that never come into being or emerge considerably later than they otherwise would', is quite common because inventors are unwilling to invest their scarce resources into the risky innovation of public goods in case of reverse engineering.)

[56] Gideon Parchomovsky, Michael Mattioli, 'Partial Patents' (2011) 111(2) Colum. L. Rev. 207. (From the perspective of economics, it is argued by some commentators that the exclusive rights of patents 'lead patentees to restrict output and charge supracompetitive prices for patented inventions' and thus some consumers will not get the products they want even at competitive prices, meaning an efficient loss in the eyes of patent scholars.); see also Elizabeth Burleson, 'Dynamic Governance Innovation' (2013) 24 The Georgetown International Environmental Law Review 477, 488. (The price mechanism fully plays the role in a genuinely efficient market by reflecting the scarcity of resources, but in an environment where market failure occurs, policies are needed to stimulate R&D, innovation, education and information should be complementary to the price mechanism to balance investment and public interests. According to the study by OECD, it finds that the benefits of shared innovation could be enhanced by increasing investments.)

[57] Maskus K.E., 'Differentiated Intellectual Property Regimes for Environmental and Climate Technologies' (2010) Environment Working Paper of Organization for Economic Cooperation and Development No.17 <http://dx.doi.org/10.1787/5kmfwjvc83vk-en> accessed on 10 December 2014.

5.3 The Components of the Regime

5.3.1 The Relationship between Patent Protection of ESTs and Social Welfare

The issue regarding how ESTs are protected becomes the focus of attention at the point when the development of EST-related industries, climate change and the issues concerning sustainable development are generally concerned. An important feature of ESTs is the universality of their distribution; qualitative differences in function and contribution to global warming could easily be found among different ESTs.[58] In order to promote the application of ESTs on the basis of general claims including individual technologies, total systems, know-how, goods, services, equipment and organizational and managerial procedures, a differentiated patent protection of ESTs, taking into full account their value and importance, is a sensible course of action to balance the discord between innovation and access to ESTs.

Generally speaking, patent protection is achieved through scope, duration and intensity, which brings about both positive and negative effects: the enhancement of innovative capacity against monopoly power upon social welfare as a whole.[59] The intensity refers to patentability, which concentrates on definitional problems and the grant standards; length denotes duration; and width represents the scope of validity of

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[58] Antoine Dechezleprêtre, Matthieu Glachant, Ivan Hascic, Nick Johnstone, Yann Ménière, 'Invention and Transfer of Climate Change Mitigation Technologies on a Global Scale: A Study Drawing on Patent Data' (prepare for the Review of Environmental Economics and Policy)<http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1414227 > accessed 5 February 2012. (ESTs that play important roles in global GHG emission reduction, including renewable energy technologies, energy conservation technologies, clean coal technologies and energy storage technologies, are widely distributed among sectors.)

[59] Dongwook Chun, 'Justifying Patent Harmonization' (2012) 12 Asper Review of International Business & Trade Law 99, 105. (According to the patent theory of utilitarianism, IPRs are designed as 'an appropriate means to foster innovation, subject to the caveat that such rights are limited in duration so as to balance the social welfare loss of monopoly exploitation'. In other words, 'patent law is designed to strike a balance between its utility by incentivizing local inventors and benefiting society by disclosing the description and disutility from the monopoly by granting the exclusive rights of patents'. It is concluded that domestic innovation minus domestic monopoly is equal to social welfare in a closed economy.)

patent rights.[60] The emphasis of this part is placed on the appropriate structure of patent rights, that is, the optimal combination of patent length, width and intensity to maximize social welfare through the balance of the positive and the negative effects, the two of which indicate the value of different ESTs. It is important to note that the determination and implementation of the three dimensions is a very complicated process that largely involves economic, legal and technological development under specific circumstances.[61] The optimal combination of the three dimensions is discussed from a legal and an economic perspective.

So far, in the existing models for innovation incentives, 'efficient outcomes in the Pareto sense' is a foremost consideration during the design of patent system.[62] According to the concept of 'efficient outcomes' explained by Coase in his famous article *The Problem of Social Cost*, when there are transaction costs, the initial enactment of property rights ought to help optimize the combined resources of the whole society, and an optimal social arrangement should help in reducing transaction costs.[63] In other words, it is necessary to take all social benefits into account. The viewpoint is of guiding significance to the optimal combination of patent rights for ESTs. Besides from creating technical information, as other inventions do, the environmental protection function of ESTs accounts for a positive externality, the solution to which must be internalized in legal systems through the balance of social costs and benefits.[64]

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[60] In many literatures, there are two dimensions of patent protection, scope and breadth. Here in this thesis, the intensity specially refers to patentability, which focuses on the discussion about the definition of ESTs and the substantive requirements of patents to ESTs.

[61] Ken Shadlen, 'Policy Space for Development in the WTO and Beyond: The Case of Intellectual Property Rights' (2005) Tufts University Global Development and Environment Institute Working Paper No. 05-06, 11-12 <http://ase.tufts.edu/gdae> accessed on 31 May 2012. (The scope of patentability has historically presented cross-country differences and the duration of patent terms varies by type of products. The determination and implementation of the two dimensions of patent protection has been regarded as an effective strategy for national industrialization, which involves many factors.)

[62] John F. Duffy, 'Harmony and Diversity in Global Patent Law' (2002) 17 Berkeley Technology Law Journal 685, 693. (From the perspective of welfare economics, according to the study made by Anindya Sen, 'the outcome is regarded as pareto efficient if no individual can be made better off without making another individual worse off'.)

[63] Ronald Harry Coase, 'The Problem of Social Cost' (1960) 3 Journal of Law and Economics 1.

[64] John F. Duffy, 'Harmony and Diversity in Global Patent Law' (2002) 17 Berkeley Technology Law Journal 685, 693. ('The patent system can be accurately described as a regulatory mechanism that

An efficient structure of patent rights provides a reasonable basis to determine the ratio that private benefits take in respect of the total social benefit. Economists pay long-term attention to the efficiency of patent system by examining optimal patent term and scope. According to Cooter and Ulen, the question of the optimal patent duration is answered by 'the best balance between encouraging creativity and discouraging dissemination', that is, the equilibrium of social benefits and costs of patents.[65]

It is believed by Landes and Posner that 'fixed costs, the inherent difficulty of inventing around a patent and the extra profits' are essential conditions involved in deciding whether a given structure of patent rights is socially optimal.[66] In Figure 1, A represents R&D input by innovators; B is the fixed cost equal to A[67]; B and C refer to the earnings of patent holders throughout the duration; C is the net profits, which must be high enough to motivate innovators[68]; D represents the social benefits after patented innovations enter the public domain. As seen from the dotted curve in Figure 1, since enhanced access to patented ESTs reduces the difficulty of inventing around a patent and increases the odds of imitation and reverse-engineering, it undoubtedly influences social costs and benefits by depressing to different degrees the curve of the original innovators' profits, which means reducing social costs.[69] By this stage, only

attempts to correct this externality by more closely aligning the private and social value of producing new information.')

[65] Robert Cooter, Thomas Ulen, *Law and Economics* (Addison Wesley Pearson, 5th edn, 2007) 131. (As further noted, the one patent term of 20 years in current patent systems is not optimal, because it is obvious that 'social costs and benefits of inventions and innovations differ, sometimes, markedly and ideally, the patent system would recognize these variations by granting different patent terms depending on the net social benefit of each invention'. However, high administrative cost involved is hindering progress in this project.)

[66] William M. Landes, Richard A. Posner, *The Economic Structure of Intellectual Property Law* (The Belknap Press of Harvard University Press 2003) 300. ('Whether a given degree of patent protection is socially desirable depends on the patentee's fixed costs, the inherent difficulty of inventing around the patent (that is, holding constant the degree of patent protection), and the extra profits that the patentee can expect to receive from greater protection'.)

[67] Ibid 24. (Here the fixed cost means 'the costs incurred before a single sale is made'.)

[68] Ibid 20. (It is pointed out by authors that 'socially-desirable investment' which produces social benefits in excess of their social costs is depressed if innovators cannot recoup their sunk costs, meaning that return of investment must be sufficiently compelling rather than just being cost-recovering.)

[69] Ibid. (According to Plant, charging license fee entitled by exclusive rights reduces access to patented

proper extension of patent duration could motivate innovators. It is not, however, a matter of the longer, the better, but is optimal at T* when the balance between social costs and benefits is achieved.

Width or breadth of patents, inversely proportionate to access to ESTs, is defined by Richard Gilbert and Carl Shaprio as a steam of profits gained by innovators during the duration of patents, which has a more direct link to private profits than the length of patents, and determines the size of C in Figure 1.[70] Here, private profits arising from exclusive rights as part of social costs are weighed against social benefits. Breath of patents has different incentive effects on research by broad or narrow rules; the former encourages 'fast, duplicative' research and the latter encourages 'slower, complementary' research.[71] In view of the declining threshold of patent grants, the narrow rule is preferred to reduce the size of C by an appropriate arrangement, guarding against the erosion of social benefits from private extra profits and ensuring the quality of green patents.[72]

From the perspective of public welfare, the higher the social welfare index, the easier demanders of ESTs can get access to what is needed, and the more capable the society is in its environment governance. The duration of EST patents 'Lg', comes from the length of patent legislation; and the scope of validity of EST patents 'Bd', represents the width of the exclusive rights. The wider this is, the more difficult it is to get access to patented technologies.[73] In addition, as the degree of patent protection is

products or technologies, which can be viewed as part of social costs, but oppositely it is hold by Landes and Posner it can increase 'incentive to create it in the first place, which is a possible offsetting social benefit'.)

[70] Richard Gilbert and Carl Shapiro, 'Optimal Patent Length and Breadth' (1990) 21 (1) RAND Journal of Economics 106.

[71] Robert Cooter, Thomas Ulen, *Law and Economics* (Addison Wesley Pearson, 5th edn, 2007) 139.

[72] Keith Maskus, 'Differentiated Intellectual Property Regimes for Environmental and Climate Technologies' (2010) Environment Working Paper of Organization for Economic Cooperation and Development No.17 <http://dx.doi.org/10.1787/5kmfwjvc83vk-en> accessed on June 12 2013. (In regard to patent standards and procedures, taking USPTO that was criticized by its excessively broad subject matter claims for green patents as an example, it points out that the diminished standards for patent eligibility harm the quality of green patents.); see also Robert Cooter, Thomas Ulen, *Law and Economics* (Addison Wesley Pearson, 5th edn, 2007) 132. (Although there is no statistic, some evidence has emerged that patent law has been over-extended and is likely to hinder creativity in some areas, for example, pharmaceutical researches.)

[73] Carmen Matutes, Pierre Regibeau and Katharine Rockett, 'Optimal Patent Design and the Diffusion

an extremely important element influencing the monopoly of patent holders, the product of the patent protection index Lg and Bd and the intensity 'Ex', here referring to the degree measured relative to the grant standards to ESTs, can be used to explain private benefits from patent protection.[74]

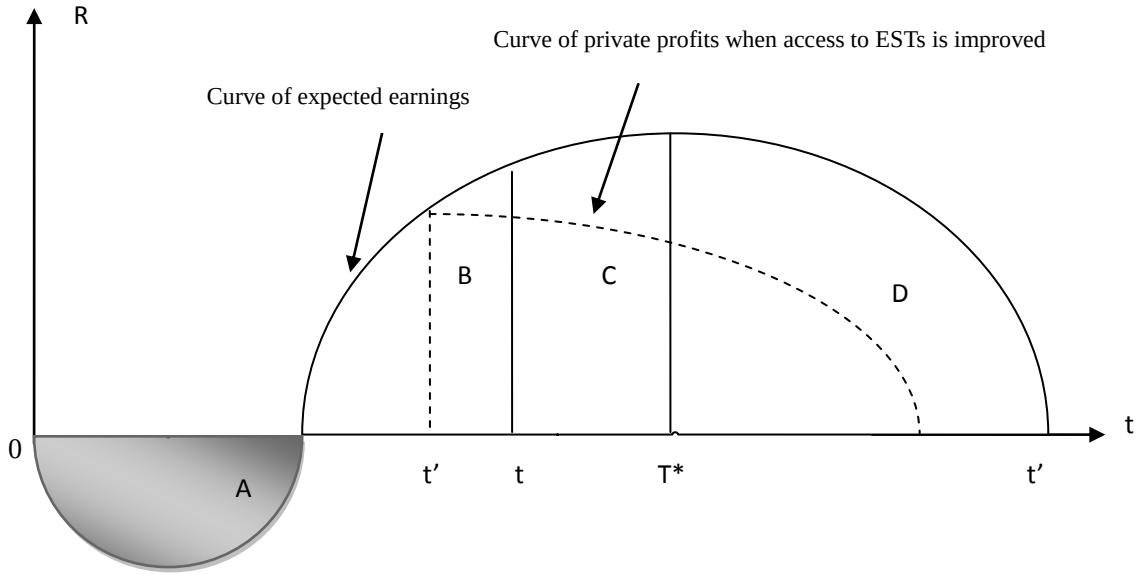

Figure 1 Influence of Increased Access to ESTs on Private Profits and Public Welfare

Accordingly, the growth of social welfare can be described as the logarithm function of some input, here referring to the three dimensions of patent protection that are respectively linked in some way to the growth of social welfare. Another important consideration in social welfare is technological spillover effect of protected inventions. With the objective of increasing effective access to ESTs, the logarithmic relationship between social welfare and patent protection of ESTs could be expressed

of Innovation' (1996) 27 (1) RAND Journal of Economics 60; See also William M. Landes, Richard A. Posner, *The Economic Structure of Intellectual Property Law* (The Belknap Press of Harvard University Press 2003) 296. ('With greater legal protection for patentees than for copyright holders comes a greater danger that the inventor will be enable to charge a higher price than he needs to recover the fixed costs of his invention, thereby restricting access to the invention more than is necessary.')

[74] William M. Landes, Richard A. Posner, *The Economic Structure of Intellectual Property Law* (The Belknap Press of Harvard University Press 2003) 300. (It is sharply pointed out by the authors 'the patentee's monopoly markup, which is of course influenced by the degree of patent protection, bears no direct relation to the fixed cost that he actually incurred in creating the patented invention'.)

as

$$\text{Ln } W = a_1 \times Lg*Ex + a_2 \times Bd*Ex + a_3 \times LnGDP.$$

Lg is viewed as the principal means of patent protection[75]; Bd is a means to reinforce such protection, by offering private net profits in exchange for information disclosure; and Ex is the threshold of patent protection, making sense to the index of Lg and Bd. LnGDP means the natural logarithm of GDP per capita, indicating the spillover effect of patented ESTs on national capability in dealing with climate change.[76] In order to keep positive effects of the spillover on social welfare, it is vital to ensure that patents are of high quality and thus can function well to promote more green inventions and produce positive externality to the environment.

Based on the above analysis, the intensity, length and breadth of patent protection jointly affect social welfare, and accordingly, in order to improve social welfare, an optimal combination of the three dimensions is put forward, which suggests that the threshold of patentability be raised on account of the eco-friendly feature of ESTs to guarantee the quality of patents; the duration of EST patents be extended to give enough incentive to investment; and the scope be narrowed to reduce social costs and also for the growth of green patent values.[77] The differentiated protection of ESTs corresponds exactly with the requirements of the above proposition. A concrete analysis of the intensity, duration and breadth of ESTs is made as follows.

[75] Paul Grootendorst, Livio Di Matteo, 'The Effect of Pharmaceutical Patent Term Length on Research and Development and Drug Expenditure: Evidence from Canada' (2007) 2 (3) Health Policy 85. (According to the case study made by Grootendorst and Matteo, it is concluded that the investment in research and development of drugs increases along with the extension of drug patent duration, leading to the emergence of more new drugs.)

[76] ELizabeth Burleson, 'Climate Change Consensus: Emerging International Law' (2009) 34 Wm. & Mary Envtl. L. & Pol'y Rev. 543, 561-562. (Country-specific commitments to emission mitigation are suggested to be measured by some of the objective criteria, including per unit of national economic output, per energy unit and population trend.)

[77] Reitzig Markus, 'What Determine Patent Value?-Insights from the Semiconductor Industry' (2003) 23 (1) Research Policy 13. (Based on the empirical study made by Markus, it is found that the value of patents is negatively related with the breadth of patent protection.)

5.3.2 The Differentiated Protection of ESTs

5.3.2.1 The Patentability

The scope of the subject matter under patent protection in TRIPS is so wide that certain basic questions about patentability are ambiguous, such as whether the innovative use of known compounds or isolated genes is patentable.[78] As the exclusive patent rights have a substantial impact on the use, transfer and competition of ESTs, the patentability standard of ESTs is not only closely related to national industrial structures and social development, but also greatly influences the operation of emission reduction targets and health problems caused by climate change.[79] This section aims to provide a set of standards for the review of EST patentability from the perspective of technical information selection.

The number of ESTs has increased substantially since the mid-1990s. According to a joint report by UNEP, EPO and ICTSD, globally there has been an average annual growth of around 20% in the number of certain ESTs since 1997.[80] With the increasingly expanding market in which ESTs are fast developing as emerging technologies, and the increase in the number of companies involved, innovators of ESTs are tending to adopt a strategy of maximizing the quantity of patents in order to

[78] Moustapha Kamal Gueye, 'Technologies for Climate Change and Intellectual Property: Issues for Small Developing Countries' (2009) ICTSD Information Note 12 2009, 5 < http://ictsd.org/i/publications/57611/> accessed on 8 January 2014. (The loose definition of patentability under Article 27 of TRIPS has raised concerns given the resulting all-encompassing patents. 'For example, patent claims on synthetic biology products and processes among the most promising technologies for cellulosic biofuels are so broad that scientists worry it could bring the discipline to a standstill. Defining the patentability criteria to adequately limit the scope of patents, on the other hand, would have a positive impact on further innovation by limiting the possibility of conflict with existing patents'.)

[79] Jonathan S. Masur, 'Regulating Patents' (2010) 2010 (7) Supreme Court Review 275, 279. (The Supreme Court of USA acknowledged that the discussion on the standard of patentability is viewed as a highly complex economic question, which should take the complexity of technologies and markets involved into consideration.)

[80] UNEP, EPO and ICTSD, 'Patents and Clean Energy: Bridging the Gap between Evidence and Policy: Final Report' (2010) 15 < http://www.ictsd.org/themes/innovation-and-ip/research/patents-and-clean-energy-bridging-the-gap-between-evidence-and-policy>accessed on 20 September 2014. (Selected CETs in this report include solar photo-voltaic, solar thermal, wind, geothermal, hydro/marine, biofuels, carbon capture and storage and integrated gasification combined cycle.)

seize the market.[81]

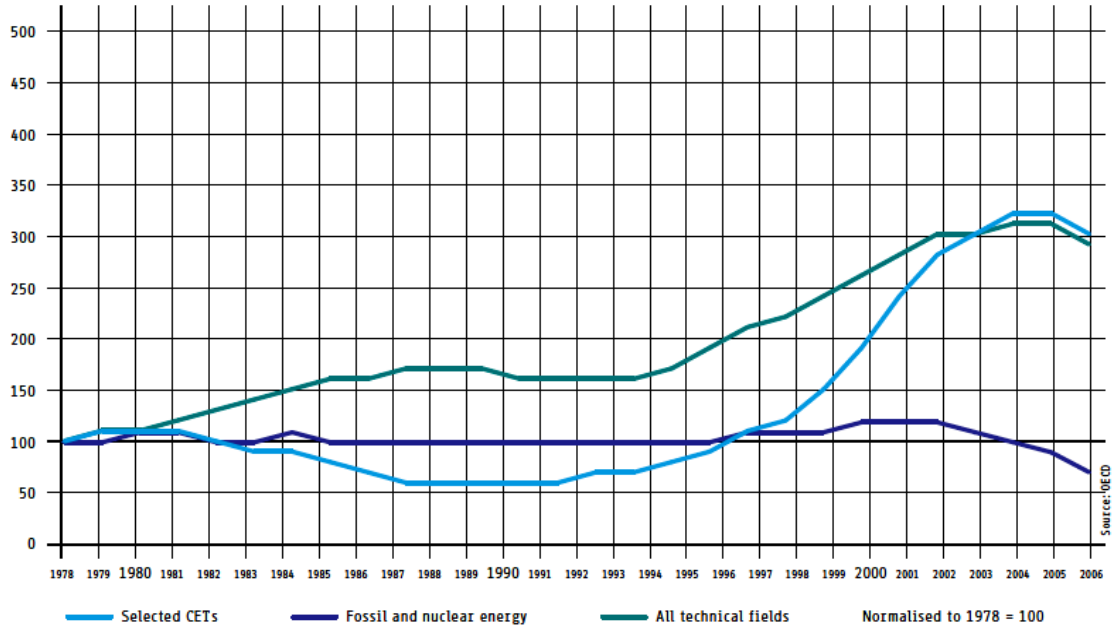

Figure 2 the Patenting Trends for Selected Clean Energy Technologies in Comparison with other Technical Fields (Source: UNEP, EPO and ICTSD, 'Patents and Clean Energy: Bridging the Gap between Evidence and Policy: Final Report (2010)')

Weak or blind innovation will lead to the failure of market promotion and cost recovery, which will greatly dampen innovators' enthusiasm.[82] The low standard of patentability will further increase the amount of patents but cannot guarantee quality, meanwhile adding unnecessary restrictions to competition. Thus, an accurate grasp of the standard of patentability is the touchstone to guaranteeing the quality of patents.

In the first instance, patents granted to ESTs must conform to certain basic characteristics and accommodate differences in the level of technological

[81] Gideon Parchomovsky and R.Polk Wagner, 'Patent Portfolios' (2005) 154 University of Pennsylvania Law Review1, 5. (It argues that 'the true value of patents lies not in their individual worth, but in their aggregation into a collection of related patents, a patent portfolio'. Starting from the overall interests, firms will typically adopt the maximization of patents quantity as the strategy, rather than evaluating their actual quality.)

[82] Federico Caprotti, 'China's Clean-tech Landscape: The Renewable Energy Technology Paradox' (2009) Spring 2009 Sustainable Development Law & Policy 6. (According to the private equity investment of 2009, the proportion of international venture capital that flows to the field of ESTs, including the most popular industries such as solar energy and transportation, is more than all other fields.)

development from country to country.[83] The basic technical features of ESTs are summarized for the purpose of guidance, drawing upon the definitions provided by several major organizations and patent offices. It finds that these definitions, broadly constructed without a specified guideline, are relatively similar, save for some slight differences.

According to OECD,

> 'Environmentally sound technologies (ESTs) are techniques and technologies capable of reducing environmental damage through processes and materials that generate fewer potentially damaging substances, recover such substances from emissions prior to discharge, or utilize and recycle production residues. The assessment of these technologies should account for their interaction with the socioeconomic and cultural conditions under which they are implemented.'[84]

UNEP defines ESTs as those technologies that

> '…have the potential for significantly improved environmental performance relative to other technologies. ESTs protect the environment, are less polluting, use resources in a sustainable manner, recycle more of their wastes and products, and handle all residual wastes in a more environmentally

[83] David Ockwell, Jim Watson, Alexandra Mallett, Ruediger Haum, Gordon MacKerron, Anne-Marie Verbeken, 'Enhancing Developing Country Access to Eco-Innovation: The Case of Technology Transfer and Climate Change in a Post-2012 Policy Framework' (2010) No. 12 OECD Environment Working Papers 2010 < http://dx.doi.org/10.1787/5kmfplm8xxf5-en> accessed on 2 November 2014. (It is pointed out in this report that the majority of existing mechanisms show indifference to indigenous eco-innovation capabilities of developing countries, which are essential to promote the transfer of ESTs and sustainable development 'based on the adoption, adaptation and development of ESTs that fit with the bespoke conditions faced by developing countries'.); see also Manuel A.J. Teehankee, Ingrid Jegou, Rafael Jacques Rodrigues, 'Multilateral Negotiations at the Intersection of Trade and Climate Change --An overview of Developing Countries' Priorities in UNCSD,UNFCCC and WTO Processes' (2012) 2 ICTSD Programme on Global Economic Policy and Institution May 2012, 45. (It is suggested that constructive views should be given based on a better understanding of the individual needs of national economies, so that countries could make appropriate response to international changes and adjustments and more important, with full access to facts and analysis they can better participate international cooperation and 'engage in constructive alliances reflecting common interests'.)

[84] OECD, Invention and Transfer of Environmental Technologies <http://www.oecd.org/env/consumption-innovation/inventionandtransferofenvironmentaltechnologies.htm> accessed on 11 November 2015.

> acceptable way than the technologies for which they are substitutes. ESTs are not just individual technologies. They can also be defined as total systems that include know-how, procedures, goods and services, and equipment, as well as organizational and managerial procedures for promoting environmental sustainability.'[85]

According to the definition put forward by the Global Development Research Center,

> 'ESTs minimize environmental degradation, whilst maintaining or improving the quality of life. ESTs are not just individual technologies. They encompass individual technologies; total systems; know-how; goods; services; equipment; and organizational and managerial procedures, that is, hard and soft technologies. Compared to traditional technologies and practices, ESTs are less polluting; use resources in a more sustainable manner; recycle more of their wastes and products; and handle residual wastes in a more environmentally and socially acceptable manner.'[86]

At a national level, the definitions of ESTs are made with different focuses in mind. Comparatively, a more exact definition is given by KIPO, whose definition considers ESTs to save or use energy and resources effectively with minimum emission of greenhouse gas and other pollutants from social economic activities.[87]

It can be seen, therefore, that ESTs do not comprise of the technologies used in particular industries, but relate to any product, service or technology that uses fewer non-renewable resources, improves energy efficiency and reduces the output of

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[85] The United Nations Conference on Environment and Development, Chapter 34, Agenda 21, 'Transfer of Environmentally Sound Technology, Cooperation and Capacity Building' (1992) <http://sustainabledevelopment.un.org/content/documents/Agenda21.pdf> accessed on 20 June 2014.

[86] The Global Development Research Center, Technology Development<http://www.gdrc.org/techtran/index.html> accessed on 10 December 2015.

[87] Kate Nuehring, 'Our Generation's Sputnik Moment: Comparing the United States' Green Technology Pilot Program to Green Patent Programs Abroad' (2011) 9 (8) Northwestern Journal of Technology and Intellectual Property 609, 619. ('In general, 'environmentally beneficial' is construed broadly without any set guidelines defining what that means, although the JPO focuses on reducing consumption and CO2 and the Korean Intellectual Property Office (KIPO) focuses upon minimizing the discharge of pollutants'.)

waste.[88] The basic characteristic renders ESTs a special kind of technology and product, stamped with marks of a time when people are nervous about the deteriorating environment and care deeply about the efficient use of exhausted resources.[89] Against such background, EST or green patents are emerging, and therefore during the review of patentability it should be particularly emphasized whether words such as *reduce, recycle,* or *improve,* or phrases such as *less pollution* or *more sustainable* could be found in the description of claims, which is viewed as the first step towards controlling the quality of EST patents.[90]

Within the following substantive review, what needs to be taken into consideration is the advancement and economy of technologies, in other words, the introduction of specific evaluation indexes, including resources, energy consumption, pollutant emission, economic cost and technology maturity in the technology application process in comparison with the most connected prior art.[91] In addition to clear description of claims, sufficient disclosure is of particular importance in the field of complex technologies.[92] Insufficient disclosure could justify the rejection of a

[88] Michael A. Gollin, 'Using Intellectual Property to Improve Environmental Protection' (1991) 4 Harvard Journal of Law & Technology 193, 196-197. (It is summarized in this article that environmental technologies include six categories, 'industrial processes which minimize resource consumption and waste production, consumer products which are environmentally benign throughout their life cycles, recycling equipment and processes, waste management technologies for solid and hazardous waste, pollution control devices, and products and methods for cleaning up pollution'. Further, it is emphasized by the author that 'environmental technology is not limited to control equipment, but is also important in manufacturing, waste management, utilities and the environmental service industry', and it is viewed as a discrete industrial sector with its own legal, technical, and commercial characteristics.)

[89] Less and McMillan (n 22) 7. (The concept of ESTs is an evolving one because some technologies that use less resource or cause less pollution today may be relatively not as environmentally friendly in the following days as they are with the emergence and availability of more advanced technologies.)

[90] EST patents named by USPTO are called as green patents by WIPO, UKIPO, KIPO, JPO and Low carbon patents by SIPO.

[91] Gollin (n 88) 197. (In comparison with the prior art, resource consumed, wastes produced, threat to human health, costs of materials and production reduced, rates of manufacture and market popularity of products increased should be considered thoroughly besides a net environmental benefit.)

[92] Keith E. Maskus and Ruth L. Okediji, 'Intellectual Property Rights and International Technology Transfer to Address Climate Change: Risks, Opportunities and Policy Options' (2010) 32 ICTSD's Programme on IPRs and Sustainable Development Issue Paper 1, 18. (Although no specific disclosure rules are required in Article 29.1 of TRIPS, it is provided in the world leading patent filing offices that patent applications must strictly follow several specific criteria, including 'description of the invention, listing of the prior art, specific and detailed claims about what the new invention precisely is, sufficient instruction that will teach someone skilled in the relevant art how to practice the invention, and

filling, and this requirement is also extremely important for the review of novelty and inventiveness of ESTs, especially when improved or combined technologies become involved.[93]

So far, there is no specific provision for novelty in TRIPS, which is considered to be a proactive way to leave room for patent laws to adapt to the development of science and technology.[94] As a matter of fact, however, an ambiguous review reduces the novelty requirement of ESTs. In practice, experienced applicants can avoid the obstacles set by the novelty requirement, by making small changes to words or by some other meticulously clever arrangements.[95] A calculated modification of claims for successful patent applications could be an effective way to implement the strategy of patent quantity maximization.[96] In this respect, the adoption of an absolute novelty requirement is a strong threshold that improves the quality of EST patents by enlarging the scope of the prior art.

At the core of an EST patent is its creative contribution to the prior art, or a solution made to any pending technical problem. The creative characteristics of ESTs are mainly expressed in claims in which inventions of different creativity levels become involved. These include initial, combined, or improved inventions, as well as new uses of known products or methods. Initial inventions refer to technologies that

disclosure of the best possible way of creating and using the invention', which work together to ensure patent quality and disclose useful information as much as possible, so that full access to new technical information could be accomplished.)

[93] European Patent Office, *the European Patent Convention*, 15th Edition October 2013< http://www.epo.org/law-practice/legal-texts/epc.html> accessed on 3 September 2015. (According to Article 84 of *the European Patent Convention*, the claims shall define the matter for which protection is sought. They shall be clear and concise and be supported by the description, which is not justifiably enough to be the legal ground for an objection. Until recently, the Expanded Board of Appeal, which is the highest case-hearing authority in EPO, has clearly stated that the accuracy of an amended claim must be evaluated in the process of objection.)

[94] Carlos M. Correa, 'Guidelines for the Examination of Pharmaceutical Patents: Developing a Public Health Perspective' (2006) ICTSD, WHO and UNCTAD Working Paper 2006 Geneva. (The TRIPS Agreement does not require the WTO members to follow some special provision for novelty but just to identify if a protected invention is novel or not conceptually from an objective perspective.)

[95] Ibid. (Obviously, a limited novelty standard will lower the threshold of creativeness of inventions, as for experienced applicants it is relatively easy to overcome obstacles set by the requirement of novelty.)

[96] Florian Kohler, Knut Blind, 'Claim Amendments as the Results of Strategic Patenting and as a Driver for Patent Value' (2010) Presented Paper at the Summer Conference 2010 on 'Opening Up Innovation: Strategy, Organization and Technology' at Imperial College London Business School June 16, 2010.

open up a new technology field or provide a new technical scheme. Combined inventions with new effects when compared with the prior art, can be granted patents for their new performance and outstanding technical advantages.[97] Improved inventions refer to significant implications of a changed relationship among fundamentals such as size, shape, scale, and molecular structure, with distinctive technical effect.[98] New use of known products or methods donates an unusual technical effect or a new function of the prior art found in any other new field.

In the absence of a wildly accepted standard of utility in TRIPS, substantive interpretation of this requirement is invited.[99] The utility of an EST needs to be substantiated in order to meet new requirements of social development distinct from the traditional meaning of utility, i.e. industrial use.[100] The obvious advantage of ESTs over traditional technologies is that resources could be used in a more sustainable and environmentally friendly way in their application process, which must meet a certain standard of environmental performance under specific conditions, with the support of scientific data.[101] This means that claims must contain specific data providing a detailed statement about the advantage of its environmentally friendly performance against the prior art, rather than the possible or expected effects on the

[97] Tamir Packin, 'A New Test for Obviousness in Combination Patents: Economic Synergy' (2006) 28 (2) Cardozo Law Review 957. (According to the 8th edition of the Black's Law Dictionary, a combination patent is defined as one granted for 'an invention that unites existing components in a novel way'.)

[98] Todd E. Rinner, 'Protecting Minor Improvements on Core Patents: Complementing Traditional Patent Protection with Strategic Disclosure' (2003) 2 The John Marshall Review of Intellectual Property Law 398.

[99] Sean B. Seymore, 'Making Patents Useful' (2014) 98 Minnesota Law Review 1046, 1052. (Utility is viewed as the most malleable patentability requirement due to the abstract and imprecise nature of 'useful', which is deemed as synonymous with the term 'utility'.)

[100] Less and McMillan (n 22) 7. (According to the UNACTD, the concept of environmentally soundness implies that ESTs should 'fulfill goals other than facilitating a given industrial, regulatory, commercial or domestic processes, and provides benefits or utility more broadly than solely to productivity'.)

[101] Hari M. Osofsky, 'Technology Transfer and Climate Change' (2011) in Lidgard, Atik & Nguyen (eds), *Sustainable Technology Transfer-A Guide to Global Aid and Trade Development* (Kluwer 2011). (According to the UNEP report, 'the environmental performance of a technology depends upon its impacts on specific human populations, biota and ecosystems, and the availability of supporting infrastructure and human resources for the management, monitoring and maintenance of the technology, as well as the sustainability of natural systems. The soundness of environmental technology is also influenced by temporal and geographical factors'.)

environment.

Even more importantly, the data provided by applicants shall go through reasonable evaluation. The environmental performance evaluation adopted as an important index in the review of EST patent application needs be taken seriously and clarified. Although a common perspective held internationally is that this special requirement ought to be incorporated into patent examination, it does not appear as a formal requirement of patentability, rather it is described in voluntary applications.[102] For instance, the UKIPO green channel is only applicable if reasons for the application and climate friendly performance of technologies are include in the statements.[103] The green technology pilot project under USPTO has similar rules that are stricter than the UKIPO green channel.[104] JPO and KIPO are making more rigorous controls on the application for acceleration programs, indicating that the social duty of applicants is regarded as crucially significant.[105]

More specifically, patent applicants are required to submit a professional assessment made by a third party that includes a data report about the objective performance of inventions for the patent granting authorities' reference, so that the wheat can be separated from the chaff in a market where the good is mixed with the

[102] Estelle Derclaye, 'Not Only Innovation but also Collaboration, Funding, Goodwill and Commitment: Which Role for Patent Laws in Post-Copenhagen Climate Change Action' (2010) 9 J. Marshall Rev. Intellectual Property L. (Special Issue) 657. (An enhanced requirement of disclosure of information about inventions' environmental impact is proposed, but an application would not be refused or revoked only because of its failure in environmental part of disclosure, meaning that it is not mandatory.)

[103] UKIPO, Green Channel Patent Statistics -Request for information on accelerated patent examination for environmentally beneficial technologies, first published on 26 November 2014<https://www.gov.uk/government/publications/green-channel-patent-statistics> accessed on 12 October 2015.

[104] USPTO, Accelerated Review of Green Technology Patent Applications <http://www.uspto.gov/inventors/independent/eye/201106/tipgreentech.jsp> accessed on 18 September 2015. (Only within the green technology pilot project under USPTO who has listed the classification numbers of green patent technologies, are patent applications eligible to apply this project in addition to a written request explaining its substantial contribution to the environmental protection. The acceleration process Track I has expanded to more inventions, not only for ESTs after this pilot program.)

[105] Japan Patent Office, Accelerated Examination and Accelerated Appeal Examination <http://www.jpo.go.jp/english/activities/examination/examination/index.html> accessed on 6 October 2015.

bad.[106] According to the definition of ESTs as summarized in this thesis, requirements in reports vary between different ESTs, the most fundamental part of which is their contribution to the improvement of traditional methods of energy utilization and the development of new and renewable energy technologies.[107] For ESTs used to improve traditional methods of energy utilization, precise details and data about energy conservation, emission reduction and energy efficiency is necessary, and for new and renewable energy technologies, the review might be relatively more lenient.[108]

In relation to this aspect, the internationalization of the environmental technology verification at present is undoubtedly a commendable endeavor. Environmental Technology Verification is an assessment activity undertaken by a third party entrusted by owners, users of ESTs, patent grant authorities or other related parties, according to clearly defined criteria with integrated use of technical principles, testing, mathematical statistics, expert evaluation and so on, to verify the technical performance, pollution control and operation maintenance of ESTs.[109] EVT was essentially initiated by national environmental protection departments to authorize an

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[106] Ashleigh Hebert, 'Expediting Green Patents: the Expedited Examination Programs' Contribution to Diminished Patent Quality' (2012) 31 Cardozo Arts & Entertainment Law Journal 249. (The patent quality remains a growing problem because patent-granting authorities value efficiency over quality which should be the priority of consideration when the environmentally-soundness of green technologies is examined.)

[107] Kate Nuehring, 'Our Generation's Sputnik Moment: Comparing the United States' Green Technology Pilot Program to Green Patent Programs Abroad' (2011) 9 (8) Northwestern Journal of Technology and Intellectual Property 609, 619-620. (Following the explanation made by the UKIPO about the Green Channel application program, applicants are required to submit a written document about the environmentally friendly characteristics of claimed technologies, but review requirements of these submitted written documents vary according to technology categories.)

[108] Ibid. (For example, the UKIPO elaborates that simple statements suffice for solar panels or wind turbines, whereas more detailed statements would be necessary for a manufacturing process that uses less energy.)

[109] David Ockwell, Jim Watson, Alexandra Mallett, Ruediger Haum, Gordon MacKerron, Anne-Marie Verbeken, 'Enhancing Developing Country Access to Eco-Innovation: The Case of Technology Transfer and Climate Change in a Post-2012 Policy Framework' (2010) No. 12 OECD Environment Working Papers 1, 35 < http://dx.doi.org/10.1787/5kmfplm8xxf5-en> accessed on 2 November 2014. (From the standpoint of firms, it is necessary to ensure the minimum standards of performance. ETV is viewed as a program that 'develops test protocols and verifies the performance of innovative technologies that have the potential to improve protection of human health and the environment'. ETV is not a private company but an independent initiative undertaken based on a 'not –for –profit public or private partnership' as an efficient means to share information.)

executive agency to manage the system and entrust an independent third body to test, review and release the information regarding ESTs. As a method of evaluating the objective technical ratings of ESTs, EVT is a good reference for the establishment of patentability standards, although the purpose of promoting the internationalization of ETV has centered around the mutual recognition of ESTs performance in the international market so as to accelerate their commercialization.[110]

5.3.2.2 The Relative Extension of EST Patent Protection

Currently, in line with TRIPS, the basic protection given to patents lasts for twenty years.[111] An increasing number of IP offices, such as USPTO, UKIPO, CIPO, JPO, KIPO etc., have taken the initiative to accelerate the examination process. This considerably shortens the period between examination and grants and as a result, increases the speed of knowledge diffusion brought about by EST patents through the actual extended period of market access of patented ESTs.[112] From this perspective, the building of a universally recognized international standard procedure to accelerate patent grants is good for the growth of social welfare and should be well supported.[113]

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[110] Ibid. (In the light of its development history, the ETV system that draws wide attention from a lot of countries is undergoing a gradual internationalized process. Following the USA, Canada, the European Union (EU), Japan, Korea, the Nordic countries and the Philippines have now developed similar pilot or fully operating programs, and Bangladesh, India and Singapore have expressed an interest in following suit. 'The EU is also currently sponsoring an initiative which will attempt to involve technology vendors in a scheme where technologies receive joint verification under all three of the US, Canadian and European verification programs, thus increasing the international standardization of the verification process and the potential access to international markets for technology vendors.')

[111] Deborah Behles, 'The New Race: Speeding up Climate Change Innovation' (2009) 11 (1) North Carolina Journal of Law & Technology 1, 29. (It is pointed out by the author that the twenty years of patent duration required by TRIPS limit access to technologies, particularly causing problems in the area of climate change because the wide availability of some ESTs is crucially of importance to GHG emission reduction needed to be made as soon as possible.)

[112] Ashleigh Hebert, 'Expediting Green Patents: the Expedited Examination Programs' Contribution to Diminished Patent Quality' (2012) 31 Cardozo Arts & Entertainment Law Journal 249, 251. (The pendency period for patent applications is reduced as the result of accelerated programs for green technologies which are rapidly growing in a sharp market competition, allowing inventions to enter the market more quickly.)

[113] Eric L. Lane, 'Building the Global Green Patent Highway: A Proposal for International Harmonization of Green Technology Fast Track Programs' (2012) 27 Berkeley Technology Law

Furthermore, according to the prior legal and economic analysis, a proper extension of patent duration could motivate innovators beyond cost-recovery incentive.

Office	Release Date	Scope of Application	Acceleration Process
UKIPO	12-05-2009	The 'Green Channel' is open to technologies with environmental benefits as long as 'a reasonable assertion' is provided, which will not be investigated but will be refused if it 'is clearly unfounded'.[114]	A patent can be granted in 9 months under this scheme, which takes much less time than the current average examination time of 24-36 months.
KIPO	01-10-2009	The special program applies to technologies that 'minimize the discharge of pollutants' and those receive 'funding or a specific green certification from the Korean government'. Additionally, a prior art search report issued by one of three service agencies officially authorized by KIPO must be submitted.[115]	Compared with the average time of 18 months for ordinary examinations, the 'super-speed' program considerably reduces the examination time; the record for the fastest time taken to grant a patent in 11 days from the date of application.[116]

Journal 1119. ('A standardized and balanced international system of expedited examination would encourage greater participation in green technology fast track programs and reduce the time to grant for a larger number of green patents, thereby fostering development and diffusion of green technologies.')

[114] The UK Intellectual Property Office, 'Patents: Accelerated Processing-Green Channel for Patent Application' <https://www.gov.uk/guidance/patents-accelerated-processing> accessed on 10 May 2015.

[115] The Korean Intellectual Property News Release, 'Thanks to super-speed examination, green technology acquires patent in a month' <http://www.kipo.go.kr/kpo/eng/> accessed on 12 April 2014. ('The super-speed examination system is subjected to green technologies that minimize the discharge of pollutants, as well as those which received funding or authentication for green growth.')

[116] Ibid.

JPO	01-11-2009	A green patent fast track initiative was introduced for technologies that contribute to energy conservation and carbon dioxide emission reduction with a description explaining such contribution, a result of prior art search and the difference between claimed technologies and the prior art.[117]	The fast track program can issue the first notification of opinions about examination within 3 months of the date of application, a markedly shortened time compared to the average time of 28 months.
USPTO	08-12-2009	The Pilot Program is made for technologies that substantively improve environmental quality, discover or develop renewable energy, save energy or use it more efficiently, and reduce emission. There is a separate request to explain the substantive contribution. Claimed technologies must also be covered in the green patent classification under USPTO.[118]	Under this program, a patent is expected to be granted within one year or less, with an average time of 36 months where claimed technologies are eligible.

Table 1 the ESTs Fast Track Programs under Major Patent Offices (Self-compiled)

[117] Japan Patent Office, 'Accelerated Examination for Green-related Applications' <http://www.jpo.go.jp/torikumi_e/t_torikumi_e/outline_accelerated.htm> accessed on 12 April 2014.

[118] The United States of American Patent and Trade Office Press Release, 'Remarks at Press Conference Announcing Pilot to Accelerate Green Technology Applications' <http://www.uspto.gov/about-us/news-updates/remarks-press-conference-announcing-pilot-accelerate-green-technology> accessed on 6 May 2015.

5.3.2.3 Differentiated Breadth of EST Patents

A differentiated patent protection for different ESTs is a possible solution to appropriately narrow the breadth of patents, as ESTs are usually protected by maximized quantity of patents due to their characteristically clustered nature.[119] From Table 1 above, it can be seen that the requirements for the width of EST patents are very lenient; patents are granted as long as the invention meets the requirements of novelty, inventiveness and industrial application provided in TRIPS.[120] As the number of global patents pertaining to ESTs rapidly increases, the premise of the differentiated protection of ESTs is the recognition of patent values resulting from patent data.[121]

The current methods of patent data analysis are principally comprised of patent indicators, patent citation and patent portfolio analysis. The latter two are strongly recommended here. The analysis of patent indicators makes an estimate of the macro trend in technology fields, rather than the assessment of the value and influence of protected technologies. The analysis of patent citation and portfolio, which suits the cluster characteristic of ESTs, could provide useful reference for the differentiated protection of ESTs in the patent value evaluation, to identify basic patents and also reveal the technology development trends.[122]

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[119] Parchomovsky and Wagner (n 81) 5. (Wagner pointed out that in the field of complex technologies where one technology is jointly protected by a number of patents, the value of patent portfolios is greater than the sum of single patent's value and large patent portfolios can effectively hinder competitors.)

[120] UNEP, EPO and ICTSD, 'Patents and Clean Energy: Bridging the Gap between Evidence and Policy: Final Report' (n 80) 67. (As in practice many patent offices open green channels and accelerate examination of patent applications for ESTs, the issue of quality of EST patents needs appropriate attention when the time is right.)

[121] Parchomovsky and Wagner (n 81) 9. (Patent data does have a signaling effect on the better understanding of defensive theories of patent values at the patent portfolio level rather than on an individual basis.)

[122] Bernice Lee, Ilian Iliev and Felix Preston, 'Who Owns Our Low Carbon Future?' (2009) A Chatham House Report on Intellectual Property and Energy Technologies, 18-19 <http://www.chathamhouse.org/sites/default/files/public/Research/Energy%20Environment%20and%20Development/r0909_lowcarbonfuture.pdf> accessed on 3 May 2013. (According to the statistic, one clear characteristic of a relatively high concentration of patent ownership is found across six energy sectors, including wind, PV, biomass, concentrated solar power, cleaner coal and carbon capture. The patent portfolio is formed based on an originally filed single patent, and the larger the patent portfolio

The patent system is intended to guarantee a comprehensive and orderly innovation system, whereby the interest of patent holders is protected through exclusion of competitors who do not share the cost of initial innovation. Those who are further behind the subsequent innovator are also excluded, so that innovative activities can proceed with a high degree of order.[123] According to the three stages of technological innovations (basic discovery, further research & development, and marketing), different types of patents are produced with varying functions during the life cycle of innovative products.[124] Most basic and core patents come into being at the incubation period of technologies. As the technology matures, improvements are made; concurrently various patents surrounding core patents form a core technology cluster, resulting in a new combination of patents taking shape.[125] The continuous upgrading of technologies further promotes the birth of new basic patents, which is referred to as a relatively complete technology development cycle.

From the perspective of patent protection, the occurrence of a patent cluster often sees improvements around a major technology that are enhanced and combined many times.[126] This demonstrates the three levels of technological development: basic, improved and combined technologies. In view of the technology development process,

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is, the more valuable the underlying technology is.)

[123] F. Scott Kieff, 'Patents for Environmentalists' (2002) 9 Washington University Journal of Law & Policy 307, 309. ('This right to exclude competitors who have not shared in bearing the initial costs of commercialization provides incentives for the holder of the invention and the other players in this market to come together in an organized way and incur the costs necessary to facilitate commercialization of the patented invention'.)

[124] Gollin (n 88) 197-198. (According to the 'trichotomy' initiated by Joseph Schumpeter, 'the technology cycle can be viewed as having three phases: invention, innovation, and diffusion. Invention is the implementation of a new idea or concept leading to a new product or process; innovation, the development and initial commercial transfer of an invention; and diffusion, the spread of a new process or product within or across markets.')

[125] Rinner (n 98) 420-421. (For each major, core patent, there is usually at least one improvement on it. The improvements on major, core patents come naturally in an open and competitive market, and are usually hold by one company that can use them as an effective strategy to prevent others from patenting a closely-related improvement.)

[126] Duncan Matthews, 'Patents in the Global Economy' (2010) Queen Mary University of London, School of Law Legal Studies Research Paper No. 73/2010, 4 <http://ssrn.com/abstract=1759522>accessed on 25 April 2012. (The cumulatively powerful effect of technologies on growth is demonstrated by 'a relatively mundane process involving minor adaptations to existing technologies', as the pioneering inventive breakthroughs are extremely rare and in most cases there are improvements around them.)

the scope of protection over inventions that are major technological breakthroughs in the field of natural science is always wide. Nevertheless, with the development of this new technology becoming available to more and more people, the creative work surrounding it gets harder, and many subsequent innovations in the relevant field are considered to be improved or combined technologies, unless there is a significant breakthrough in fundamental means and methods.[127]

As ESTs represent the trend of a new technology revolution with highly multi-technological intersection and integration, the development of ESTs is supposed to make substantial contribution to energy conservation and pollution reduction in traditional sectors, as well as also lending itself to the progress of alternative energy technologies.[128] Accordingly, patent claims about ESTs might contain individual, improved or combined methods, processes, know-how, goods, equipment, material or substances that are relevant to the subjects of emission reduction from sources, new energy, improvement of resource utilization efficiency, carbon capture and sequestration and so on.[129]

Some research has shown that in the absence of policy intervention, the innovation of processes and methods will strengthen competition, whereas innovation of products will relax price competition.[130] Consequently, enterprises usually tend to

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[127] Ibid. (Subsequent innovations to basic or core patents are often minor and incremental improvements which are prohibitive enough to allow a company to preserve the value of a basic, core patent and maintain its market monopoly.)

[128] Keith E. Maskus and Jerome. H. Reichman, 'The Globalization of Private Knowledge Goods and the Privatization of Global Public Goods' (2004) 7 (2) Journal of International Economic Law 279, 290. (Today, cutting-edge technologies behave in a way that differs from the ways the traditional technologies of the industrial revolution did harm to other public goods, such as environment, health, education that were almost total neglected by old generations.)

[129] Babette Never, 'Toward the Green Economy: Assessing Countries' Green Power' (2013) No. 226 German Institute of Global and Area Studies Working Paper on the Research Programme: Power, Norms and Governance in International Relations June 2013, 9. (Based on the definition made by Environmental Technology Action Plan of the European Commission, ESTs refer to 'all forms of innovation activities resulting in or aimed at significantly improving environmental protection. Eco - innovation includes new production processes, new products or services, and new management and business methods, whose use or implementation is likely to prevent or substantially reduce the risks for the environment, pollution and other negative impacts of resources use, throughout the life cycle of related activities'.)

[130] Mukesh Eswaran and Nancy Gallini, 'Patent Policy and the Direction of Technology Change' (1996) 27 (4) RAND Journal of Economics 722.

file applications for products rather than methods. From a social welfare point of view, the scope of products under patent protection has a significant impact on the accessibility of goods, whereas the protection of methods requires that the efficiency created by claimed know-how, processes or procedures is improved above the level of the prior art. In considering the attainment of patent exclusive rights, in the discussion below ESTs are divided into basic, improved and combined innovations, which represent different levels of creativity and have different impact on social welfare, including their environmental impact. Accordingly, consideration of differentiated breadth is necessary to promote access to ESTs by controlling the scope of protection of products and methods related to ESTs.

A. Basic innovations

A basic innovation corresponding to a completely independent claim is to be analyzed first. Among ESTs, technologies with a high level of creativity often refer to the first invention, e.g. a new method or know-how, the development of new equipment, or a new material. Most of these belong to major and core patents within that area of technology.[131] For example, in respect of flexible solar cells, a new material DuPont Kapton polyimide film has been developed and used in cadmium telluride film photo-voltaic modules. This material has created a new world record for light energy conversion efficiency.[132] Moreover, this new material is considered to be the first invention in this field, despite its proximity to energy conversion efficiency of

[131] The WHO Report, 'Local Production for Access to Medical Products : Developing a Framework to Improve Public Health' (2011) The Report comes from the Joint Project largely conducted by the World Health Organization (WHO), the United Nations Conference on Trade and Development (UNCTAD), the International Centre for Trade and Sustainable Development (ICTSD) on 'Improving access to medicines in developing countries through technology transfer and local production', 20 <http://www.who.int/phi/publications/local_production_policy_framework/en/> accessed on November 21, 2013. (Basic or core innovation refers to originated inventions or breakthrough in relevant technology areas, for example the introduction of a new technology into an existing market or an existing technology into a new market, or changes the way the offering is delivered, relative to small but significant changes.)

[132] A team from Swiss Federal Material Science and Technology Laboratory use this new colorless film to do the experiment of energy conversion, the result of which shows that the conversion efficiency reaches 13.8% and refreshes the record of 12.6%.

the commonly-used photo-voltaic glass, as it is one hundred times thinner and two hundred times lighter.[133]

Timely information disclosure of basic innovations will drive subsequent innovation and consequently promote technological progress. This might not, however, be to the advantage of the originators' own subsequent creation as the R&D costs of fundamental innovation are usually high and the survival of initial innovators is challenged by subsequent innovators.[134] Extending the scope of protection for products originated in the basic innovation stage will force new arrivals to present products that differ substantially from the first creation so that users stimulate price competition, which is helpful to increase access to ESTs.[135] Disclosure of information relating to the basic innovation of methods can encourage more effective competition, and thus paralyze access difficulties caused by patented products. It follows, therefore, that the wide scope of basic innovation in methods, know-how, processes, procedure, goods, equipment, materials, and substances is conducive to access to ESTs.

B. Innovations of improvements

Improved innovation is based on the full application of prior art. The significant effect corresponds to subordinate patent rights; the new patented technology contains all the characteristics of the prior art. As techniques and technologies used to exploit traditional energy come of age, technologies that improve the efficiency of traditional energy and the way it is utilized could be used to minimize the adverse effect of

[133] Ibid.

[134] David Popp, Nidhi Santen, Karen Fisher-Vanden, Mort Webster, 'Technology Variation VS. R&D Uncertainty: What Matters Most for Energy Patent Success?' (2012) National Bureau of Economic Research Working Paper No.17792, 4. ('Interestingly, it is found that increases in subsequent patents lead to a proportionally higher increase in citations to earlier high quality patents, suggesting that these high quality patents may induce subsequent innovations.')

[135] Adam B. Jaffe, Richard G. Newell, Robert N. Stavins, 'A Tale of Two Market Failure: Technology and Environment Policy' (2005) 54 Ecological Economics 164, 167. (It is argued by the author that innovations create not only knowledge spillovers for other competitors but also value spillovers for the users of new technologies, because 'the process of competition will typically drive a firm to sell a new device at a price that captures only a portion of its full value, which means that consumers also reap some of the benefits from new technology'.)

traditional energy on the environment.[136] A good example of this is advanced clean coal technology, a set of improved technologies developing out of the hierarchy between the subcritical to supercritical and ultra-supercritical parameter levels.[137]

Circulating fluidized bed technology is a type of advanced clean coal technology that has lower discharge of pollutants, better fuel flexibility, higher burning efficiency and stronger load adaptability with adjustments of parameters and utilization of new wear preventive and refractory materials.[138] For such type of improved technologies, patent protection only applies to the improved part; to methods rather than products. The protection of improved methods or processes could create a more intense competition in emission reduction and energy conservation, by emphatically encouraging more efficient access rather than strategic disclosure.[139]

There are a large number of ESTs that are improvements of basic or mature innovations in high-tech industries, such as the semiconductor industry and biotechnologies.[140] These can be used to restructure traditional and new energy sectors due to their vanguard role and relevance to energy conservation and emission reduction. These valuable innovations should be encouraged and protected, especially in light of their contribution to reducing production cost and damage to the

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[136] Elisa Lanzi, Elena Verdolini, Ivan Haščič, 'Efficiency Improving Fossil Fuel Technologies for Electricity Generation: Data Selection and Trends' (2011) Sustainable Development Series by Foundazione Eni Enrico Mattei 10.2011, 2. (According to the statistic by IEA 2010, fossil fuel source is likely to remain a major input for power generation, so the development and application of technologies that can improve the efficiency of fossil fuel and the way it is used would do a substantial contribution to reducing GHG emissions caused by fossil fuel, and thus be a major concern for countries when making any decision or taking measures against climate change.)

[137] Ibid 5-6. (The development of clean coal technologies has witnessed great improvements in efficiency at various stages of the coal-to-electricity process. For example, pulverized coal combustion technology consists of subcritical, supercritical and ultra-supercritical levels with the current highest efficiency at ultra-supercritical level.)

[138] Ibid 7-8.

[139] Rinner (n 98) 421-422. (From the perspective of protecting full value of core innovations for companies, it is suggested by Rinner that minor improvements on core patents be published as a strategic disclosure, to prevent other competitors from patenting an improvements without 'prohibitive costs of blanket-patenting'.)

[140] Dechezleprêtre, Glachant, Hascic, Johnstone, Ménière (n 57) 45. (According to the IPC Codes for some renewable energy technologies, devices or materials involving semiconductor, biotechnology and other closely-related industries are commonly found.); Eric L. Lane, 'Cancun, Climate Change, and Intellectual Property Rights: No News is Good News for Green Patents' (2011) 2011 Eur. J. Risk Reg. 61.

environment. During the review of claims, however, in addition to the general principles, a more stringent inventiveness requirement is applicable, which includes priority factors such as the correlation of applicable technology fields, the difficulty of improvement, technical effects thereof, and an unpredictable expanding function by the use of known methods.[141]

For example, thin-film solar PV manufacturing technology is a technical improvement developed from the technology used to make the substrate deposited conductive material layer in the computer industry.[142] In the patent application claim, the most important part applicants should focus is the reason the real difference exists between the manufactured technology applied to thin film in solar cells and to hard disks in the computer industry. In addition to this, the claim should explain that the improved technology applicable to thin film solar cells is a non-obvious method used to solve technical problems in a different field from that where it originates. For such kind of technology, patent protection should be limited to new procedures and methods, excluding products and equipment.

Another common point should be raised here: certain ESTs in specific areas reflect modesty improvements of known technologies and know-how. For example, geothermal power generation technologies refer a set of advanced exploration technologies, drilling technologies, and highly-efficient heat utilization technologies. The former two have been wildly used in energy exploitation, and the latter is also

[141] Frauke G. Braun, Jens Schmidt-Ehmcke, Petra Zloczysti, 'Innovative Activity in Wind and Solar Technology: Empirical Evidence on Knowledge Spillovers Using Patent Data' (2010) DIW Berlin German Institute for Economic Research Discussion Paper 2010, 1-2. (The knowledge spillover occurs either at the international or national level, either in the same technology field or other economic sectors or some closely-related technology field or sectors. For example, the solar PV sector, strongly entwined with the semiconductor industry, uses its silicone by-products for solar cell manufacturing and takes advantage of its process know-how, demonstrating a typical example of cross-industry spillovers.)

[142] John H. Barton, 'Intellectual Property and Access to Clean Energy Technologies in Developing Countries: An Analysis of Solar PV, Biofuel and Wind Technologies' (2007) ICTSD trade and sustainable energy series, Issue Paper No.2, 9. (As the newer technology compared with the first generation of solar PV that was based on crystalline silicon, much the same material used in semi-conductors for computers, thin-film solar PV manufacturing technology applies various semiconductors to the surface of facilities like a glass with lower cost and higher production efficiency.)

commonly seen in the process of energy conversion. As far as technologies relating to non-specific areas are concerned, such improvements are capable of easy migration to another related technology field. Accordingly, these are viewed as discover of new use, rather than as creative new solutions for different technical problems. As such, these improved technologies will not often be protected by patent systems.[143]

C. Innovations by combination

The following discussion pertains to combined innovations between known and improved technologies, denoting that the innovations must be based on an element of prior art. Claimed inventions generally involve technical advancement resulting from a combination of known technologies, demonstrating the intersection and correlation of patented technologies. A characteristic of ESTs is that they are comprised of combined technologies from multiple fields. ESTs are closely related to semiconductor materials and processes, electrochemical technologies, optical components, systems, equipment, optical fiber, optical control technology and so on, largely because electricity is the form of energy conversion in which ESTs operate.[144] Consequently, many different forms of combined ESTs are found in patent applications: combinations of known equipment and processes, combinations of known materials and processes, and combinations of different materials.

a. Combinations of known equipment and processes

[143] Edward Van Gieson and Paul Stellman, 'Killing Good Patents to Wipe out Bad Patents: Bilski, the Evolution of Patentable Subject Matter Rules, and the Inability to Save Valuable Patents Using the Reissue Statute' (2011) 27 Santa Clara Computer & High Tech. L. J. 403, 406-407. (The US patent law has specific and more liberal provisions about the new use of known process, permitting 'the patenting of new uses of known processes and machines, subject to the other statutory requirements of 35 U.S.C. §§ 102-103 that the invention be novel and that the 'subject matter as a whole' would have been non-obvious at the time the invention was made to a person of ordinary skill in the art'.)

[144] Zhiping Yang, Yunwei Chen, Shu Fang, 'The Comparative Study on the Correlation between Inventive Patents from Chinese Academy of Science and Foreign Research Institutions' (2010) 12 Science and Technology Management Research 215. (The study on the interactive correlation of patented technologies shows that the phenomenon of technology crossing is commonly seen between semiconductor materials, processes, discrete devices and electrochemical technologies, and also between optical components, systems, equipment, fiber and optical control technologies, indicating that patent applications for crossing technologies between the two groups of technologies are very active.)

To be patentable, combinations of known equipment and processes must show maximum regard for the requirement of inventiveness, which is much harder to meet than the other two requirements.[145] Personnel within the field are typically skillful in using a combination of equipment and processes to develop different types of products; however, bringing things together does not necessarily signify creativity.[146] In some cases, however, if it can be made clear in the application form that the known equipment and processes come from different areas and, most importantly, the combination has an entirely different function, then this combination can be protected as a patented method or product.[147]

For example, the combination of single particle separation technology used for chip production in the semiconductor industry and the process of solar PV manufacturing slots generates a trough zone in separating links in solar PV. This demonstrates that the combination of key elements creates a function and a result that was not previously contemplated by the known processes.[148] It is not easily observable that the single particle separation technology could provide that kind of space for sunlight concentration when dealing with the separation of semiconductor chips.

[145] Packin (n 97) 958-962. (A combination patent is defined as 'a patent granted for invention that unites existing components in a novel way' in Black's Law Dictionary. To be patentable, a combination patent must be useful, novel and non-obvious. A combination of known components can be novel and useful as long as it does not exist anywhere in the prior art and is of industrial application. However, to determine whether such a combination is non-obvious is much harder, which requires a series of tests.)

[146] Ibid 968. (According to 340 U.S. 152, three patents were invalidated on the ground that a combination which only unites elements of prior art 'with no change of their respective functions' is obvious and thus non-patentable.)

[147] David Ockwell, Jim Watson, Alexandra Mallett, Ruediger Haum, Gordon MacKerron, Anne-Marie Verbeken, 'Enhancing Developing Country Access to Eco-Innovation: The Case of Technology Transfer and Climate Change in a Post-2012 Policy Framework' (2010) No. 12 OECD Environment Working Papers 2010, 15 < http://dx.doi.org/10.1787/5kmfplm8xxf5-en> accessed on 2 November 2014. (In this article, hybrid cars are taken as an example of 'radical innovation', which combine the two existing technologies, the internal combustion engine and battery-driven electric motors, in the manufacture of 'a new, significantly more energy efficiency vehicle'.)

[148] Packin (n 97) 968. (According to US Supreme Court, if the combination of components functions in the same way that they do in the prior art, they are obvious and not patentable.)

b. Combinations of known materials and processes

In patent claims, it is quite common to find combinations of known materials and processes, especially in the field of solar photovoltaic systems.[149] The key to become patented is that this combination can achieve significant technological breakthroughs and thus meet the requirement of inventiveness. The dye sensitized solar PV cell developed by SONY Company is a good example, which combines molecules extracted from the dye with the coated printing technology to make multicolor and diversified design. Light absorbed by the dye molecules is converted into electrical energy, achieving the world's highest light-to-electricity conversion rate of 9.9%, with a minor impact on the environment.[150]

c. Combinations of different materials

Certain claims are made directly for combinations of materials, such as wide band gap semiconductors, which are granted patents depending on synergistic effect.[151] In most cases, coordination between two or more materials is considered a discovery rather than a creation.[152] Claims for combinations of

[149] Joern Huenteler, Tobias S. Schmidt, Jan Ossenbrink, Volker H. Hoffmann, 'Technology Life-Cycle in the Energy Sector- Technological Characteristics and the Role of Deployment for Innovation' (2012) Presentation at the School of Science and Technology Policy at KAIST, South Korea, the Energy Policy Consortium Seminar at Harvard University, USA, the ECN/ETH Zurich side Event at UNFCCC COP18 in Doha, Qatar, the International Sustainability Transition 2012 Conference in Copenhagen, Denmark, and the International Schumpeter Society Conference 2012 in Brisbane, Australia, 26-27. (Chosen as one of the research case technologies that have high significance of scale production, solar PV is considered as one that includes all technologies related to power generation, using the photovoltaic effect, associated procedures and elements. Accordingly, 'solar PV systems can be characterized as process-intensive products, some of which will thus exhibit an even earlier and more pronounced focus on process innovations'.)

[150] Jihuai Wu, Zhang Lan,, Jianming Lin, Miaoliang Huang, Yunfang Huang,, Leqing Fan, Genggeng Luo, 'Electrolytes in Dye-Sensitized Solar Cells' (2015) 115 (5) Chem. Rev. 2136.

[151] Packin (n 97) 960. (One of the two approaches employed by the US Supreme Court in examining the non- obviousness of combination patents is 'synergy test', which 'requires that the known elements, when combined, must function in a synergistic way, where the function of the whole is greater than the sum of the parts'.)

[152] Shadlen (n 61) 13-14. (By setting their own rules on the requirement of creativity, countries can deny patents to discoveries so as to control the scope of patent protection. Taking India's amended Patent Act as an example, it is stated clearly that discovery of new forms or combination of known substances that do not produce efficacy improvement is not eligible to patent protection.)

> materials are substantially equivalent to technical method claims; to a large extent, combinations of materials provide methods to use a variety of materials simultaneously within one area. They are not typically regarded as creative unless a novel and non-obvious synergistic effect is established through scientific experiments and fully disclosed.[153] In general, combinations of materials are closely connected with technical effects. The use of combinations of different materials in known processes can produce unexpected results which significantly improve the performance of existing technologies or reduce their negative environmental impact. For example, for the first time, two wide band gap semiconductor materials, ZnO and one inorganic compound ZnSe, have been used in the solar photovoltaic power generation process, the effect of which greatly increase the stability and extend the usage of solar photovoltaic cells.

Generally, the breadth of patents for basic innovations is relatively broad. On the other hand, the breadth is narrow for improved and combined innovations, given that a vague standard of patentability is made for ESTs in the international patent system, which has objectively contributed to a surfeit of non-basic and non-core patents. Under the great wave of green innovations, the number of patents for improvements and combinations surrounding basic and core patents has increased dramatically.[154] Nevertheless, the quality of those patents may not be effectively guaranteed, which weakens the role of patents in stimulating innovation that is distinguishable from duplicate research. It also amplifies the negative effect of monopoly, which deserves serious attention. Therefore, with regard to improved and combined ESTs, the principle behind protection is to primarily grant patents on methods, supplemented by

[153] Tamir Packin, 'A New Test for Obviousness in Combination Patents: Economic Synergy' (2006) 28 (2) Cardozo Law Review 957, 960.

[154] Carolyn Fischer and Richard G. Newell, 'Environment and Technology Policies for Climate Mitigation' (2008) 55 (2) Journal of Environmental Economics and Management 142, 144. (Given the difficulty in making breakthrough technologies, focus has been placed on emission reduction over the 'near-to-mid term and incremental improvement of existing technologies'.)

patents on products.

5.3.3 Key Sector-Based Classification of ESTs

In light of climate mitigation and adaptation, the new classification system of ESTs, which is more significant than in other technology fields, is both inevitable and necessary. A comprehensive and accurate retrieval of EST patents is the first step. In June 2009, USPTO officially launched *EST Concordance*, restructuring groups of patents exclusively for tackling climate change in accordance with the existing standard within the current USPC and IPC system.[155] EST Concordance is an example of the IPC classification system, under which climate change mitigation and adaptation technologies are divided into five categories: alternative energy, energy storage, environmentally friendly agriculture, environmental purification, protection or restoration, and EST-related regulations, design and education.[156]

WIPO has been paying attention to the technological challenges from climate change and the role of IPRs, especially the role of patents in addressing climate change, and is dedicated to working with all parties to promote the reform and development of patent systems. In order to solve the issue of EST patents classification and database construction, WIPO established a working group on the international patent classification. In September 2010, this group introduced an online retrieval tool, IPC Green Inventory, to facilitate the retrieval of EST patents, working toward the integration of ESTs in the various fields within the existing international patent classification database.[157] A commendable feature of the IPC Green Inventory

[155] The US Patent and Trade Office, 'Environmentally Sound Technologies Concordance' < http://www.uspto.gov/web/patents/classification/international/est_concordance.htm> accessed on 2 February 2014. (In view of their dispersed character across various technology fields, ESTs are identified as environmentally sound only by means of their functions in environmental performance. The ESTs Concordance is designed 'to serve as an entry point for locating EST subject matter'.)

[156] Ibid. (It is worth noting that 'the EST Concordance was created to serve as a broad guide for the classifications of ESTs, and is neither exhaustive nor exclusive of ESTs as a whole'.)

[157] WIPO, International Patent Classification Green Inventory < http://www.wipo.int/classifications/ipc/en/est/> accessed on 21 December 2014.

is that the retrieval terms are designed according to the technical terms under the UNFCCC and involve two hundred topics directly connected to ESTs. This indicates that WIPO has converted its deep concerns on climate change into tangible actions, and has intensified its efforts to strengthen its cooperation with the UNFCCC on climate change and other relevant issues.[158]

The international patent classification index list under WIPO falls into seven categories: alternative energy production, transportation, energy conservation, waste management, agriculture/ forestry, administrative, regulatory or design aspects, and nuclear power generation.[159] Each of these categories corresponds to all relevant international patent classification numbers. The international patent classification index system becomes the international classification standard of climate mitigation technologies, viewed as a new milestone in the reform of the IPC system.

Efficient innovation of ESTs is based upon the comprehension of the current development trends in ESTs, but the IPC Green Inventory and the location of ESTs within its design is based on the functions of technologies, i.e. the inherent characteristics and properties of ESTs, which are not an immediate sign of the overall development of related industries.[160] The technical application of closely related ESTs is of particular prominence on a sectoral basis. Against the reality of energy shortage and environmental degradation, fundamental industries such as power generation and transportation, which are necessary for guaranteeing social economic sustainable development, have to satisfy their domestic and international obligations

[158] Scott Taylor, 'Where are the Green Machines?: Using the Patent System to Encourage Green Invention and Technology Transfer' (2011) 23 The Georgetown International Environmental Law Review 577, 586. (WIPO, under the auspice of Patent Cooperation Treaty, is eminently calculated for a good organization to develop an appropriate standard for review of green technology application, and has intensified its efforts to deal with issues closely-related to EST patents by learning lessons and lending experience from UNFCCC. The creation of the PCT Green Inventory classification system launched in September 2010 by WIPO is a good example, aiming at facilitating the retrieval of patent information for EST patents.)

[159] WIPO, the IPC Green Inventory <http://www.wipo.int/classifications/ipc/en/est/> accessed on 12 July 2015.

[160] Ibid. ('The links in the PATENTSCOPE column allow the user to automatically search and display all international patent applications available through PATENTSCOPE which are classified in the relevant IPC place.')

of energy conservation and emission reduction.[161]

According to the IPCC Fifth Assessment Report made by the third working group, Climate Change 2014: Climate Change Mitigation, the deep decarburization of electric power industries is a critical part of solutions to climate change.[162] A core part of the definition of ESTs put forward in this chapter involves upgrading technologies utilized in fossil energy and innovating within clean energy. Thus, a strong emphasis on the development of non-fossil energy generation technologies such as hydropower, nuclear power and wind power is an important measure to encourage energy conservation and emission reduction in electric power industries in the future.[163]

It is essential for all countries to understand the kinds of technologies industries require for energy conservation and emission reduction. This is usually reflected in the levels of industrial development and the necessary elements of production. Existing patent classification fails to provide precise corresponding information, hindering the implementation of energy saving and emission reduction policies within these industries and sectors.[164] Therefore, a new classification of ESTs based on key sectors and industries is necessary.

In general terms, the proposed international EST patent classification is

[161] H-Holger Rogner, Dadi Zhou, Rick Bradley, Philipp Crabbé, Ottmar Edenhofer, Bill Hare, Lambert Kuijper, Mitsutsune Yanaguchi (2007) Chapter 1 Introduction in B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds), *Climate Change 2007: Mitigation of Climate Change* (Cambridge University Press 2007) 99. (It is estimated that the global annual carbon dioxide emission reaches as many as thirty billion tons, about 40% of which come from power plants, 23% from transportation, 22% from cement plants, steel mills and oil refineries.)

[162] Intergovernmental Panel on Climate Change, Fifth Assessment Report 'Climate Change 2014: Climate Change Mitigation' by Working Group III < http://www.ipcc.ch/report/ar5/wg3/> accessed on 3 June 2015.

[163] Kalpana Murari, 'Transfer of Technology in A Post-Kyoto Framework' (2010) Working Paper Series 2010, 7 < http://ssrn.com/abstract=1909468> accessed on 10 October 2013. (Renewable energy and energy-efficient technologies should be supported by subsidies for renewable-based electricity to help reducing GHG emissions and increasing research and development activities.)

[164] Peter Drahos, 'Bargaining over the Climate: Lessons from Intellectual Property Negotiations' (2011) 2 Climate Law 1, 9. (In the light of climate change, sectoral approaches have been paid attention to and widely discussed especially for high-emission industries such as steel, cement and aluminum. 'Large companies will probably face increasing incentives to negotiate a sectoral approach to emissions reduction. For example, the South Korean steel producer POSCO will have an emissions-reduction target under Korea's Target Management System for greenhouse gas reduction, and may well face a tougher target under the Korean cap-and- trade scheme being discussed by policymakers in Korea.')

established by forming energy conservation and emission reduction routes in line with the characteristics of related industries, in order to determine IPC numbers for the relevant ESTs via integrated retrieval. The classification of the technical knowledge required for emission reduction by key industries is segmented in a degradation sequence, so that it can reflect the comprehensive performance of energy conservation and emission reduction within the entire industry. Afterwards, the classification numbers of the ESTs in each technology group could be further determined after retrieval and analysis in the IPC Green Inventory.

The specific steps can be split into five parts. The first step, based on the statistics of global greenhouse gas emission in economic sectors issued by IPCC Working group, is to demarcate technological contents in the key sectors and establish the classification navigation through a close combination with the structure characteristics of the IPC Green Inventory, so as to preliminarily determine the corresponding IPC classification numbers of these industries and sectors.[165] A thorough analysis of the classification characteristics of a target industry and the Green Inventory is necessary; classification solely based on industry fails to form an exact correspondence with the IPC classification numbers, which affects the patent retrieval results the industry-related ESTs.[166]

On the other hand, the IPC Green Inventory is unable to directly relate to the industries, as it follows the classification standard from a principally technical standpoint and partly also from the perspective of technology applications.[167] It is

[165] Intergovernmental Panel on Climate Change, Fifth Assessment Report 'Climate Change 2014: Climate Change Mitigation' by Working Group III < http://www.ipcc.ch/report/ar5/wg3/> accessed on 3 June 2015. (The report sums up the trend, composition and sources of global GHG gas emissions from the perspective of history and evaluate the corresponding discharge space and path according to the statistics of gas emission in major economic sectors in order to reach the goal of temperature control by 2℃.)

[166] Huenteler, Schmidt, Ossenbrink, Hoffmann (n 149) 14. (Taking the wind energy as an example, it finds that the initial set of classes listed in the IPC 'Green Inventory' is not always corresponding to relevant key words extracted from the innovation literature about 'wind motors'.)

[167] WIPO, International Patent Classification Green Inventory < http://www.wipo.int/classifications/ipc/en/est/> accessed on 21 December 2014. (The IPC Green Inventory is designed for searching and retrieving patent information in hierarchical sets of sections, classes, subclass and groups and serves as an indispensable tool for industries to search information for the state of art in a particular technology field.)

necessary, therefore, to combine the actual demands and short-term targets of energy conservation and emission reduction in key sectors with the characteristics of the IPC classification, with the Green Inventory acting as a bridge so that EST patents could make due contribution to the mitigation and adaptation of climate change.

The second step is to clarify the definitions and categories of the industries involved. Some have been defined clearly in reference books, whereas others can be defined according to technological application fields. The next step is then to use keywords from these definitions to validate and complement the IPC numbers of ESTs as preliminarily determined through the IPC Green Inventory. Afterwards, the fourth step is to set up the table of industry-based EST classification. It can be seen that in certain industries, a secondary classification of ESTs corresponds to the subgroup within the IPC.[168] In the final step, the citation of the ESTs is obtained by retrieval, and a code is given representing the industry that the technology belongs to. For ESTs in industries that are solely linked to the IPC, the citation can be found through classification retrieval. For those that partly correspond to the IPC, both keyword retrieval and the IPC classification number is needed to determine the citation of the EST.

It can be seen that the development and application of ESTs is guided by the key sector-based classification principle. For example, coal-fired electrical power plants and the coal-fired steel industry, adhering to the emission reduction route of 'efficient clean combustion, collaborative control of pollutants, and waste recycling', are surviving in a sustainable way by relying mainly on ESTs that include clean coal combustion technologies, nitrogen oxides control technologies, smoke and dust control technologies, sulfur dioxide control technologies, PM 2.5 control technologies and carbon capture and storage technologies.[169]

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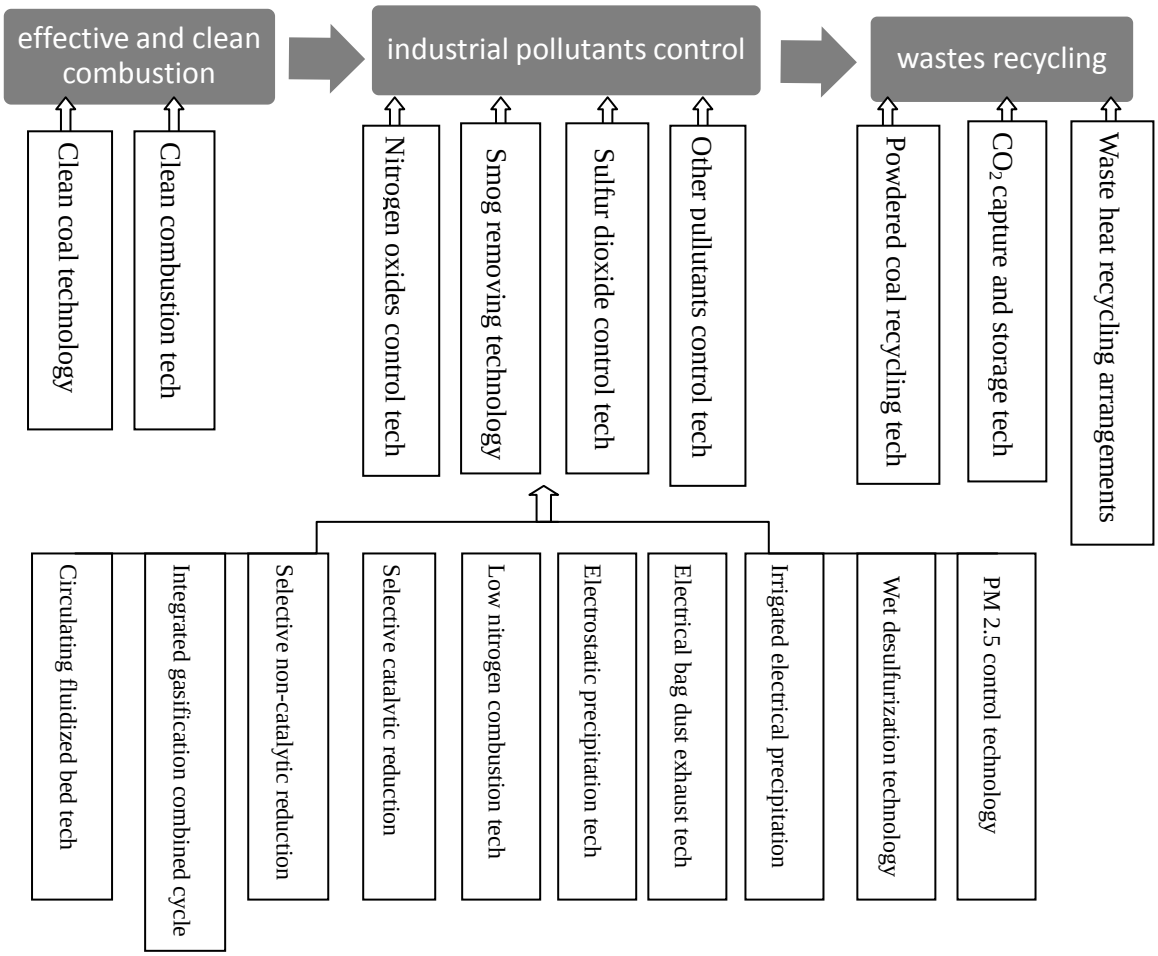
[168] WIPO, International Patent Classification Green Inventory < http://www.wipo.int/classifications/ipc/en/est/> accessed on 21 December 2014. (ESTs do not always coincide with their corresponding IPC places, though they are subsets of the corresponding IPC.)

[169] David Popp, 'International Innovation and Diffusion of Air Pollution Control Technologies: the Effects of NOx and SO_2 Regulation in the US, Japan, and Germany' (2006) 51 Journal of Environmental Economics and Management 46. (Based on the patent data analysis, it finds that the choice of technology in coal-fired power generation is primarily affected by pollutant emission



5.3.4 Consideration of the Public Interest

Patent protection of ESTs from the perspective of public interest is a hotly debated topic, showing that special attention is needed for ESTs of both private and public attributes. To date, the importance and necessity of EST patents for the protection of public interests has not been demonstrated clearly.[170] This section

restrictions in different countries.)

[170] Amy L. Landers, 'Liquid Patents' (2006) 84 Denver University Law Review 199. (Although a larger goal to benefit the public than just to obtain revenues and leverage monetary value of patents is viewed as 'an integral to the reward theory's encouragement of invention and disclosure' supported by patent systems, patents are usually in practice deemed to be free of regulation even when those private rights are used in conflict with the public interest. It is believed by the author that even where industries are in a good state of competition, the broader social benefits may not be necessarily supported by the tradition patent laws, therefore the modification of current patent systems is urgently needed to ensure

focuses on the embodiment of public interests in the field of ESTs, and a variety of ways in which public interests can be taken into account in this regime.

Public interests can be interpreted as the encouragement towards EST innovation, or the improvement of access to ESTs. It is difficult to fairly define which kind of public interest overweighs the other. This leads to two tendencies: one is the generalization of public interests, i.e. abusing or usurping the term 'public interests' to practice favoritism. The other is the nihilism of public interests without participation channels and legal protection.[171] In the context of climate change, however, the public interest in the improvement of access to current ESTs is of wider influence, and from a long-term perspective the differentiated patent protection of ESTs better satisfies the sustainable development requirement.[172] In addition, the demand for the public interest mentioned here is specific and clear, namely the claim for environmental rights and the right to health.[173] Currently, the main difficulty lies in how to consider public interests in a reasonable way, as the public demand is at odds with the use and right to profit from ESTs under patent protection.

In respect of practical steps, priority is given to the innovation of EST patents, including the formation of technical schemes, patent application, patent examination, patent grants, which is viewed as a process of pursuing rights within the scope of

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the practice dose not harm the public interest.)

[171] Alexander Adam, 'Technology Transfer to Combat Climate Change: Opportunities and Obligations under TRIPS and Kyoto' (2009) 9 Journal of High Technology Law 1, 7. (According to Article 8 of the TRIPS Agreement 'Member may, in formulating or amending their laws and regulations, adopt measures necessary to protect public health and nutrition, and to promote the public interest in sectors of vital importance to their social-economic and technological development, provided that such measures are consistent with the provisions of this Agreement', the public interest can be interpreted with different emphasis from different perspectives in the light of national social goals.)

[172] Henning Grosse Ruse-Khan, 'Sustainable Development in International Intellectual Property Law – New Approaches from EU Economic Partnership Agreements?' (2010) 29 ICTSD Programme on IPRs and Sustainable Development 1, 16-18. (The full access to ESTs is repeatedly emphasized and required by the UNFCCC, which can be understood as a special case which addresses the public interest incorporated in environmental concerns as recognized in the concept of sustainable development.)

[173] Keith E. Maskus, 'Intellectual Property and the Transfer of Green Technologies: an Essay on Economic Perspectives' (2009) WIPO Journal 2009, 2-3. (The international technology transfer to improve environmental protection has not been treated with due attention and as ESTs are heterogeneous and the demand for them is context-specific, it is quite important to study claims for them based on concrete facts and special targets.)

disclosed information.[174] Nonetheless the practical value and effectiveness of ESTs cannot be entirely guaranteed during the substantive examination stage, and stakeholders who are affected by authorization errors may be unable to afford such risks.[175] Consequently, in view of public interests, it is reasonable to allow the public to question the validity of environmentally sound patents within a designated timeframe by submitting opinions on the rejection or invalidity of patents. This includes any reason to believe that the relevant ESTs do not meet the standards of patentability, insufficient disclosure, as well as other reasons.[176]

In respect of the application of protected ESTs, this relates to the implementation of patent rights, patent license, transfer, financing and patent alliance. Excessive emphasis is placed on the economic value of ESTs over their non-economic attributes.[177] Although global climate change is becoming the major concern that influences human health and survival, the degree of this challenge varies between regions and countries; it seems that such differences are ignored in TRIPS, simply described as other 'conditional' uses without authorization of right holders.[178] The large-scale use of ESTs can significantly reduce the negative impact on health of

[174] Gormley (n 32) 135. (Patents are granted to encourage inventors to create new technologies and make them available to the public, but if a proper balance of the two sides of this purpose cannot be drawn, there would be no benefit to the public.)

[175] Frederick M Abbott, 'Trends in Local Production of Medicines and Related Technology Transfer' (2011) <http://www.who.int/phi/publications/local_production_trends/en/> accessed on 7 January 2014, 25. (The great concern is expressed by stakeholders over security of supply and it is believed that the local production that is built upon efforts to overcome market access barriers presented by patents would increase such kind of security, or otherwise local manufacturers have to pay high cost for it.)

[176] Lisa Larrimore Quellette, 'Do Patent Disclose Useful Information?' (2012) 25 (2) Harvard Journal of Law & Technology 532, 572. (To invalidate patents for insufficient disclosure has been approved under the new post-grant review proceeding in the American Invents Act. Before the new post-grant proceedings are created, questioning patents for insufficient disclosure can only be used as a defense in patent lawsuits, but now a third party or the public are allowed to raise questions about the validity of patents in the first nine months after a patent is granted.)

[177] Jay P. Kesan, 'Carrots and Sticks to Create a Better Patent System' (2002) 17 Berkeley Technology Law Review 145, 159. (It is believed that to put patents to use as quick as possible is a good way to maximize the economic value of patents by promoting disclosure of patent information, which is likely helpful to enhance technological development.)

[178] Gormley (n 32) 131-132. (Generally, people tend to ignore less obvious changes, for example climate and environment. As a result, the historical development of patent laws that were viewed 'environmentally neutral', showed little concern about environmental protection, which is now considered contrary to the public interest.)

environmental problems caused by climate change, which is comparable to the use of drugs to alleviate and eliminate diseases. Accordingly, each country shall be allowed to highlight the non-economic value of EST patents to their specific situation, by providing that for some industries involved in serious environmental problems, the use of key ESTs is justified by their considerable influence on national environment and health.[179]

Last but not least, from the perspective of technology diffusion, there are limitations in the transfer of ESTs based on the right of exclusive use and profit. On one hand, in light of a development cycle of products that goes through successive periods of incubation, growth, maturity and decline, when advanced technologies enter their mature phase and the domestic market is big enough to explore the international market, they start to flow extensively from where they originated to other regions. On the other hand, in order to get rid of the dependence on imported technology, other regions begin to intensify their efforts in promoting their own developed products to rival with patent owners who maintain as much of a market advantage as possible though sets of patents.[180] When of technology importers' cost advantages reach a certain point, owners of technologies will choose to assign patent rights to make profit again. As the development cycle continues, more and more patents, mainly peripheral and improved patents, emerge. This particularly occurs during the most extreme mature stage of technologies, when owners of technologies try to maintain market advantages through patent packages against competition,

[179] Henning Grosse Ruse-Khan, 'Sustainable Development in International Intellectual Property Law – New Approaches from EU Economic Partnership Agreements?' (2010) 29 ICTSD Programme on IPRs and Sustainable Development 1, 17. ('In the absence of specific 'integrative' treaty provisions on the international level, a sustainable development (treaty) objective should generally offer sufficient freedom to adopt good faith measures that balance IP with other societal interests at stake.' Accordingly, IP protection should be tailored to domestic needs and show respect to national specific environmental and health concerns.)

[180] Alireza Naghavi, 'Strategic Intellectual Property Rights Policy and North-South Technology Transfer' (2005) 18 The Fondazione Eni Enrico Mattei NOTA DI LAVORO 2005, 21-22 <http://www.feem.it/Feem/Pub/Publications/WPapers/default.htm> accessed on 19 May 2016. (According to Naghavi, other regions here point to emerging countries with limited innovation capacity that are able to undertake their own R&D activities by taking full advantage of 'the cost-reducing technologies of competing firms', rather than those less-developing countries that are incapable of engaging in any innovation activities.)

resulting in increased difficulty in access to these technologies.

Despite creating opportunities, the clustered characteristic of ESTs also brings challenges to their wide application. ESTs with a high correlation are easy to gather, but overly scattered patents make it difficult to spread technologies.[181] Obviously, patent cooperation and patent licensing is an inevitable choice at the point where large-scale application of ESTs needs to be accelerated, specifically meaning that patent applicants work together to place interrelated and complementary technologies into one system, corresponding to collections of patent rights. As one of the most common strategies of ESTs owners, patent portfolios are extremely useful for patent holders to maintain competitive advantages.

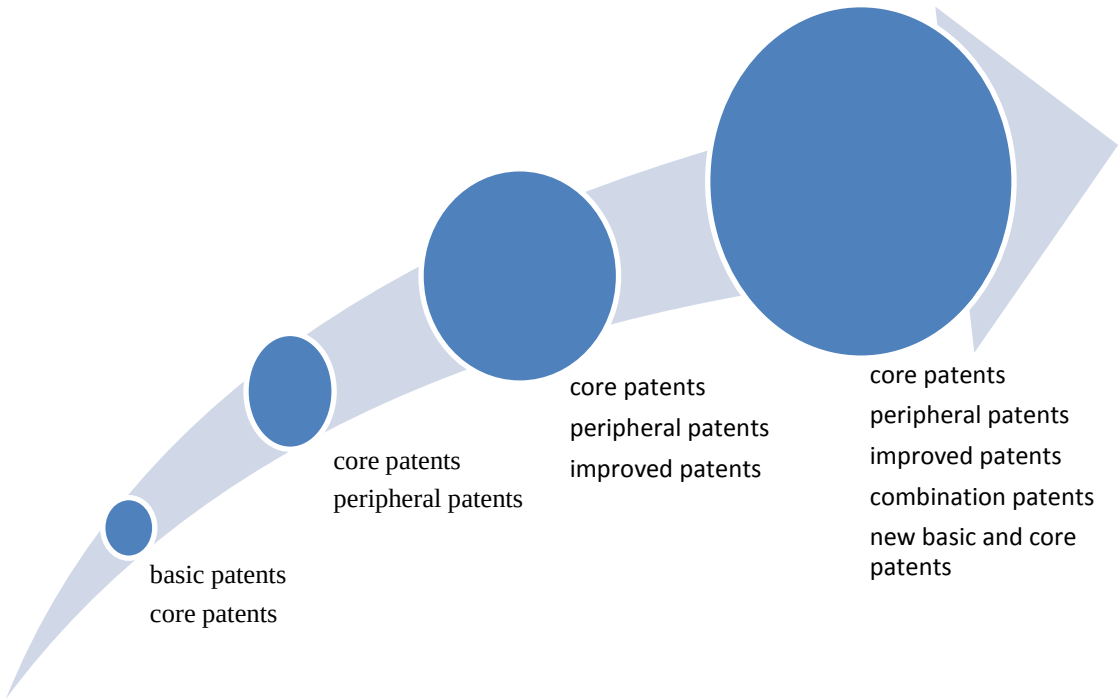
Nevertheless, the exclusive privilege of patent portfolios also leads to restrictions on speed and scope of technology diffusion.[182] Patents of minor improvement and peripheral patents around core patents in patent portfolios have a negative impact on competition through their positive role in encouraging innovation, thereby prejudicing interests of consumers, end-users and those countries that obtain technologies by parallel imports that are subsequently charged of infringement.[183] Confirming the justifiability of the parallel import of these minor improvements and peripheral technologies could expand the scope of and accelerate the speed of EST diffusion to assist recipients to protect their own rights through various channels. A point worth emphasizing is that, although innovators have to face competition from home and abroad, and are under pressure to recoup costs as recipient countries of ESTs speed up

[181] Sherman E, 'Green IP: A Thorny Challenge' (2008) 35 IP Law & Business 132. (Taking the biomass fuel as an example, patents owned by the top five patent holders are fewer than 100, whereas more than a thousand companies hold just one patent.)

[182] Gideon Parchomovsky, R.Polk Wager, 'Patent Portfolios' (2005) 154 University of Pennsylvania Law Review 1, 9. (It is concluded that 'the portfolio-dominated patent system will have serious distributional consequences, where large, resource-rich, incumbent firms will see a mounting advantage because of their ability to more effectively implement a patenting strategy based on patent portfolios. Companies with small patent portfolios will find it difficult to compete against firms with large patent holdings'.)

[183] Ibid 57. (The view is held in this article that the most significance of patent portfolios for their holders is that 'litigation is less necessary to achieve marketplace ends'. It is found that firms lacking effective patent portfolios have an increasing difficulty in competing with their more portfolio-rich opponents and will be easily involved in 'the more costly, more prolonged, and higher risk strategy of patent litigation'.)

transformation and upgrade their own technologies, owners of ESTs are still able to generate excess profits by exporting their core technologies and components.[184] It is reasonable to establish a mechanism of compulsory licensing and parallel import of ESTs on the basis of the different properties of ESTs.



5.4 The Quadrilateral Platform for the Regime

Choosing an appropriate platform to form a resultant force against uncertainty in institutional and economic exchange is a puzzled but inevitable legal issue for the formulation and implementation of such an international regime.[185] As analyzed in

[184] Alireza Naghavi, 'Strategic Intellectual Property Rights Policy and North-South Technology Transfer' (2005) 18 The Fondazione Eni Enrico Mattei NOTA DI LAVORO 2005, 9-15 <http://www.feem.it/Feem/Pub/Publications/WPapers/default.htm> accessed on 19 May 2016. (The study finds that profits are the major concern of Northern firms to decide how to serve the overseas market, by exporting final products in case of high risk of imitation or by establishing local subsidiaries to avoid trade and transportation cost. If the trade costs are weighed against the losses from imitation, Northern firms will choose to support the local production. As for ESTs, especially where core technologies or components are involved, the owners are more willing to export technologies rather than to make FDI.)

[185] Thomas Cottier, Marina Foltea, 'Global Governance in Intellectual Property Protection: Does the Decision-making Forum Matter?' (2012) 3 (2) The WIPO Journal 139, 140. (By comparing the impacts

Chapter 3, the biggest obstacle to the current climate talks is the institutional difficulty in coordinating the conflict between the UNFCCC and TRIPS under the WTO, indicating the tension between access to ESTs in the name of protecting the environment and public health, and private interests of EST patent holders.[186] Optimistically, there is a possibility of cooperation on the basis of the common interests of mankind in the pursuit of sustainable development. The special regime discussed in this thesis entails no more than the reform of the international patent system by coordinating interests among the members of WIPO; essentially a game of great importance between WIPO and other interested international organizations.

5.4.1 The Joint Efforts under WIPO, UNFCCC, WTO and WHO

A comprehensive patent regime to manage innovation, transfer and application of ESTs shall give full consideration to the arrangements for climate change under UNFCCC, WTO, WIPO and WHO. Only an international organization with the ability to coordinate these arrangements can be considered as the core coordinator. As a professional management institution of global intellectual property, WIPO appears superior to other organizations in its capacities to encourage and conclude new IP treaties, coordinate national IP legislation, engage and promote IP-related research, and provide assistance to developing countries. As a matter of course, WIPO has the primary responsibility for the establishment of an EST-related special patent regime.[187]

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of the IP rule-making forums at different levels on the achievement of keeping a balance between rights and obligations of stakeholders involved, it is found that 'the balance is better preserved in a multilateral norm-setting', so it is suggested in this article that 'IP rule-making in these fora is encouraged while taking proper account of the current political constraints under which they operate'.)

[186] K.Ravi Srinivas, 'Climate Change, Technology Transfer and Intellectual Property Rights' (2009) Research and Information System for Developing Countries Discussion Paper RIS-DP#153,2009, 34. (Currently, most of the issues about EST patents and transfer are discussed in bilateral or regional fora rather than at multilateral levels simply because private investors involved are unwilling to sacrifice their interests.)

[187] Halbert (n 43) 254. (As issues about IP protection have entered the public domain from the privacy of the negotiating room, WIPO has been placed on the center of several heated debates concerning

That is not to say, of course, that the cooperation is excluded between WIPO and other organizations such as the UNFCCC, UNEP, WHO, and the TRIPS Council under the WTO. These bodies can provide WIPO with professional assistance in objectively analyzing the science information upon which the EST-related patent system is built, and provide necessary experience and advice relating to funds and means of EST transfer.[188] Understanding how to deal with the relationship between the EST-related patent system and the current international patent system, especially the cooperative relationship with TRIPS under the WTO, is the key to the successful establishment and implementation of the special patent system.[189]

5.4.2 WIPO as the Core Coordinator and Administrator

WIPO's role in global IP management is the reason why it has been chosen as the lead entity over three other organizations that are also involved.[190] Despite the fact that the TRIPS Agreement under the WTO, another one of the international organizations responsible for IP issues, has become the minimum standard of national protection of IPRs, questions are raised in respect of the function and jurisdiction of the WTO in IP legislative issues. These reservations are based on the argument that

development issues such as human rights, public health and environmental protection, by committing to establishing 'a new IP paradigm that takes into consideration the needs of its global south constituencies'.)

[188] Alexander Adam, 'Technology Transfer to Combat Climate Change: Opportunities and Obligations under TRIPS and Kyoto Protocol' (2009) 4 Journal of High Technology Law 1. (Based on the analysis of the history of international climate negotiations, it is recognized that international organizations have played different roles of significance in giving rise to the understanding of this global issue. For example, the IPCC provides scientific and technical advice to the UNFCCC who has also proposed several means of financing and promoting technology transfer.)

[189] Thomas Cottier and Marina Foltea, 'Global Governance in Intellectual Property Protection: Does the Decision-making Forum Matter?' (2012) 3 (2) The WIPO Journal 139. (As the organizations with greatest relevance to the global IP norm setting, the question of how to deal with the interface between the WIPO and WTO cries out for solutions to managing and strengthening IP rules generation in a proper way at the multilateral level.)

[190] Peter Ollier, Interview with Geoffrey Yu, Former WIPO Deputy Director-General, 'What WIPO Should Do Next' (2008) 181 Managing Intellectual Property 24. (Against the background that IP is an issue that cuts cross so many different fields, 'if it is essentially an IP issue then it should be discussed in WIPO, of course there might be trade implications and health implications but I believe the essential discussions should take place at WIPO'.)

the obligations and function of the WTO concern the dynamic adjustment of technology trade exchanges as opposed to any jurisdiction over IP.[191] Comparatively, since the beginning of its founding, especially after becoming a specialized agency of the UN, WIPO is committed to the international protection of IPRs, and inherits the notion advocated by the UN that includes IPRs as an organic part of human rights as a whole.[192]

Given that a closed system could never compete against an open one, the regime under WIPO is dedicated to making WIPO function more flexibly as one operation system that operates a variety of software, or a unit where different peripheral devices can be inserted. WIPO working in such a manner, devoid of vitality, is one of the important reasons for the birth of TRIPS.[193] Although the scope of IP protection is planned within TRIPS, which draws outline of an overall framework for the enforcement of IPRs and provides specific measures, the international protection function of TRIPS is strictly confined to seven categories of IPRs. These categories

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[191] Halbert (n 43). (WIPO's traditional jurisdiction over IP issues has been challenged and threatened by the powerful teeth of enforcement mechanisms in TRIPS. Only five of the seventy-three articles of TRIPS, are related to technology trade, indicating that WTO is intended to strengthen its jurisdiction over IP protection via international trade.)

[192] Article 27 of the Universal Declaration of Human Rights in 1948 states that

> '(1) everyone has the right freely to participate in the cultural life of the community, to enjoy the arts and to share in scientific advancement and its benefits. (2) Everyone has the right to the protection of the moral and material interests resulting from any scientific, literary or artistic production of which he is the author.'

Article 15 of the International Covenant on Economic, Social and Cultural Rights provides that

> '1. The States Parties to the present Covenant recognize the right of everyone: (a) To take part in cultural life; (b) To enjoy the benefits of scientific progress and its applications; (c) To benefit from the protection of the moral and material interests resulting from any scientific, literary or artistic production of which he is the author. 2. The steps to be taken by the States Parties to the present Covenant to achieve the full realization of this right shall include those necessary for the conservation, the development and the diffusion of science and culture. 3. The States Parties to the present Covenant undertake to respect the freedom indispensable for scientific research and creative activity. 4. The States Parties to the present Covenant recognize the benefits to be derived from the encouragement and development of international contacts and co-operation in the scientific and cultural fields.'

[193] Frederic M. Abbott, 'Distributed Governance at the WTO-WIPO: an Evolving Model for Open-Architecture Integrated Governance' (2000) 3 Journal of International Economic Law 63, 66. (It is believed that 'the main objective of the developed countries during the Uruguay Round was to move the IPRs center of gravity from WIPO to the WTO', giving the birth of the TRIPS Agreement. This is primarily due to WIPO's failure to 'adequately prescribe the types of IPRs protection sought by the developed countries' and the absence of an effective enforcement mechanism in WIPO.)

are almost, but not completely, irrelevant to other issues such as the environment.[194] The binding force and enforcement of TRIPS, strengthened by the WTO dispute settlement mechanism, is extreme IP protection with in a closed system.[195]

Unfortunately, the TRIPS Agreement acts in a relatively constrained manner compared to the WIPO, who develops the management of IP in an open model. Disadvantages from the high integration of the international IP protection standard have led to wide concerns and criticism. The conflict between the uniformity of a minimum protection standard provided in TRIPS and the imbalance in the levels of social and economic development between members and trade sanctions for non-performance of obligations have a negative impact on the solutions to issues related to climate change.[196]

Through the construction of a special EST patent regime, WIPO is to assume responsibility for devising programs for relevant conferences, taking the leading role in negotiations and drafting of agreements, summarizing all required documents, monitoring the operation and coordination of the regime and providing dispute resolution support services for ESTs.[197] What needs to be stressed is that the legally binding nature of the regime under WIPO is paramount for its enforcement. As a key coordinator, WIPO could maintain its good reputation by paying close attention to reality, utilizing a consultation mechanism and considering the capacities of

[194] Shadlen (n 61) 6. (Prior to TRIPS, the governance of IP issues is regarded as weak both procedurally and substantively, but since IP issues are considered to be 'trade-related', the IPR protection is enhanced substantially, seen from a major classification of IPRs and detailed provisions in the multilateral trade field.)

[195] Peter K. Yu, 'Are Developing Countries Playing a Better TRIPS Game?' (2011) 16 UCLA J. Int'l L. Foreign Affairs 311.

[196] Thomas Cottier, Marina Foltea, 'Global Governance in Intellectual Property Protection: Does the Decision-making Forum Matter?' (2012) 3 (2) The WIPO Journal 139, 145. ('Since the TRIPS deal concerns various stakeholders, including individuals, corporations, nations and society—all having different goals and expectations from IP—the critics have viewed the TRIPS Agreement as a symbol of imbalance.')

[197] Ivan Morales, 'Balancing Intellectual Property Rights and Clean Technology Development: Encouraging Cooperation' (2017) 17 Houston Journal of Health Law & Policy 405, 421. ('WIPO's international usefulness is further demonstrated by its ability to help mediate disputes across borders through its dispute resolution services' which can be 'specially targeted to disputes arising in the transfer of green technologies'.)

stakeholders from a more humanized perspective.[198] Moreover, WIPO could take this opportunity to explore a path of sustainable development, so that its institutional transformation is able to cope with challenges from all sides.

Establishing an EST patent regime under WIPO could help further consolidate WIPO's authority and independence within the international IP legislation. The establishment and development of WIPO has seen efforts from industrial countries to preserve and safeguard its jurisdiction, and the attitudes of developing countries converting from passive acceptance to active participation.[199] The struggle for legislative power in IP issues between WIPO and the WTO, WIPO and other UN agencies, is a matter for the independence of WIPO, which is of great significance for its future development.[200]

5.4.3 The Roles of the Three Other Organizations

It is of particular importance that various major organizations involved in IP issues related to climate change are able to harmonize well with each other. With the growing number of international organizations entering into discussions on the same

[198] Gerald J. Mossinghoff, 'Patent Harmonization through the United Nations: International Progress or Deadlock?' (2004) 86 Journal of the Patent & Trademark Office Society 5. (Despite out of the purpose to make developing countries better fulfill obligations under TRIPS, WIPO contributes to positive settlement of actual difficulty confronted by the developing and least developed countries by providing them with substantial assistance.)

[199] Oliver Cattneo, 'The Interpretation of the TRIPS Agreement: Consideration for the WTO Panel and Appellate Body' (2000) 3 The Journal of World Intellectual Property 664. (As one of the most controversial issues at the WTO Ministerial Conference in 1999, the debate over IPRs reminded people of GATT negotiations in which representatives from developing countries insisted that substantive IP issues be argued and resolved in the framework of WIPO, showing that the legislative authority of WIPO was strongly supported by them, while industrial counties held that the IP issues be dealt with in the international trade rules. Under the condition of lack of consensus, developing countries were forced to accept the agreement on IPRs as a single part of the package in return for market access to agriculture and textile sectors of developed countries.); See also Abbott, 'Distributed Governance at the WTO-WIPO: An Evolving Model for Open-Architecture Integrated Governance' (n 193) 69. ('It is foreseeable that in the post-Uruguay Round environment, WIPO's role will be enhanced vis-d-vis the WTO because developing countries are less likely to agree to adopt higher and more restrictive IPRs rules in the WTO context.')

[200] Oliver Cattneo, 'The Interpretation of the TRIPS Agreement: Consideration for the WTO Panel and Appellate Body' (2000) 3 The Journal of World Intellectual Property 664.

subject, a consensus needs to be reached that international organizations with respectively clear functions are not comparatively stronger or weaker, but rather interdependent one upon another on a cooperative basis. To proceed otherwise would be an enormous waste of the world's resources.

As a principal duty of WIPO is EST-related rulemaking, WTO ought to place its own priority on its contribution to promoting EST-related trade development. The transfer of ESTs could be regarded as a good starting point for international cooperation that is specific to a particular purpose such as climate mitigation and adaptation. Although so far nothing is absent under WTO, except a unified and standardized regulative system for the adjustment of technology trades, the articles on technology transfer in TRIPS is of great value and significance for the transfer of ESTs.[201]

As set forth by the WTO as its purpose, an open, complete, sound and durable multilateral trading system has been established for the development of global trade in goods and services, global employment and stable growth through reasonable use of resources.[202] Despite there being no mention of technology trades, it highlights that the WTO complies with the goals of sustainable development, takes into account the actual development levels of its members, and is committed to environmental

[201] Padmashree Gehl Sampath and Pedro Roffe, 'Unpacking the International Technology Transfer Debate: Fifty Years and Beyond' (2012) Working Paper 25-26 <http://ictsd.org/downloads/2012/07/unpacking-the-international-technology-transfer-debate-fifty-years-and-beyond.pdf> accessed on 3 May 2013. (Dated back to 1970s, a unified standard of technology transfer at the international level was badly needed so as to meeting national technological demand. Although the inevitable correlation between IP and technology transfer is realized, technical assistance is the focus of United Nations' recommendation rather than the revisiting of relevant international conventions. Against this background, the International Code of Conduct on the Transfer of Technology was drafted under the aegis of the United Nations, but it was not adopted.)

[202] WTO, Ten Things the WTO Can Do <https://www.wto.org/english/thewto_e/whatis_e/10thi_e/10thi00_e.htm> accessed on 7 December 2015. (In order to full understand the function of the WTO, what the WTO can do is listed as follows: 1 ... cut living costs and raise living standards; 2 ... settle disputes and reduce trade tensions; 3 ... stimulate economic growth and employment; 4 ... cut the cost of doing business internationally; 5 ... encourage good governance; 6 ... help countries develop; 7 ... give the weak a stronger voice; 8 ... support the environment and health; 9 ... contribute to peace and stability; 10 ... be effective without hitting the headlines.)

protection by improving the means of protecting the environment.[203] It is evident that promoting the development of EST-related trade is consistent with the duties of the WTO. In addition, as one of the major characteristics of the WTO, the dispute settlement mechanism is the important basis for the orderly operation of multilateral trading system. The core function of the WTO in the field of IP may serve as a forum of last resort for disputes over IP issues, even though the jurisdiction of the WTO dispute settlement mechanism is limited to disputes within the TRIPS Agreement.[204]

In the face of challenges from the global shift caused by climate change, a solid foundation for the achievement of common goals has been laid with universal applicability through international cooperation in the UNFCCC. Article 4 and 5 play a guiding role and credibly reinforce that the special patent regime is essential and significant to meet the challenge of climate change.[205] Unlike other international environmental laws, the UNFCCC is backed up by a strong financing mechanism, providing a powerful guarantee for the funds needed for the transfer of technology.[206]

The WHO is the international organization responsible for the governance of the global public health. Its role within the special regime would be similar to its role in any global response to public health crisis, that is, to encourage innovation incentives and further transfer of technology, such as technology licensing on a less commercial form.[207] The WHO is responsible for providing technical information about climate

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[203] Abbott, 'Distributed Governance at the WTO-WIPO: an Evolving Model for Open-Architecture Integrated Governance' (n 193) 68-69. (It is worth noting that cross-concession can be reached in certain areas of IP governance between WTO Members. Within the WTO sphere of influence, strong compliance obligations are imposed by using trade measures.)

[204] Ibid 70. (It is pointed out by Adrian Otten at WIPO meeting of International Trade Law Committee of International Law Association on 25 June 1999 that to serve as a forum of last resort is the WTO's core function in the IPRs arena, which is 'exemplified in decisions of the Appellate Body and Dispute Settlement Body'.)

[205] Gerald J. Mossinghoff, 'Patent Harmonization through the United Nations: International Progress or Deadlock?' (2004) 86 Journal of the Patent & Trademark Office Society 5. (Being officially a UN agency brings both benefit and drawback, meaning that the way WIPO operates has to be inherent in the UN systems and be affected by political issues.)

[206] UNFCCC, Climate Finance <http://unfccc.int/focus/climate_finance/items/7001.php> accessed on 10 October 2015.

[207] WHO, Public Health, Innovation, Intellectual Property and Trade-Technology Transfer < http://www.who.int/phi/implementation/tech_transfer/en/> accessed on 7 December 2015. ('Transfer of health-related technologies to developing countries can enable recipient countries to produce the

change and public health, publicizing that climate change is the greatest threat to global health of the current century.[208]

5.5 Conclusion

This chapter focuses on the establishment of a patent system that is specially designed for ESTs under WIPO, together with collective efforts of the UNFCCC, WTO and WHO, so as to harmonize patent protection and access to ESTs. This part supports improving accessibility of ESTs to the greatest extent by using patent systems. This significant contribution is built upon the answers to three questions that needed to be addressed when designing such a regime. First of all, probable cause has been identified to establish a specially-designed patent system to facilitate access to ESTs across the world, especially in countries that urgently require ESTs to reduce local GHG emissions. With the particular regulative object, the legal relationship and the regulative method, the proposed regime attempts to find breakthroughs in the relationship between climate mitigation and adaptation, innovation and access to ESTs, thus demonstrating why EST patents should be treated differently from a legal perspective.

Secondly, the components of the EST-related patent regime has been discussed, including the three-part structure of patent rights comprised of length, width and intensity, analyzed from a legal and economic perspective, under the new classification standard, and in consideration of public interests. It argues that against the background of the increasingly strengthened global patent protection, the establishment of such a regime is conducive to reducing discord between patents and other closely-related public matters, principally referring to efforts against climate

product locally and may result in increased access to the product and improved health. This technology transfer can take several forms, ranging from license agreements, provision of information, know-how and performance skills, to technical materials and equipment.')

[208] WHO, Health and Climate Change: Road to COP 21 <http://www.who.int/globalchange/en> accessed on 7 December 2015.

change.

Moreover, an appropriated platform is explored to reach the universal regime.[209] It is recommended in this chapter that WIPO act as the core coordinator, taking into account the responses to climate change under the UNFCCC, WIPO, WTO and WHO. This view is based primarily on WIPO's superiority to other international organizations in its capacities to conclude new IP treaties, coordinate national patent laws, promote patent-related research, and provide assistance to developing countries according to their respective practical difficulties.[210]

Following this chapter, the question how to prove the differentiated patent system is workable is answered. As the effective implementation of the patent regime for ESTs relies on a specific context, the problem of adaptability must be considered when it is carried out under different jurisdictions. As the biggest emerging country and so one that clearly faces the dual pressure of economic transition and emission reduction, China could be selected as a particular focus to explore domestic application of this special patent system.

[209] WIPO, Conference on Intellectual Property and Public Policy Issues July 2009< http://www.wipo.int/meetings/en/details.jsp?meeting_id=17642 >accessed on 12 January 2016. (A conference on IP and public policy issues was held by WIPO to address some matters of great concern about 'the interface of intellectual property with other areas of public policy, in particular, health, the environment, climate change and food security'. It shows that WIPO can serve as a platform to discuss solutions to some global IP-related challenges.)

[210] Morales (n 197) 420, 422. (It is believed that 'WIPO's intrinsic reason is to balance IPRs and the needs of humanity, which makes it the ideal international agency to tackle the development of clean technologies'. The most significant advantage of WIPO comes from its ability to handle the problem that newer and clearer technologies do not reach the places where they are needed most and urgently. 'Though WIPO may not be prepared to take the lead role on a local level, the structure of WIPO makes it uniquely suited to facilitate communication and transfer of clean technologies across countries'.)

Chapter 6 The Application of the Patent Regime for ESTs: from the Perspective of China

This chapter focuses on the discussion regarding how to flexibly apply this universal EST patent system in a specific context, against the background that its implementation must work with characteristics of EST-related industries at a national level.[1] It argues that the validity of the patent regime for ESTs is determined by the interaction between the internal contradiction of this system itself and the external economic environment.[2] The internal contradiction here means the dual role of patents in addressing climate change, i.e. to encourage innovation and impede access to patented technologies, and the external economic environment primarily denotes technological innovation capacity and technology development models. In order to answer the question, this part follows three steps.

First, the study is set in an appropriate context - in China - as it is recognized as one of the largest emitters of GHGs with a great potential for emission mitigation. Based on the analysis of the current situation of the EST-related industries in China, including technology acquisition and innovation environment, the up-to-date development of ESTs in China is discussed from the international and domestic perspective, that is, the flow of ESTs in China (inflow and outflow), in order to assess China's specific technical demands in respect of energy conservation and emissions reduction.

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[1] David Ockwell, Jim Watson, Alexandra Mallett, Ruediger Haum, Gordon MacKerron, Anne-Marie Verbeken, 'Enhancing Developing Country Access to Eco-Innovation: The Case of Technology Transfer and Climate Change in a Post-2012 Policy Framework' (2010) No. 12 OECD Environment Working Papers 2010, 38 < http://dx.doi.org/10.1787/5kmfplm8xxf5-en> accessed on 2 November 2014. (The context-specific technological development which varies inter- and intra- nationally requires an international mechanism with a capability to deal with IP issues in specific instances.)

[2] Joshua D. Sarnoff, 'The Patent System and Climate Change' (2011) 16 (02) Virginal Journal of Law and Technology 302, 326. (It is found by the Berkeley study that patents works as internal tools and processes by offering incentives between 'slight' and 'none' to encourage innovation, R&D and commercialization. The patent system and international treaty measures work together to reach expected 'internally coordinated environmental benefits' through the external technological development and transfer to developing countries.)

Second, against this backdrop, it argues that a differentiated patent protection is necessary to reconcile patent protection and access to ESTs in China. By following the principle of combining the unity and diversity, this study finds that differentiated patent protection from both substantive and procedural perspectives is desirable to alleviate the discord between economic transformation and climate protection.[3] Specifically, the function of patent protection in increasing access to patented ESTs is brought into full play in two main aspects, namely, the actual working and local innovation.[4] Third, the implication of differentiated patent protection for ESTs on China's and the global sustainable development is discussed, including its influence on the building of China's green innovation environment and market competition for ESTs around the world.

6.1 Analysis of the Specific EST-related Context of China

It must be noted that the universal patent system for ESTs should be flexibly applied in accordance with the actual situation.[5] The reason why China is chosen as a particular focus is that, as the world's largest GHG emitter, it plays a significant role in the global response to climate change. Currently, with accelerated development of industrialization which increases the demand of energy, China faces mounting pressure to control GHG emission as its consumption structure of energy, which is

[3] Antoine Dechezleprêtre, 'Fast-tracking Green Patent Applications-An Empirical Analysis' (2013) Issue Paper No. 37 ICSTD Programme on Innovation, Technology and Intellectual Property February 2013. (With the growing globalization of the patent system, one of some important questions which need to be taken into consideration is that 'whether the patent system could remain technology-neutral or it runs the risk of greater fragmentation when confronted with various demands for the differentiated treatments specific sectors and technologies'.)

[4] Matthew Rimmer, 'Patents for Humanity' (2012) 3(2) the World Intellectual Property Organization Journal 198. (The patent system is primarily concerned with furthering the progress of technological innovation, without regard to the applicability of inventions in specific policy areas.)

[5] Henning Grosse Ruse-Khan, 'Sustainable Development in International Intellectual Property Law – New Approaches from EU Economic Partnership Agreements?' (2010) 29 ICTSD Programme on IPRs and Sustainable Development 1, 10. (IP protection is supposed to be adequate and effective, meaning that it should be carried out according to 'an individual situation and tailored to the specific circumstances of the case at hand'.)

dominated by coal and is unlikely to be changed in quite a long time, is causing serious pollution problems.[6]

In order to overcome the bottleneck of economic development and environmental protection, it is of great significance for China to adopt and put into effect this special patent system. Based on the analysis of the current situation of the EST-related industries in China, including technology acquisition and innovation environment, the up-to-date development of ESTs in China is discussed from the international and domestic perspective, that is, the flow of ESTs in China (inflow and outflow), in order to assess China's specific technical demands in respect of energy conservation and emissions reduction.

6.1.1 The Development Bias of ESTs in China's Key Sectors

Development models determine that the level of GHG emissions and actions taken accordingly to mitigate emission are inseparable from social economic and technological development. The value of ESTs lies in their powerful support for enhancement of energy efficiency in avoiding, decreasing and delaying the adverse effects of climate change.[7] This will ultimately benefit areas such as the environment and public health and promote technology revolution.

As the development bias of ESTs is largely affected by national resources, varying resource conditions are always accompanied by different choices of developmental paths for ESTs.[8] Given the substantial differences in natural resource

[6] Elizabeth Burleson, 'China in Context: Energy, Water and Climate Cooperation' (2010) 36(3) William Mitchell Law Review 101, 110. (Even though China is ambitious to develop renewable energy, it must be noted that 'roughly 30% of China's wind power assets are not adequately connected to the grid' and the capacity of its coal-fired power generation capacity had been rapidly expanded despite China's commitment to global emission reduction.)

[7] Lesley K. McAllister, 'Adaptive Mitigation in the Electric Power Sector' (2011) 53 Brigham Young University Law Review 2115, 2138. (Reducing the impact of important energy sectors on the environment is a crucial benefit even in the absence of climate change. 'With climate change, reducing such environmental impacts is likely to become even more valuable.')

[8] Padmashree Gehl Sampath, John Mugabe and John Barton, 'Realizing the potential of the UNFCCC Technology Mechanism: Perspectives on the Way Forward' (2012) Issue Paper No. 35 ICTSD

settings between China and western industrial countries, a distinctive development pattern of ESTs is presented with China's own typical characteristics.[9] The following analysis of the development tendency of China's key EST-related industries indicates that the development path of ESTs with Chinese characteristics is a natural choice that conforms to the specific biased context.

The EST-related industries that are at different stages of development in China are seen by the booming development of technologies that reduce emissions at source and improve energy efficiency, and the diversified development of new energy technologies.[10] In the context of a low carbon economy as a global concern, energy conversion technologies and energy efficiency technologies, such as technologies used for coal and natural gas conversion and efficiency improvement, are attracting rapidly-growing popularity.[11] The use of these technologies, particularly in the field of conventional energy, are of great significance for emerging economies like China whose energy structure based on coal determines that it is an inevitable choice to support the development and diffusion of these technologies, in order to fulfill its international obligations on emission reductions.

Programme on Innovation, Technology and Intellectual Property May 2012 1, 7. (By taking into consideration of their unique features, ESTs aim at providing alternative solutions to reach the same results in the existing well-established global energy system by using different kinds of natural resources or by improving energy efficiency of current ESTs, in order to address climate change.)

[9] ELizabeth Burleson, 'Climate Change Consensus: Emerging International Law' (2009) 34 Wm. & Mary Envtl. L. & Pol'y Rev. 543. (One of important factors that determine what should be done accordingly to realize mitigation targets by each individual country is resource endowment with natural and geographical characteristics.)

[10] Thomas L. Brewer, 'International Technology Diffusion in a Sustainable Energy Trade Agreement (SETA): Issues and Options for Institutional Architectures' (2012) International Centre for Trade and Sustainable Development 1, 35. (According to the definition given by IPCC, energy efficiency technologies refer to those that can improve 'the ratio of useful energy or other useful physical outputs obtained from a system, conversion process, transmission or storage activity to the input of energy measured as kWh/kWh, tonnes/kWh or any other physical measure of useful output like tonne-km transported, etc.'.)

[11] Bernice Lee, Ilian Iliev and Felix Preston, 'Who Owns Our Low Carbon Future?' (2009) A Chatham House Report on Intellectual Property and Energy Technologies <http://www.chathamhouse.org/sites/default/files/public/Research/Energy%20Environment%20and%20Development/r0909_lowcarbonfuture.pdf> accessed on 3 May 2013. (Taking wind energy as an example, generators are important conversion technologies to ensure efficient conversion of mechanical power into electricity. Similarly, in sectors of solar PV, biomass and clean coal, energy conversion devices and processes play a key role in guaranteeing a trouble-free operation of energy systems with a final form of electricity.)

In accordance with the study conducted by Ueno, China's main EST-related industries are divided into seven categories: supercritical and ultra supercritical coal-fired power plants, natural gas combined cycle power plants, photovoltaic power generation, wind energy, waste heat recovery for steel and cement plants, energy efficiency room air conditioners, compact fluorescent lamp.[12] It can be seen from this study that apart from the renewable energy technologies such as PV power generation and wind energy, the rest are those technologies that work well for efficiency improvement of traditional fossil energy.

To some degree, this study reflects the development bias of ESTs in China where the dominant status is inhabited by emission reduction technologies at source and energy efficiency technologies that are polluting in comparison with new energy technologies, even though they are defined as environmentally sound.[13] With a relatively complete industrial system in which pollution-intensive industries such as petrochemical, steel, construction materials, electricity, coal mining and processing continue to exist all through the foreseeable future, China is unable to devote so much effort to clean energy as the main way of sustainable development like some other developing countries, although it is 'on its way to reaching the same levels of R & D expenditure in renewable energy as the industrialized countries'.[14] Pollution-intensive industries, also referred to as non-environmentally sound industries that concentrate in heavy chemical sectors such as energy and resources, are obviously recognized for their low utilization rate, high-density pollutant discharge and serious damage to the

[12] Takahiro Ueno, 'Technology Transfer to China to Address Climate Change Mitigation' (2009) Issue Brief No. 09-09 U.S. Global Leadership: An initiative of the Climate Policy Program at Resources for Future 8.

[13] DRCNET Statistic Database System, 'the amount of carbon emission reduction renewable energy power generation in comparison with coal-fired power' http://www.drcnet.com.cn/www/integrated/ accessed on 12 May 2016.(For example, according to the statistics published by state research website, compared with coal-fired power generation, new energy power generation can effectively reduce carbon emission hydro power by 265.2 g/KWH, nuclear power 264.3, geothermal energy 263.7, wind energy 236.3 and solar energy 235.3.)

[14] Babette Never, 'Toward the Green Economy: Assessing Countries' Green Power' (2013) No. 226 German Institute of Global and Area Studies Working Paper on the Research Programme: Power, Norms and Governance in International Relations June 2013, 22.

ecological environment.[15] Therefore, the R&D of ESTs is unavoidably influenced by the necessity and urgency to accelerate the reform and upgrading of these industries.

With regard to China's electricity industry, for example, up to the end of 2014, China's installed gross capacity of generating equipments amounted to more than 5.5 trillion KWH, of which thermal power is 75.2 %, hydropower is 19.2 %, wind power 2.8 %, nuclear power 2.3 % and solar power 0.4 %.[16] From the point of view of emission reduction, the most widely-used thermal power technologies, such as internal combustion engine power and coal-fired steam turbines, have remained dominant in the electricity market even though they have low efficiency of power generation and are highly dependent upon fossil energy which causes serious environmental pollution. However, the advanced technologies in this field, such as IGCC, SC, USC, have a limited share of the market, and find it hard to get large-scale application in the short term.[17]

The report by the research group from Chinese Academy of Sciences on sustainable development strategy shows that, in the next few decades advanced ESTs will continue to reduce GHG emissions, although they will need higher original investment and longer cycle of construction than traditional high-carbon technologies.[18] According to calculations based on the related technical parameters,

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[15] Elisa Lanzi, Elena Verdolini and Ivan Haščič, 'Efficiency Improving Fossil Fuel Technologies for Electricity Generation: Data Selection and Trends' (2011) Sustainable Development Series by Foundazione Eni Enrico Mattei 10.2011, 4. (The rapid economic development of emerging countries is firmly supported by a fossil fuel intensive industrial paradigm that is based on massive consumption of energy and resources, giving rise to an unfavorable influence on sustainable development.)

[16] China Electricity Council, 'Retrospective Analysis of China's Electricity Industry in 2015'<http://www.chinabidding.com.cn/zbw/dlpd/info_show.jsp?record_id=76699> accessed on 12 December 2015. (The statistic here mentioned is issued by China Electricity Council in the review report of the development situation of electricity industry of 2014.)

[17] David Ockwell, Jim Watson, Alexandra Mallett, Ruediger Haum, Gordon MacKerron, Anne-Marie Verbeken, 'Enhancing Developing Country Access to Eco-Innovation: The Case of Technology Transfer and Climate Change in a Post-2012 Policy Framework' (2010) No. 12 OECD Environment Working Papers 2010 < http://dx.doi.org/10.1787/5kmfplm8xxf5-en> accessed on 2 November 2014 1, 38. (IGCC which is viewed as the most efficient coal-fire power technology in the demonstration stage costs more than traditional coal technologies, preventing it from entering into the phase of large scale of commercialization.)

[18] Chinese Academy of Science Research Center for Sustainable Development, Policy Study on Climate Change Mitigation and Adaptation<http://www.rcsd.org.cn/Website/index.php?ChannelID=21&WCHID=3> accessed on 3

the results indicate that, with its technological progress, China's cumulative quantity of emission reduction is expected to reach as much as 5.8 billion tons by 2030, if USC units over 600,000 KWH are used as the dominant technologies and IGCC is speeded up, and at the same time outdated production facilities are closed down quickly.[19] In other words, in the absence of technology upgrades to current coal-fired power generation units, nearly 6 billion tons of carbon emissions will probably be added in China by 2030. Therefore, broad use of highly-efficient improved techniques is crucial to reducing emissions of the electricity sector. Otherwise, there will be high costs to pay by China and the wider world because of climate change.[20]

Admittedly, in the long run, in order to reduce the reliance on traditional fossil energy, the development of new energy is necessary to diversify and clean China's energy structure. Consequently, China now puts a high value on its new and renewable energy that can bring both promising and solid results as supplements to the traditional energy to address the dilemma between economic development and environmental protection.[21] As predicted, China will intensify efforts over next decade to adjust its coal-dominant energy consumption structure, raising the share of non-fossil fuels in the primary energy consumption from a mere 11.4% in 2015 to 15% in 2020, as its unilateral commitment to the international community.[22]

May 2016.

[19] Albert Mumma and David Hodas, 'Designing a Global Post-Kyoto Climate Change Protocol that Advances Human Development' (2008) 20 The Georgetown International Environmental Law Review 619, 641. (As a representative of middle income countries, China has the ability to create conditions for enterprises from developed countries to invest in improving the efficiency of China's coal fired power plants from 30-45 percent by 2030, with advanced clean coal technologies, substantially reducing carbon dioxide emission.)

[20] McAllister (n 7) 2126. (As one of the three categories of technological alternatives for emission reduction in the electric power sector which is responsible for a large amount of GHG emission, energy efficiency technology is the key to improving productivity of unit energy consumption and reducing waste of energy.)

[21] W. A. Brock and M. S. Taylor, 'Economic Growth and the Environment: A Review of Theory and Empirics' (2005)1 Handbook of Economic Growth 1749. (With large quantities of empirical researches, it is confirmed by Brock and Taylor that the negative correlation is not necessarily found between economic development and environmental protection, and instead economic growth can be viewed as a prerequisite to the improvement of the environment.)

[22] John Whalley and Sean Walsh, 'Post-Copenhagen Negotiation Issues and the North-South Divide' (2009) 8 Seattle Journal for Social Justice 773, 792 <http://digitalcommons.law.seattleu.edu/sjsj/vol8/iss2/12/> accessed on 8 January 2014. (In addition to

6.1.2 The Flow of ESTs in China's Market

The flow of ESTs in the market is not just simple duplication or imitation but a continuation of an innovation process with a change of time and space, during which the ability of enterprises to differentiate, absorb and develop new technical knowledge will play a crucial role.[23] With the road map set to inflow, re-innovation then outflow, it is predicted that the influence of ESTs will consistently expand as economic and environmental benefits rise.

The development objectivity of technologies benefits the introduction and upgrading of ESTs in less advanced countries and the flow of ESTs is driven ever forward by market demand and policy incentives.[24] As analyzed in Chapter 5, the flow of patented ESTs is distinguishable in different stages of technology development.[25] Basic and core technologies are initially transferred to China, along with technology spillover that has a positive effect on the capacity building of local innovation. Subsequently, a large number of peripheral patents, improved patents and patent portfolio enter China's market where finished units and products are exported to the global market, especially developing countries. This indicates that China is a global manufacturing power rather than a technically advanced country.

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their Kyoto Protocol commitments, many countries have made a commitment to significant emission reduction in a phased manner by 2020. Among these countries, EU and China are typical representatives. 'The EU has committed itself to a 20-20-20 program to achieve a 20 percent reduction in emissions and a 20 percent use of renewables by 2020. In the case of China, there is a 20 percent reduction in energy consumption relative to GDP, a 20 percent use of renewable energy, and a 45 percent reduction of emissions relative to GDP, also by 2020'.)

[23] Keith E. Maskus, 'Intellectual Property and the Transfer of Green Technologies: an Essay on Economic Perspectives' (2009) WIPO Journal 2009, 1. (Maskus starts with critique to the view that technologies flow along one-way direction from developed countries which are the headstream of advanced technologies to technology-poor countries mediated by IPR that generally increases cost of imitation and hamper access to needed technologies in the latter.)

[24] Matthieu Glachant, Damien Dussaux, Yann Ménière, Antoine Dechezleprêtre, 'Greening Global Value Chains: Innovation and the International Diffusion of Technologies and Knowledge' (2013) OECD Green Growth Papers 2013-05, 13. ('For the most part, technology diffusion towards the developing world is driven by a demand for green technologies induced by environmental policies in industrialized countries including through the Clean Development Mechanism'.)

[25] See 5.3.4.

6.1.2.1 The Inflow of ESTs (Core Technologies）

The inflow of ESTs driven by market demand is accomplished through paid technology license and transfer.[26] Patented ESTs are transferred to China so that the local manufacturers have the opportunity to use a green technology system and produce green products.[27] In this process, the absorptive ability of Chinese companies plays a key role.[28] This ability relies mainly on whether companies can get access to required knowledge and technologies in order to avoid the waste of resources caused by duplication of investment. As it seems impossible that the process of technology innovation is completely independent, it is difficult for companies to obtain all the necessary knowledge on their own, particularly on environmentally-sound systems and projects that involve many cross-field technologies and require strong local absorptive ability to enhance cooperation with external partners. The introduction of technology is a shortcut to strengthening the capability of technology innovation and helps enterprises to develop in leaps and bounds. In this way, only by continuously upgrading absorptive capacity and accomplishing re-innovation through identifying and transforming external knowledge could the adverse situation in which Chinese companies start off with outdated technologies be corrected.[29]

The inflow of ESTs into China's market is realized in different ways. For certain products that need to be produced on a large scale, original equipment manufacturing

[26] Lei Yang and Keith E. Maskus, 'Intellectual Property Rights, Technology Transfer and Exports in Developing Countries' (2008) No.2464 CESifo Working Paper 5. (In order to acquire full know-how, producers in developing countries have to pay high license fees for the legal inflow of patented technologies and the production cost is decreased more than it would be with imitation through 'production inspection, reverse engineering, or trial and error'.)

[27] Keith E. Maskus, 'Intellectual Property and the Transfer of Green Technologies: an Essay on Economic Perspectives' (2009) WIPO Journal 2009, 2. (As one of channels of international technology transfer, patented technologies licensed by cross-national companies are believed to yield more efficient production abroad because of expended flow and innovation of technologies.)

[28] Yang and Maskus (n 26) 2. (It finds that welfare in the South country may increase or fall, depending on the absorptive ability (high or weak) of its firms to implement new technologies.)

[29] Ibid 6.(The absorptive ability of developing countries means the capacity to learn, understand and use advanced technologies, which is exogenous and determined by education level and infrastructure in developing countries.)

is commissioned by transnational corporations and training is provided at the same time. In the case of other more complicated operation systems, through vertical integration, raw materials, intermediate products and the necessary technological information are often provided to avoid imperfect conditions in local markets.[30]

Currently, China's manufacturing capability has been improved largely through the introduction of key components and materials, reflecting that China's ability in independent innovation has gaps in comparison with the world-class level in certain key areas of ESTs. Taking SC&USC as an example, China's major manufacturers, Harbin, Shanghai and Dongfang, have to import materials from foreign manufacturers for the production of key components that can be exposed to extreme physical conditions.[31] In another case, Suntech still needs to purchase equipment for manufacturing semiconductors from European manufacturers, even though it was the world's second largest PV manufacturer in 2009.[32]

The inflow of ESTs could also be brought about by gratuitous spillover effect. Through international exchange, technical advantages of developed countries provide a strong demonstration effect on local companies.[33] In addition, the inflow of ESTs

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[30] Padmashree Gehl Sampath and Pedro Roffe, 'Unpacking the International Technology Transfer Debate: Fifty Years and Beyond' (2012) ICTSD Working Paper June 2012 1, 28 <http://ictsd.org/downloads/2012/07/unpacking-the-international-technology-transfer-debate-fifty-years-and-beyond.pdf> accessed on 3 May 2013. (For the purpose of the Draft International Code of Conduct on the Transfer of Technology, in some cases, the flow of technological knowledge is essential for recipient countries to acquire, install and use in an efficient manner intermediate goods and/or raw materials that are purchased, leased or obtained by other means.)

[31] Takahiro Ueno, 'Technology Transfer to China to Address Climate Change Mitigation' (2009) Issue Brief No. 09-09 U.S. Global Leadership: An initiative of the Climate Policy Program at Resources for Future 8.

[32] Rasmus Lema and Adrian Lema, 'Technology Transfer? The Rise of China and India in Green Technology Sectors' (2012) 2 (1) Innovation and Development 2012, 6<http://ssrn.com/abstract=2003367 or http://dx.doi.org/10.2139/ssrn.2003367> accessed on 3 March 2013. (Suntech Power, as the Chinese leader, rose as a promising business with a substantial amount of independent and cooperative invented technologies, and developed its world-class technological expertise 'with in-house R&D and various mechanisms – licensing, a joint venture, overseas FDI and acquisitions and collaboration with the University of New South Wales. Suntech also has local technology cooperation linkages with research institutions, such as Sun Yat-Sen University and Shanghai University of Technology.')

[33] David Popp, 'Policies for the Development and Transfer of Eco-Innovations: Lessons from the Literature' (2009) No.10 OECD Environment Working Papers 2009, 15 <http://dx.doi.org/10.1787/218676702383> accessed on 10 May 2016. (Demonstration projects are viewed as 'disembodied technology transfer', one type of technology transfer, involving the flow of

can increase local inventory of EST-related knowledge and labor resources which are important factors affecting local absorptive ability. As a result, innovation is likely to grow, and due to accumulative circulation temporary advantages captured from innovation may eventually turn into long-term comparative advantages.

6.1.2.2 The Outflow of ESTs (Finished Units)

The outflow of ESTs means that the results of re-innovation are flowing out from China to other countries and regions. The main way to demonstrate the re-innovation ability of a company is to optimize and integrate technical knowledge and develop comparative advantages by effective use of external technical information.[34] The re-innovation ability of Chinese EST companies relies on its status as the world's manufacturing factory, from which finished products flow to other countries by volume production.

So far, most of the ESTs flowing out from China's market belong to products in the lower section of industrial chains or low-tech units that can be mass-produced, which are as important to Chinese companies as R&D in the upper section in the competitive strategy. For instance, more than 90% of PV modules and over 70% of compact fluorescent lamps produced in China serve the international market.[35] However, the China's total exports of complex high-tech ESTs are still low, in spite of some orders from other developing countries. One of the major problems that China's

know-how or experience. 'Just as teaching a man to fish enables the learner to provide for himself, disembodied technology transfers enable the recipient to develop skills that can be used in later projects initiated by the recipient country.')

[34] Tian Tang and David Popp, 'The Learning Progress and Technological Change in Wind Power: Evidence from China's CDM Wind Projects' (2014) CESIFO Working Paper No. 4705 Category 10: Energy and Climate Economics March 2014. (It is pointed out in this article that technological change is accompanied all the way by a learning process which is accomplished through different channels, including learning through R&D, previous experience and the network interaction between project developers and manufacturers, effectively reducing costs and increasing local capacity based on the evidence from China's wind power projects.)

[35] Takahiro Ueno, 'Technology Transfer to China to Address Climate Change Mitigation' (2009) Issue Brief No. 09-09 U.S. Global Leadership: An initiative of the Climate Policy Program at Resources for Future 8.

EST manufacturers face is the quality of their exports which has a side effect on the dissemination of ESTs.[36] Thus, it can be seen that China's ability in independent innovation is not comparable with its achievements in manufacturing, even though China has been viewed as the leader in renewable energy production in recent years.[37]

Previous research has shown that China's vibrant performance in export markets would be inconceivable without its huge investment in the development of ESTs. This is considered the first step into the international export market after brainstorming countries or regions where there may be a gap for products made in China.[38] Although there is data suggesting that China's investment in renewable energy has been growing, especially for the manufacture of wind turbines and solar components and photo-voltaic panels, there is a sense that in most cases the relationship between patent systems, technology transfer and exports has not been given as much attention as it perhaps deserves.[39]

The role of patents in reducing production costs and expanding export is controversial. There is a belief that a tightened patent system can offer patent owners protection against risks from contracting problems while enhancing the performance

[36] Joern Huenteler, Tobias S. Schmidt, Jan Ossenbrink, Volker H. Hoffmann, 'Technology Life-Cycle in the Energy Sector- Technological Characteristics and the Role of Deployment for Innovation' (2012) Presentation at the School of Science and Technology Policy at KAIST, South Korea, the Energy Policy Consortium Seminar at Harvard University, USA, the ECN/ETH Zurich side Event at UNFCCC COP18 in Doha, Qatar, the International Sustainability Transition 2012 Conference in Copenhagen, Denmark, and the International Schumpeter Society Conference 2012 in Brisbane, Australia, 5. (As for mass-produced goods, the problems of quality and cost reduction are above all to be solved.)

[37] Antoine Dechezleprêtre, Matthieu Glachant, Ivan Hascic, Nick Johnstone, Yann Ménière, 'Invention and Transfer of Climate Change Mitigation Technologies on a Global Scale: A Study Drawing on Patent Data' (prepare for the Review of Environmental Economics and Policy) 30-31 <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1414227 > accessed 5 February 2012. (Taking China, Russia and Brazil as examples, export rate of inventions by inventor countries indicates that the average value of inventions in emerging countries is probably low.)

[38] Yang and Maskus (n 26) 3. (According to empirical study in several developing countries conducted by Hasan and Raturi, it is demonstrated that investment in technology is an important factor that has impact on its entry to export market, including financial support from both public and private sources, imports of technologies and friendly cooperation with multinational companies.)

[39] Emmanuelle Ganne, 'Climate Change: Not Only about Costs, But Also Opportunities' (2010) 5 Yale Journal of International Affairs 164, 165. (Based on the market data, China is believed to more than any other country well understand the opportunities offered by global action against climate change, given the emphasis China has placed on the development of renewable energy, especially the manufacture of solar panels and wind turbines.)

of licensees in export markets by improving quality and efficiency.[40] On the other hand, contrary to this view, strict IP protection increases the cost of legal copy and suppresses global competition and the transfer of ESTs.[41] It argues in this thesis that patents play an irreplaceable role in driving the transition to green re-innovation from the pure introduction of ESTs, during which the re-innovation is determined by local absorptive ability. The special EST patent regime under which differentiated protection is provided based on the value of different ESTs is expected to improve local absorptive ability and encourage more positive competition, by expanding export opportunities and enhancing gains of consumers at home and abroad.

6.1.3 The Legislation of EST-related Patent Protection in China

6.1.3.1The Domestic EST-related Patent Law and Administrative Regulations

There has been a desirable trend in recent years to bring the reform of China's patent law gradually in line with international standards of patent protection. In the light of the increasing importance of ESTs, Article 5 of Patent Law of the People's Republic of China and Measures for the Use of Patent Compulsory License is highly relevant to the exceptions to exclusive rights.[42] Despite increasing emphasis on the

[40] Keith E. Maskus, 'Intellectual Property and the Transfer of Green Technologies: an Essay on Economic Perspectives' (2009) WIPO Journal 2009. (Maskus regards patents as contracts, the enforcement of which plays a positive role in information flow and sustained international technology transfer.); Charles K. Ebinger and Govinda V. Avasarala, 'Transferring Environmentally Sound Technologies in an Intellectual Property Friendly Framework' (2009) Energy Security Initiative Policy Brief 09-08 by Brookings Institution. (If breach of contracts or technology imitation occurs, higher costs will be paid for involved technologies because of strengthened patent protection.)

[41] Susan K. Sell, 'The Quest for Global Governance in Intellectual Property and Public Health: Structural, Discursive, and Institutional Dimensions' (2004) 77 Temple Law Review 363, 370. (Expanded IPRs has promoted economic concentration in high-tech sectors, which brings about some consequences that include a reduction of the number of suppliers of certain technologies, inhibition of competition and higher cost of technology transfer.)

[42] Article 5 of Patent Law of the People's Republic of China, < http://www.law-lib.com/law/law_view.asp?id=2824> accessed on 15 May 2015. ('No patent right shall be granted for any invention-creation that is contrary to the laws of the State or social morality or that is detrimental to public interest.' The laws of the State refer to the laws that are formulated and promulgated by the National People's Congress or the Standing Committee of National People's

development of ESTs, regulations set for EST patents still have weak points. For example, no regulation of priority examination is jurisdictionally focused for the progressively growing number of EST patent filings. Until 2010, in order to safeguard the legitimate rights of exhibitors in Shanghai Expo, the State Intellectual Property Office (SIPO) offered priority review for expo patent applications, paving the way for the subsequent priority examination of EST patent applications.[43]

On 19th June 2012, the SIPO promulgated Administrative Measures for Priority Examination of Invention Patent Applications. This came into effect from 1st August 2012.[44] Article 2 of the *Measure*s provides that patent examination must be arranged as a priority for eligible inventions at applicants' requests and files will be closed within one year from the date of the request permission, which is impressively faster than a regular invention application.[45] Article 4 clearly categorizes the scope of green patent applications eligible for priority examination as follows: (a) patent applications of great importance in the fields of energy conservation and environmental protection, a new generation of information technologies, biological technologies, high-end equipment manufacture, new energy technologies, new materials and new energy vehicles; (b) applications involving low-carbon and energy saving technologies that make a substantial contribution to green development; (c) other applications of great

Congress according to the legislative procedure. Social morality is ethical and moral rules which are widely believed by the public legitimate and well-accepted with strong local color. Being detrimental to public interest means working of a patent will harm society and the public, or have a side effect on the normal order of the State and society.)

[43] State Intellectual Property Office of the People's Republic of China, An Approach for Priority Examination of Expo Patent Applications <http://www.sipo.gov.cn/tz/gz/201003/t20100329_509668.html> accessed on 12 June 2016. (Shanghai World Expo organizer made a commitment to exhibitors that inventions first exhibited at Shanghai Expo retain its novelty to apply a patent in China within six months from the date of exhibition, meaning that these inventions are qualified for patent priority examination.)

[44] State Intellectual Property Office of the People's Republic of China, Administrative Measures for Priority Examination of Invention Patent Applications (No.65 Decree) deliberated and approved by session of SIPO, coming into effect from 1 August 2012 <http://211.157.104.86:8080/ogic/view/govinfo!detail.jhtml?id=1526> accessed on 15 May 2016.

[45] William Fisher and Alex Xia, 'The Fastest Routes for Green Patents-China' (2012) 222 Managing Intell.Prop.60, 61. (It is very impressive that the speed to complete priory examination is comparatively much faster than a regular invention application which takes an average of three to five years to grant.)

significance for the State and public interests in need of priority examination.[46]

In addition, applications in electronic form are required, and substantive examination has to be initiated before priority examination. However, the primary limit is procedural and documents have to be submitted as required, including application requests signed and sealed by intellectual property offices at the level of province, autonomous region and municipality, search reports in an appropriate format made by qualified agencies or patent grant authorities of other countries and examination results with their Chinese translation.[47] In addition, the SIPO is responsible for accepting and examining requests, informing applicants of results in time, and issuing the first action of examination opinions within thirty working days from the date of a request for priority examination being approved.[48] Accordingly, applicants can deliver their replies or supplements and modifications as soon as possible.[49] This priority examination system indicates that China takes the protection of EST patents seriously, while gaining some useful experience for successful application of the specially-designed patent system for ESTs in China.[50]

6.1.3.2 The Commitments to International Legal Documents

[46] Article 4 of China's Administrative Measures for Priority Examination of Invention Patent Applications < http://211.157.104.86:8080/ogic/view/govinfo!detail.jhtml?id=1526> accessed on 15 May 2016.

[47] Fisher and Xia (n 45). (Detailed rules and regulations as to what procedure to be used to obtain provincial-level endorsement of a prioritized examination request are not found in the Measures, indicating that local intellectual property offices under the State Intellectual Property Office have right of discretion to this issue.)

[48] Ibid. (The time taken to get the first office action varies from office to office because provincial IP offices have discretion to make a decision whether to endorse such an application. It is estimated, taken Shanghai IP office as example, that one or two weeks are needed to get endorsement.)

[49] Ibid. (As stipulated in the Measures, applicants must respond to the first office action within two months to avoid cancellation. In other words, the status of priority examination is to be null and void due to failure of timely reply and thus patent applications involved will have to follow a regular application procedure.)

[50] Ibid. (Though a few questions still need to be solved and the Measures remains untested, 'if an application on a green technology is found eligible, the prioritized patent examination under the Measures will likely shorten the prosecution time and allow expedited grant of green patents. This will be of benefit not only to the patent applicant but also to China's national and public interest.')

China's commitments to international legal documents are made up of two main sections, namely targets of GHG emission reduction against climate change and the minimum protection of IP set up in TRIPS. According to the international environmental documents, international efforts to mitigate climate change include not only emission reduction targets but also a wider range of targets, such as energy consumption targets and proportion of renewable energy use.[51] In this way, greater influence on developing countries experiencing rapid economic growth can be exerted, thus leading to transformation to steady industrialization. In The Middle-and-long Term Development Plan of National Renewable Energy published in 2007, China committed itself to the target of increasing renewable energy to 15% of total energy consumption by 2020.[52] In March 2010 when signing the non-binding Copenhagen Accord, China made a commitment to reduce carbon dioxide emissions per unit of GDP by 2020 by as much as 40%-55% of the 2005 level.[53]

China is obliged to provide a high level of IPR protection that lives up to the standard set by TRIPS to maintain access to the international market, although developing countries are allowed to make a corresponding arrangement of patent protection according to economic development and adopt different patent strategies at each stage of development. In general, the level of patent protection follows a weak to strong course.

In order to drive a global shift in the green economy away from the growth built

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[51] John Whalley and Sean Walsh, 'Post-Copenhagen Negotiation Issues and the North-South Divide' (2009) 8 Seattle Journal for Social Justice 773 <http://digitalcommons.law.seattleu.edu/sjsj/vol8/iss2/12/> accessed on 8 January 2014. (Pursuant to the report on the thirteenth session of the UNFCCC Conference of the Parties, actions required to minimizing damage from climate change include emission reduction targets and as well as other related targets such as renewable energy targets and energy consumption targets, the corresponding measures of which are aimed at complying with agreed targets among all stakeholders.)

[52] National Development and Reform Commission, The Middle-and-long Term Development Plan of National Renewable Energy < http://xwzx.ndrc.gov.cn/mtfy/zymt/200709/t20070906_157774.html> accessed on 17 June 2016. (It is pointed out that the following emphasis of China's renewable energy is to develop hydro, wind, solar and biomass energy so as to realize sustainable development by increasing the renewable share of its total energy consumption to 15% by 2020.)

[53] The Copenhagen Accord <http://unfccc.int/meetings/copenhagen_dec_2009/items/5262.php> accessed on 20 March 2016. ('The Conference of the Parties (COP), at its fifteenth session, took note of the Copenhagen Accord of 18 December 2009 by way of decision 2/CP.15.')

upon fossil fuels, responsibilities are shared primarily by industrialized countries and emerging-market countries.[54] A comprehensive study by Mattoo and Subramanian elaborates what should be done to generate a technological revolution, listing concrete responsibilities from the carbon price-related, trade-related and technology-related perspectives.[55] This analysis report indicates that emerging-market countries seem to take much more of a role in boosting the green technology revolution and improving the protection of IPRs, primarily by limiting the use of compulsory licenses and strengthening the enforcement of IP laws.

As can be seen, the obligations to protect the environment and the responsibility of IP protection that seems incompatible with each other are in fact subtly linked together by ESTs. The climate system has witnessed a significant change with the main characteristic of global warming, exerting great influence on public life and health in different ways.[56] As the facilitation of innovation and application of ESTs is an important method in the fight against climate change, efforts made to modify and adjust patent laws, according to the obligation to practice the low carbon mode, is essentially to prevent the negative impact of human activities on environment as much as possible for the environmental, economic and social sustainable development.[57]

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[54] Manuel A.J. Teehankee, Ingrid Jegou, Rafael Jacques Rodrigues, 'Multilateral Negotiations at the Intersection of Trade and Climate Change --An overview of Developing Countries' Priorities in UNCSD,UNFCCC and WTO Processes' (2012) 2 ICTSD Programme on Global Economic Policy and Institution May 2012, 6. (A green economy is defined as one 'results in the improvement of human wellbeing and social equity with substantially increased investment in economic sectors that build on and enhance the earth's natural capital or reduce ecological scarcities and environmental risks'. The further explanation is given that 'these economic sectors include renewable energy, low-carbon transport, energy-efficient buildings, clean technologies, improved waste management, improved freshwater provision, sustainable agriculture, forestry, and fisheries and these investments are driven by, or supported by, national policy reforms and the development of international policy and market infrastructure'.)

[55] Aaditya Mattoo and Arvind Subramanian, 'A 'Green-print' for International Cooperation on Climate Change' (2013) Policy Research Working Paper by Trade and Integration Team of The World Bank Development Research Group 6440.

[56] Elizabeth Burleson and Winslow Burleson, 'Innovation Cooperation: Energy Bioscience and Law' (2011) 2011 (2) University of Illinois Law Review 101, 119-121. (In order to address post 2012 climate coordination at the international level, it is announced by the United States Environmental Protection Agency that public health and welfare are being threatened by greenhouse gas emission. It is generally held that public health should serve as 'a strong driver of environmental protection'.)

[57] Estelle Derclaye, 'Intellectual Property Rights and Global Warming' (2008) 12 Marquette Intellectual Property Law Review 263, 286. (In the author's opinion, the growing trend that holds

There are several determinants which have an important effect on such expected reform and change of patent laws, such as technology innovation patterns, differences in technology and industries, and intensity of competition. The first determinant is the technological innovation pattern. China has always attached great importance to public investment in technological innovation and has also adopted legal and administrative measures that support enterprise innovation on a large scale simultaneously. The Law on Renewable Energy of People's Republic of China passed in 2005 stabilized government-led renewable energy subsidies legally, by providing that technologies that are eligible for government subsidies must be composed of independent innovation with 70% of its technical contents.[58] In view of China's technological innovation system which features a state-led greening of industries, an EST-related patent system in favor of the diffusion of technologies is preferable as it focuses on the industrialization of patented technologies.[59]

How to adjust patent systems partly depends on the competition intensity of EST market. In the case of relevant industries where the competition on ESTs is intense, high standards of patent protection may trigger patent races, wasting innovation resources, and an enlargement of the knowledge gap between developing and developed countries.[60] A patent protection system that is inclined to technology diffusion is preferable. Uncompetitive industries, by contrast, are more likely to adapt

'human rights must be respected in all ways possible, including by way of IP laws' should be supported.)

[58] National Energy Administration, The Law on Renewable Energy of People's Republic of China passed by the fourteenth session of the tenth standing committee of the People's Congress in 28 February 2005 and amended by the twelfth session of the eleventh standing committee of the People's Congress in 26 December 2009< http://www.nea.gov.cn/2012-01/04/c_131260380.htm > accessed on 18 May 2016.

[59] Carlos M. Correa, 'Intellectual Property Rights and the Use of Compulsory Licenses: Options for Developing Countries' (1999) Trade-related Agenda, Development and Equity Working Paper, South Centre, 1999, 24-25 <http://www.iatp.org/files/Intellectual_Property_Rights_and_the_Use_of_Co.pdf> accessed on 10 October 2014. (It is suggested that developing countries should 'preserve the maximum possible freedom under international rules' to design patent protection system by fully considering their own needs in such areas as promotion of technology transfer and local industrialization.)

[60] Alireza Naghavi, 'Strategic Intellectual Property Rights Policy and North-South Technology Transfer' (2005) 18 The Fondazione Eni Enrico Mattei NOTA DI LAVORO 2005<http://www.feem.it/Feem/Pub/Publications/WPapers/default.htm> accessed on 19 May 2016. (A weak patent protection encourages more know-how and technical information to be disclosed, which is good for cost reduction of industries in south countries.)

to a patent system that inclines to encouraging innovation. A mutually reinforcing relationship between patent protection and competition indicates that patent protection may lead to monopoly and unfair competition which is likely to occur without patents.

The heterogeneity of technology and industry should also be taken into full account before choosing a proper level of patent protection.[61] With a gradually strengthened internationalization of patent protection, effective implementation of a universal patent system at a national level is an important reflection of its flexibility, indicating that with the principle of seeking advantages and avoiding disadvantages a patent system should meet demands of different industries with different technological levels.[62] In general, industries with relatively high levels of technology adopt strict patent protection, while those with a lower level of technology or at the rising stage of its development are recommended to carry out easy patent protection.[63] Adhering to the combination of unity and diversity, the EST patent system can effectively prevent activities that impair fair competition and hamper industrial progress by fully considering those heterogeneous characteristics.

[61] Keith E. Maskus., 'Differentiated Intellectual Property Regimes for Environmental and Climate Technologies' (2010) Environment Working Paper of Organization for Economic Cooperation and Development No.17, 13-14 <http://dx.doi.org/10.1787/5kmfwjvc83vk-en> accessed on 12 May 2014. (Given the different efficiency of ESTs which depends on the specific countries and its socioeconomic geographic characteristics, it is not an easy task to establish a comprehensive international or national climate framework without making tradeoffs in various social targets.)

[62] UNEP, EPO and ICTSD, 'Patents and Clean Energy: Bridging the Gap between Evidence and Policy: Final Report' (2010) 66 < http://www.ictsd.org/themes/innovation-and-ip/research/patents-and-clean-energy-bridging-the-gap-between-evidence-and-policy>accessed on 20 September 2014. (The considerable differences within various sectors of ESTs which might have the low or high levels of technology characteristics have to be considered when the role of patents and other policies in technology transfer are studied.)

[63] Kevin Mcgarry, 'U.S. Patent Reform and International Public Health: Issues of Law and Policy' (2008) 3 Intercultural Human Rights Law Review 299, 304. (Taking IT industry as an example, a weak patent protection is strongly proposed so that greater innovation is promoted and patent abuse 'by patent troll firms or the building of patent thickets to please Wall Street' can be prevented. IBM's attempt to patent a system for using the restroom on the airplane is a typical example of a junk patent which tends to 'serve no purpose other than to fortify a monopoly on any idea no matter how absurd or impractical it is, unlikely to achieve real life implementation'.)

6.2 Flexible Application of EST Patent System in China

The application of the universal patent system in China requires Chinese governments publish laws and regulations in detail on the application, examination, grant requirements and dissemination of ESTs. In this regard, the definition of ESTs, substantive examination standards, differentiated protection, review procedure, the interpretation of related public interests and the use of compulsory licensing should be clearly stipulated by law based on the specific context of China.

6.2.1 Substantive Examination

It is important in a substantive examination to comprehend the characteristics of ESTs, and appropriately define them which are closely related to China's pollution-biased technological architecture.[64] The specially-designed patent system for ESTs means a form of special treatment with limited applicable coverage. Patent applications can enjoy the terms of protection because of their environmental benefits, so the primary issue of concern is to analyze and identify completely what kind of technology could be the object of this patent system. As those technologies that have more economic benefits than environmental benefits protected under general patent system do not detract anything from public interests and are not necessarily proved to be good for the environment, the comparison with the prior art is required as to whether it should be given special treatment within the scope of protection under this regime.[65]

[64] Elizabeth Burleson, 'China in Context: Energy, Water and Climate Cooperation' (2010) 36 (3) William Mitchell Law Review 101, 107. (The development of ESTs in China is directed by its industrial structure, in which heavy industry shares a great part of China's emission. 'China today produces about 35 percent of the world's steel, 50 percent of its cement, and 28 percent of aluminum manufactured worldwide. Steel alone emits more CO_2 than all Chinese households; the chemical industry uses more energy than all the cars on China's roads; and aluminum smelters consume more electricity than the entire commercial sector.')

[65] Estelle Derclaye, 'Not Only Innovation but also Collaboration, Funding, Goodwill and Commitment: Which Role for Patent Laws in Post-Copenhagen Climate Change Action' (2010) 9 J. Marshall Rev. Intellectual Property L. (Special Issue) 657.

As has been pointed out in the fifth chapter, technologies are defined as environmentally friendly by comparison, as long as they use fewer non-renewable resources, improve energy efficiency and discharge less pollutants than the prior art. As for the specific operating aspects, general principled statements plus enumerative method are used to clearly define ESTs as, for example, technologies that reduce GHG emissions, use less non-renewable energy, recycle materials, encourage the use of new energy and alternative resources as much as possible, and improve the durability of products.[66] In addition, as types of cross-disciplinary technologies, ESTs include but are not limited to clean power generation technologies, energy storage technologies, energy conversion technologies, energy operation infrastructure, construction materials and lighting technologies, general technologies such as advanced power-generating or power-driven machines and variable frequency control technologies.[67]

The mastery of environmental standard of technologies plays an important part in carrying out the special EST patent system. Since the establishment of such a system is to promote the innovation of and access to ESTs and thus provide sound environment, the environmental standard is an important indicator in determining the patentability of a technology. The EST patent system must give full consideration of signatories' respective international environmental obligations, when applied in these countries where authorities in charge of patent examination have to refine the environmental standards of technologies.[68] In fact, extensive consensus has been

[66] Qiongdi Chen, Yungen Hu, 'The System Design of Green Patents' (2009) 03 Chinese Science and Technology Forum 107.

[67] Ibid. (The USA Clean-Tech Group defines ESTs from the particularized perspective as ones not in a certain area but in various areas, including but not limited to renewable energy power generation technologies, energy conversion technologies, energy running infrastructures such as smart grid and intelligent power system, building materials and lighting technologies, biodegradable plastic, water filtration and seawater desalination technologies, technologies with less pollutants and emission, carbon trade modes, other green policies and investment institution and so on.)

[68] Cameron Hutchison, 'Does TRIPS Facilitate or Impede Climate Change Technology Transfer into Developing Countries?' (2006) 3 (2) UOLTJ 517, 532-533. (The use of technology-based or industry-based environmental standard is recommended by commentators in the climate negotiations as an effective way to reduce and monitor compliance with GHGs emission. Particularly, standards for electrical industry, carbon capture and storage and transportation sector should be primarily set up for their importance and relatively easy administration.)

reached at an international level that environmental standards of technologies should be within the scope of patent examination. Nevertheless, it is still in a legally fuzzy state, due to the complexity of its implementation process as well as the limited ability of patent examination authorities.

The application of an appropriate environmental standard has great positive and practical significance for China's weak environmental regulations and its pollution-biased technological architecture.[69] The introduction of appropriate environmental standards of technologies can give correct guidance to technologies towards green development, and be used as a kind of constraint in order to control the development of non-environmentally sound technologies. In this regard, specific GHG emissions and energy consumption standards are set based on goals of energy conservation and emission reduction, realized through important processes and key equipment in their respective technological fields; an example of which can be seen in what the Japanese government has done.

During the negotiations of the Kyoto Protocol, Japan became part of the global voice for new challenges and was the world's first country to introduce the 'Top Runner Program' which set goals of energy saving for several kinds of products, including 'room air conditioners, passenger vehicles, freight vehicles, fluorescent lightning, TV sets, copying machines, computers, magnetic disk units, video cassette recorders'.[70] This program sets the highest standard in the market of that time rather than the average or previous standard for all manufacturers of these products, and thus firmly established Japan's leading position in the top quality products of high

[69] Elizabeth Burleson, 'China in Context: Energy, Water and Climate Cooperation' (2010) 36 (3) William Mitchell Law Review 101. (In spite of stringent environmental regulations, enforcement of China's environmental regulations encounters resistance of a narrow-minded idea that regards them as a hindrance to industry profits.)

[70] Osamu Kimura, 'Japanese Top Runner Approach for Energy Efficiency Standards' (2009) SERC Discussion Paper 09035. (Initiated with nine products in 1998, Japanese 'Top Runner Approach' which aims to improve energy efficiency of end-use products and to develop the world's best energy-efficient products expanded to 21 products by 2009. Regarded as 'one of the major pillars of Japanese climate policy', this program sets 'mandatory energy efficiency standards, based on the most efficient (top runner) products in the market, for a variety of appliances, equipment, and automobiles'.)

efficiency and energy saving.[71]

In 2008, Japan launched 'Cool the Earth by the Innovation of Energy Technologies Program' which designed R&D road maps of science and technologies respectively for 21 potential sectors, including power generation and transmission technologies, transportation, business, residential building and cross-subject technologies such as highly-efficient natural gas and coal-fired power generation, PV power generation, nuclear power, effective superconducting electricity transmission, intelligent transportation systems, fuel cell vehicles, hybrid power vehicles, carbon dioxide capture and storage, and efficient building.[72]

With the advancement of technologies, a dynamic criterion to assess the environmental soundness of technologies will be put forward, because institutional failure or loose standards are not conducive to technological catch-up and in turn undeveloped ESTs restrains the development of environmental standards.[73] In view of the complex environmental standards based on the definition of ESTs, a complete set of examination standards and procedures is needed as a reference for patent examiners to accurately determine whether a technology is environmentally friendly by assessing its impact on the environment. Given the difficulty of environmental standard examination, examiners with strong specialized knowledge and practical skills are required to complete the assessment of technological environmental characteristics, with assistance from professionals from the state environmental authorities ensuring the accuracy and efficiency of patent examinations.

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[71] Ibid. (With the rate of energy efficiency improvement ranging from 16% to 80%, Japanese top runner program has made remarkable achievements which are evaluated based on the empirical case study of selected products in this article.)

[72] Miranda Schreurs, 'Assessing Japan's Role as a Global Environmental Leader' (2004) 23 (1) Policy and Society 88 <http://www.sciencedirect.com/science/article/pii/S1449403504700284> accessed on 12 June 2016.

[73] Michael Hasper, 'Green Technology in Developing Countries: Creating Accessibility through a Global Exchange Forum' (2009) Duke Law & Technology Review 1, 4. (Process or products differentiation under strict environmental regulations would not cause incremental cost for producers but instead less pollution to environment and more efficient use of raw material. 'As a concrete example, more stringent sulfur dioxide emissions standards in the United States as enacted from a cap-and-trade program in 1990 reduced compliance costs while enhancing innovation and promoting competition in the raw materials input market.')

More stringent requirements of creativity must be applied in light of the pollution-biased development of ESTs in China. Different from the traditional technological innovation mode that concentrates on internal economy, the innovation of ESTs follows the rule of ecological economics that takes economic, social and environmental benefits as common development targets and keeps the innovation of technologies moving in a promising direction towards a resource-conserving and environmentally-friendly society in which all people live in harmony with nature.[74] In this special patent system, targets set for cutting energy use and pollutant emissions are as equally important as economic targets in innovative processes of ESTs, which is markedly different from the traditional innovation mode, in which requirements of national energy saving work as constraint conditions on technical designs of ESTs rather than being treated as one of the targets.[75]

Depending on how difficult it is for new technologies to entry into relevant creative activities and what kind of role new enterprises play, innovative activities are classified into destructively-creative activities, in which new technologies are easily integrated and new enterprises play a primary role, and accumulatively-creative activities, in which large enterprises take a dominant position with high entry barriers for new innovators.[76] As accumulative technologies, patents that improve ways of

[74] Liping Wang, 'The Study on the Basic Theories of the Innovation of Environmental Technologies' (2013) 7 Industrial Technology Economies 68.

[75] Lynn Mytelka, 'Technology Transfer Issues in Environmental Goods and Services: An Illustrative Analysis of Sectors Relevant to Air-pollution and Renewable Energy' (2007) ICTSD Trade and Environment Series Issue Paper No.6 2007, 1. (The Geneva-based Business Council for Sustainable Development, for example, advocates that solutions to environmental issues should be regarded as 'part of a larger process in which investment in R&D is aimed at innovations that make production both cleaner and more competitive. This presupposes a decisional matrix that contains a "multi-goal" approach'.); see also Matthieu Glachant, Damien Dussaux, Yann Ménière, Antoine Dechezleprêtre, 'Greening Global Value Chains: Innovation and the International Diffusion of Technologies and Knowledge' (2013) OECD Green Growth Papers 2013-05, 7-8. (It is very common in the manufacturing that the form of innovation 'comes through diffuse incremental improvements made by line workers or others not officially designated as engineers or lab technicians across the value chain'. It is fundamentally pointed out that as cutting energy use and pollutant emissions is generally not private profitable yet under standard market conditions, economic targets are apparently more important and attractive to inventors. In the absence of policies providing incentives and imposing constraints on emission and polluting practice, green technologies are less desirable.)

[76] F. Malerba and L. Orsenigo, 'Technological Regimes and Sectoral Patterns of Innovative Activities' (1997) 7 (6) Industrial and Corporate Change 83.

traditional energy utilization show strong signs of monopoly, which becomes an obstacle to the innovation of and access to ESTs, and accordingly a stricter grant standard is necessary to increase access and guarantee quality of these patents by narrowing the scope of protection.

Regarding the upgrade of China's industrial structure in particular, it has a more realistic significance in breaking down entry barriers of technologies which embody the concept of energy conservation and efficiency as well as emission reduction from sources other than those of new energy technologies.[77] However, in the long run, as destructively-creative technologies, new energy and renewable energy technologies with greater environmental benefits than economic returns in the early stage of development have distinct superiority in cost consumption in China, where establishing and running new enterprises and equipment costs less than reconstructing old ones by technology improvement to gain energy saving effects.[78] According to China's current situation, it is appropriate to enlarge the extent of patent protection for new energy technologies by both method and product protection, so as to pay more attention to innovation of these technologies consistent with the principle of differentiated protection.

The interpretation of public interests in EST patent protection can effectively prevent public interests from becoming an omnipotent weapon against each other by patent owners and free riders due to the lack of measure standards.[79] In fact, public

[77] McAllister (n 7) 2115. (It is pointed out that energy efficiency and conservation are viewed as 'mitigation alternatives with lowest environmental impact'. Energy efficiency technologies play a significant role in preventing pollution and habit destruction in some industries, for example electric power generation that depends on the consumption of fossil fuel with high environmental impact.)

[78] Bernice Lee, Ilian Iliev and Felix Preston, 'Who Owns Our Low Carbon Future?' (2009) A Chatham House Report on Intellectual Property and Energy Technologies 55 <http://www.chathamhouse.org/sites/default/files/public/Research/Energy%20Environment%20and%20Development/r0909_lowcarbonfuture.pdf> accessed on 3 May 2013. ('Technologies such as solar energy and offshore wind all show much scope for further innovation and cost-reduction. The same is true for energy efficiency. For example, adoption of 'ultra- supercritical' technology and building many identical power plants means now it costs a third less to build an ultra-supercritical power plant in China than a less efficient coal-fired station in the United States.')

[79] Ujjwal Kacker, 'Technology Transfer and Financing: Issues for Long Term Climate Policy in Developing Countries' (2009) 3 Carbon & Climate Law Review 292, 300 < http://heinonline.org/HOL/Page?handle=hein.journals/cclr3&div=51&g_sent=1&collection=journals#310> accessed on 8 January 2014. (Opportunities are created for free riders when monitoring and

interests are not a totally abstract conception, and thus it is possible and necessary to offer some interpretation so as to establish a theoretical basis for the clear use of a compulsory license. Though TRIPS keeps an open mind on the use of compulsory licensing, its actual implementation is fraught with difficulty in developing countries like China where the use of compulsory licensing is likely to encounter technical and legal barriers.[80]

It is still, nevertheless, essential to overcome legal obstacles to bring about the possibility of external application.[81] The latest revision of Patent Law of the People's Republic of China stipulates six reasons for the use of compulsory licensing, namely failure to work or insufficient working, monopoly, national emergency, public interests, public health contained in public interests, dependence upon patent working, among which monopoly and public health is newly added.[82] Though the six reasons contain the relevant contents listed in TRIPS, other exceptions such as the governments' use and national demand for patented products can also provide reference for lawmakers.

EST-related public interests can be mainly interpreted from the perspective of technical requirements as China's response to climate change.[83] The research

performance standards are absent.)

[80] Joshua D. Sarnoff, 'The Patent System and Climate Change' (2011) 16 (02) Virginal Journal of Law and Technology 302, 329. (Given difficulties in reaching consensus on treaty amendments, developing countries have to resort to existing flexibilities in TRIPS, which will 'generate further tensions over intellectual property rights with developed North that may result in dispute proceedings in the WTO'. However, political difficulties of applying compulsory licenses in particular case force developing countries to adopt 'broader but more administrable exclusion of patent eligibility' and other options that may better improve access to ESTs.)

[81] Paul Gormley, 'Compulsory Patent Licenses and Environmental Protection' (1993) 7 Tulane Environmental Law Journal 131, 142. ('The compulsory license provision avoids the inequitable and environmentally unacceptable consequences of such a situation in which '[a] bind can result for a permit applicant who is required by regulators to use a technology, but is prevented by the patent owner from doing so' by allowing the applicant to use patented technology necessary to meet an applicable emissions standard.')

[82] The Standing Committee of the 11th National People's Congress, Patent Law of the People's Republic of China (2008 Amendment) passed by the sixth session of the Standing Committee of the 11th National People's Congress < http://211.157.104.86:8080/ogic/view/govinfo!detail.jhtml?id=94> accessed on 22 June 2016. (Section 6 includes eleven articles about the conditions for the use of compulsory license.)

[83] Maskus (n 61) 10. ('That technological change and diffusion make a difference is evident from the greater costs of abatement if needed reforms and technologies are delayed.')

conducted by International Energy Agency indicates that in order to achieve scenario binding emission reduction targets, sixty-two core general and specialized technologies in six major sectors, petrochemicals, cement, steel, building, transportation, electricity power generation, are believed to make a crucial contribution to China's emission reduction; however, forty-two of them have yet not been mastered by Chinese firms.[84] Expenditures on purchasing imported core technologies from multinational companies comprise a high percentage of the total cost to fight against climate change.[85] The failure of price negotiation probably has a strong impact on local effective emissions control and public health.[86]

The consideration of specific situations in which patented methods are working can be introduced into the scope of patent protection as an important part of the interpretation of public interests to properly distinguish the feasible and actual technology workings.[87] In terms of EST patent protection, much emphasis should be placed on the dissemination of patented ESTs and their local actual working because of China's role of great significance in global response to climate change. This is a deep consideration of the specific external environment in which technologies are applied. In view of the technical background and working conditions for patented

[84] International Energy Agency, Energy Technology Perspective 2015 Mobilizing Innovation to Accelerate Climate Action < http://www.iea.org/publications/freepublications/publication/EnergyTechnologyPerspectives2015ExecutiveSummaryEnglishversion.pdf> accessed on 22 June 2016. (The comprehensive report, which designs a path towards a sustainable energy system in 2050, tracks the development and evolution of selected technologies and sectors against the interim 2025 targets of the International Energy Agency 2°C Scenario. 'This report also shows how emerging economies, and China in particular, can foster a low-carbon transition through innovation in energy technologies and policy.')

[85] Maskus (n 61) 10. (It is estimated that the world as a whole may spend three or four percent of its global GDP in 'stabilizing GHGs in the atmosphere at a maximum of 550 parts per million (ppm) of carbon dioxide', and 'the figures do not account for unknown environmental feedback effects that could increase as accumulations of GHGs continue to mount'.)

[86] Deborah Behles, 'The New Race: Speeding up Climate Change Innovation' (2009) 11 (1) North Carolina Journal of Law & Technology 1, 39. (A green program is proposed by the author that by compulsory license makes patented technologies available at 'the price which should be determined by the proposed office in conjunction with the innovator based on the utility of the innovation to mitigate climate change emissions or impacts'.)

[87] Michael A. Carrier, 'An Antitrust Framework for Climate Change' (2011) 9 (8) Northwestern Journal of Technology and Intellectual Property 513. (Based on a case study of smart grid in U.S., situational awareness that aims at monitoring actual working of system components and performance is given much attention.)

ESTs, the improvement of energy efficiency only by a few percentage points in China will have a very positive impact due to its large share of global energy consumption and GHGs emissions.[88] Based on the report made by the Chinese Academy of Science which analyzes the influence of improvement in coal-fired power generation technologies on emission reductions of the electric power industry, China needs to focus on the long-term climatic impacts of infrastructure construction and encourage actual working and production of urgently needed ESTs.[89]

6.2.2 Procedural Examination

A special examination procedure is also an essential part of the regime for its effective implementation. If a complicated and time-consuming patent examination process is retained, it will do harm to the innovation, promotion and application of ESTs, and restrain creativity and initiative of innovators. Without sacrificing the standard of patent grants, to simplify procedures and shorten examination time will greatly encourage EST patent application.[90] As suggested in the previous chapters, the green channel and accelerated examination process adopted by some developed countries could unleash a cascade of innovation.[91] Although in China some

[88] Elizabeth Burleson, 'China in Context: Energy, Water and Climate Cooperation' (2010) 36(3) William Mitchell Law Review 101. (Give the huge amount of China's energy demand, the International Energy Agency has reasons to believe that China's contribution to GHG emission reduction is crucial to achieve global goals.)

[89] Mei Gechlik, 'Making Transfer of Clean Technology Work: Lessons of the Clean Development Mechanism' (2009) 11 San Diego International Law Journal 227. (China attaches great importance to infrastructure projects from a long-term perspective, which has been clarified in its stimulus plans that focus on sector-specific energy efficiency and environmental impact.)

[90] Ashleigh Hebert, 'Expediting Green Patents: the Expedited Examination Programs' Contribution to Diminished Patent Quality' (2012) 31 Cardozo Arts & Entertainment Law Journal 249, 251. (It is arguably noted that the expedited examination programs of the United States applying to green technologies, including the accelerated examination program and the Green Technology Pilot Program, the latter of which has less stringent filing requirements than the former, have negative impact on the United States' patent system, specially resulting in diminished patent quality which means 'the capacity of a granted patent to meet (or exceed) the statutory standards of patentability', though they are believed to bring benefits to this sector, such as encouraging investment from both businesses and individuals and promoting competitiveness.)

[91] See 5.3.2.2.

regulation has been found to provide preferential treatments for certain ESTs, it is obvious that these measures are incapable of meeting realistic demands, in contrast to the increasing number of green applications.[92] Additionally, as these preferential treatments are not specially constructed for ESTs applications, the ambiguous definition of ESTs can give rise to non-environmentally sound technologies which sneak into priority examination, causing free riding and burdening patent authorities especially at the moment when the number of Chinese patent applications has been rocketing.[93]

Applicants for this procedure must underline what kind of green technology it is and which sectors or industries it belongs to in written and electronic application statements, and make an explicit request for the use of this accelerated procedure. In addition, a retrieval report from qualified agencies and an assessment report on the environmental impact of technologies from institutions authorized by patent administrative departments should be submitted by applicants in a prescribed format, so that competent patent examiners can make prudent decisions when it comes to approving requests for accelerated procedures.[94]

Up until now, the absence of legal support has been a problem for the assessment of environmental influence of technologies.[95] With reference to China's relevant

[92] Maskus (n 61) 18. (According to the study on global patent application in seven ESTs, including waste, solar, ocean, fuel cell, biomass, geothermal and wind power, it finds that a considerable expansion of patent application in developing countries, all of which took place in a small group of emerging countries, 'accounting for over 99 percent of local applications in developing countries'. Particularly in China a significant source of new ESTs is invented, holding a large share in solar energy and fuel cells.)

[93] Matthieu Glachant, Damien Dussaux, Yann Ménière, Antoine Dechezleprêtre, 'Greening Global Value Chains: Innovation and the International Diffusion of Technologies and Knowledge' (2013) OECD Green Growth Papers 2013-05. (It is noted by the author that one of issues remains to be done for developing countries is that methodologies and roadmaps are needed to identify what kind of technologies should be given priority according to their actual situation.)

[94] Hebert (n 90) 262. (It is acknowledged that while a retrieval report of the prior art is time-consuming and costly, applicants can significantly benefit from a meticulous search to make an exhaustive check to estimate if the application is qualified and also can modify their patent claims in an accurate manner. Consequently, it should 'be a part of the process irrespective of whether it is required by the particular program involved'.)

[95] Elizabeth Burleson, 'Energy Revolution and Disaster Response in the Face of Climate Change' (2011) 22 (169) Villanova Environmental Law Journal 101, 109. (According to Professor Robin Kundis Craig, the common law may have advantage of being flexible to provide legal support that is needed

provisions concerning environmental influence assessment, it is reasonable to presume that agencies that provide this kind of professional service will be issued qualification certificates by the State's patent administrative department and engage in services of a permitted level as stated on their certificates and be responsible for the conclusions drawn by them. As provided in Article 19 of The Law on Environmental Impact Assessment of the People's Republic of China, agencies commissioned to provide technical services for environmental impact assessment of projects have to pass the qualification test of the State environmental protection department before offering services, work with levels and scopes of environmental impact assessment as stipulated on issued certificates and be responsible for conclusions made by them.[96] The specific requirements for qualification and administrative measures in this regard need to be formulated by administrative departments of environmental protection under the State Council. In addition, Article 20 states that reports on environmental impact assessment must be prepared by agencies with appropriate qualifications.[97]

In contrast to the simplification of procedures, it may make it more difficult for China to reduce the time of examination in practice. Fast examination implies that patent examiners must confirm the degree of environmentally soundness of technologies in a quick and transparent way.[98] In addition to documents submitted by applicants, limited administrative resources are a great challenge.[99] Generally, unless

for climate change adaptation regimes.)

[96] The Standing Committee of National People's Congress, The Law on Environmental Impact Assessment of the People's Republic of China passed by the thirty session of the ninth standing committee of the People's Congress in 28 October 2002 and coming into force on 1 September 2003 < http://www.gov.cn/gongbao/content/2002/content_61822.htm >accessed on 16 May 2016. (Moreover, it is stipulated in Article 19 that agencies that are qualified to provide technical services for environmental impact assessment of projects shall not have interest tie with administrative departments of environmental protection that are responsible for assessing and approving reports submitted by commissioned agencies or other relevant authorities of examination and approval.)

[97] Ibid. (It is further provided in Article 20 that 'no units or individuals may designate for any construction corporation any agency to make assessment of the environmental impacts of any construction project'.)

[98] Hebert (n 90) 251. (Examiners are encouraged by accelerated examination programs to spend less time on each application, raising the possibility that 'patents will be either improperly granted or improperly denied'.)

[99] Gideon Parchomovsky and R.Polk Wagner, 'Patent Portfolios' (2005) 154 University of Pennsylvania Law Review1, 61. (Poor review of filings partly due to insufficient resources has been

extra resources are provided, the examination of one department speeds up by using the resources of other sub-departments.[100] In other words, it leads to an increase in administrative costs to shorten the time of examination so only by fully guaranteeing personnel and financial resources can fast examination become a reality.

6.3 Implication of the Implementation of the Special EST Patent System in China

6.3.1 The Implication for China

The implication of a special EST patent system for China is mainly embodied in three aspects, namely capacity building of local green innovation to improve the quality of ESTs manufactured in China; stimulus to competition on ESTs both domestically and internationally, and fulfillment of China's commitment and contribution to addressing climate change. It is a difficult problem for IP protection to pursue further efficiency and give due consideration to equity at the same time. Moreover, the free-wheeling attitude towards copying and imitation is now viewed as an undesirable way to promote capacity building of local innovation by developed countries who are unwilling to transfer high technologies to developing countries which just copy them and ignore patent rights similar to what these developed countries did during the period of technology catch-up.[101]

observed in the study of PTO of United States that is under-funded and under-staffed. What is worse, 'the recent increase in the number of filings has stretched the PTO to its limit, and perhaps beyond'.)

[100] Maskus (n 61) 23. ('In any event, expedited treatment of a sub-set of applications will result in some lengthening in the treatment of other applications unless additional resources are provided.')

[101] Ken Shadlen, 'Policy Space for Development in the WTO and Beyond: The Case of Intellectual Property Rights' (2005) Tufts University Global Development and Environment Institute Working Paper No. 05-06, 8-9 <http://ase.tufts.edu/gdae> accessed on 31 May 2012. ('The reduction of policy space under TRIPS is best illustrated with reference to the three axes of variation noted above: establishing private rights over knowledge becomes more automatic, the rights are more absolute, and they last longer. Whereas countries could previously deny patents to certain types of inventions so as to encourage reverse-engineering and lower the barriers to entry in technologically-intensive sectors, now countries must offer patents in virtually all fields.')

For developing countries like China in particular, technical spillover effect of ESTs can accelerate the establishment of industries which are of great significance to energy conservation and emissions reduction. Fortunately, the EST patent system mentioned here is a compromise in a situation where the international community is demanding a response to ongoing climate change and a feasible method to encourage innovation without impediment to increasing access to much-needed ESTs.[102]

The Chinese authorities are intensely aware that with acute problems of imbalanced, uncoordinated and unsustainable development, the only possible way to solve the dilemma between economic development and shortage of resources lies in scientific and technological innovation, especially the innovation of ESTs. Following the groundbreaking empirical study conducted by Grossman & Krueger, an inverted U-shaped relationship has been found between pollution levels and per capita incomes.[103] Without considering the structure effect of the shift of pollution-intensive industries from developed counties to developing countries, the arrival of the turning point must rely on the innovation and application of ESTs.[104]

China has been intensifying its efforts in striking a balance between sustainable innovation and technology diffusion, that is, a trade-off between welfare today and future welfare resulting from a higher technological level.[105] In this regard, the differentiated protection of ETSs from the perspective of patent law is perfectly in

[102] Jerome De Meeus and Alain Strowel, 'Climate Change and the Debate around Green Technology Transfer and Patent Rules: History, Prospect and Unresolved Issues' (2012) 3 (2) WIPO Journal 178, 183-184. (Not only supported by a group of developing countries, the claim of integrating an IP compromise into the climate deal also gains the support from the European Parliament. However, this claim did not receive a feasible response.)

[103] Gene M. Grossman and Alan B. Krueger, 'Economic Growth and the Environment' (1995) 110 (2) Quarterly Journal of Economics 353.

[104] B. R. Copeland and M. S. Taylor, *Trade and the Environment: Theory and Evidence* (Princeton University Press 2003) and W. A. Brock and M. S. Taylor, 'The Green Solow Model' (2010) 15 (2) Journal of Economic Growth 127. (After a lot of theoretical research positive relationship between environmental protection and economic growth is explained, and the immediate causes of pollution levels declining with economic growth are summarized into two: (1) The structure effect caused by the fact that pollution-intensive industries are massively transferred from developed countries to developing countries; (2) technical effect of the progress of energy conservation technologies and clean production technologies.)

[105] Andreas Schaefer, 'Enforcement of Intellectual Property, Pollution Abatement, and Directed Technical Change' (2017) 66 Environmental Resource Economy 457, 460.

harmony with China's innovation policy and industrial upgrading of recent years. China is now viewed as an impressive catch-up innovator in some renewable energy sector, for example, the wind energy, although wind energy corporations from developed countries are still based at the core of innovation systems.[106] China's access to some high-level ESTs is required if China is to develop its indigenous innovative capabilities and fulfill its task of reducing emission through industrial upgrading. For instance, as China dominates the global coal market and continues to exploit its large domestic coal reserves, wide-spread use of ESTs in the coal-fired power industry is crucial for China to reduce its rapidly increasing GHG emissions.[107]

It argues that the standard of patent protection should be appropriate to local technological development, otherwise the more stringent it is, the more incentives stakeholders have to avoid it, thereby adding the risk of piracy and the cost of enforcing IPRs.[108] The traditional patent protection broadly applies to all inventions without differentiation. Given the heterogeneity of ESTs, undifferentiated protection will reduce the options of some ESTs and delay access to them, and increase the cost of imitation, giving rise to piracy, and on the other hand will cause needless duplication of innovations and decrease quality of products in the field of some ESTs.[109] So it is reasonable and economically effective that different standards apply to different ESTs, for example, stringent standard applying to improved technologies and lenient standard to basic and core technologies. In accordance with a value-based judgment, differentiated protection scope is set for different types of ESTs, giving

[106] Johan Nordensvard, Yuan Zhou, Xiao Zhang, 'Innovation Core, Innovation Semi-periphery and Technology Transfer: the Case of Wind Energy Patent' (2018) 120 Energy Policy 213, 214.

[107] Christian Downie, Peter Drahos, 'US Institutional Pathways to Clean Coal and Shale Gas: Lessons for China' (2017) 17 (2) Climate Policy 246, 247. (According to the International Energy Agency, as the world's largest coal user, producer, and importer, China dominates the global coal market.)

[108] Chen Zhou, 'Can Intellectual Property Rights within Climate Technology Transfer Work for the UNFCCC and Paris Agreement? (2018) 19 International Environment Agreements 107, 116. (It is pointed out by Hutchison that 'TRIPS is probably an impediment to technology transfer'. Furthermore, according to Faure, the more strigent the standards are, the more incentives stakeholders have to avoid them. The strict standards will increase the cost of obtaining patented technologies and the risks of piracy.)

[109] Ibid.

priority to the innovation of some ESTs and accessibility of other ESTs.[110]

As described earlier, ESTs are primarily divided into two parts: those that are used to improve ways of traditional energy utilization and those that explore and use new and renewable energy. The former which improves traditional energy utilization ways and energy efficiency plays a more practical part than new energy technologies in China with coal-dominant energy consumption structure and meets stricter grant requirements under the special patent system.[111] A higher requirement of creativeness actually expands access to ESTs and indirectly enhances local innovation capacities. On the other hand, with a wide scope of patent protection, new and renewable energy technologies are protected richly in the form of both products and methods so as to put stress on innovation of emerging ESTs.

The special EST patent system can be carried out flexibly on a basis of China's biased development of ESTs and actual demand for ESTs, requiring both increasing access to ESTs that make traditional energy used in a more environmentally-sound way and a dynamic innovation of new and renewable energy technologies.[112] Taking coal-fired power generation as an example, high level objectives and standards are strictly carried out to control GHG emissions and other pollutants through a carbon emission permits trading mechanism that can restrain gross fossil fuels consumption and production as well as the development strategy of clean coal combustion technologies such as IGCC, IFCC and so on.[113] In addition, the innovation of carbon

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[110] Shadlen (n 101) 10-11. (IP could be used as a tool to reach development goals by facilitating access to some technologies in strategic sectors or decrease prices of some products that are of great demand by the public while not diminishing innovation of these products.)

[111] Mei Gechlik, 'Making Transfer of Clean Technology Work: Lessons of the Clean Development Mechanism' (2009) 11 San Diego International Law Journal 227, 243-245. (Given its real situation, China's central government puts much emphasis on energy efficiency and environmental problems, as well as the use of clean energy by issuing related policies, laws and regulations, all of which indicate that environmental issues, particularly climate change, are perceived as an economic development issue.)

[112] Ujjwal Kacker, 'Technology Transfer and Financing: Issues for Long Term Climate Policy in Developing Countries' (2009) 3 Carbon & Climate Law Review 292, 293 < http://heinonline.org/HOL/Page?handle=hein.journals/cclr3&div=51&g_sent=1&collection=journals#310> accessed on 8 January 2014. (The wide diffusion and use of ESTs are supposed to improve energy efficiency, introduce less-pollution energy and further develop renewable energy, driving economy towards a low-carbon mode by the cycle of technological discontinuity and innovation.)

[113] David Popp, 'Lessons from Patents: Using Patents to Measure Technologies Change in

capture and storage technologies is of equal importance to this industry to deal with carbon produced by coal-fired power plants.

It is equally important to point out that the implementation of the differentiated patent regime highlights government's involvement. Interestingly, IPRs 'hardly pose a problem in the public domain and governments' involvement may be more effective than strong IPRs as an incentive to stimulate basic scientific research'.[114] The actively supportive role of governments is fully demonstrated in China, which is viewed as 'an example of a country that creates an environment conducive to the successful development of clean technologies'.[115]

The enforcement of IPRs, affected by the state of national economic development, is another issue that matters the implementation of the differentiated patent regime in China, who is widely criticized for lacking an adequate legal environment to enforce IPRs.[116] Though the standard of IP protection achieves unification internationally, the enforcement of IPRs differs in various degrees. According to Schaefer's research, there exists a reinforcing interaction between the incentives to enforce IPRs and the willingness to pay for pollution abatement measures.[117] On the one hand, pollution abatement measures 'reduce disposable incomes and thus investment in R & D but increase total factor productivity in subsequent periods and provide thus higher

Environmental Models' (2005) 54 Ecological Economics 209, 210. (The review of environmental literature tells us that market-based policies, such as tradable emission permits, are generally believed to be more effective than a command and control policy, both of which are essential part of measures to promote the innovation and change of ESTs.)

[114] Ivan Morales, 'Balancing Intellectual Property Rights and Clean Technology Development: Encouraging Cooperation' (2017) 17 Houston Journal of Health Law & Policy 405, 417-419. (By taking China as an example, a cross-government approach is presented as an effective method to address climate change through international cooperation. Based on the statistic, China is demonstrative of the positive effect of state involvement could have on the research and development of ESTs.)

[115] Ibid 418.

[116] Schaefer (n 105) 458-459. ('Earlier stages of economic development are characterized by low savings, thus low investment in R&D, low enforcement levels of IPRs and a low willingness to pay for tax-financed pollution abatement measures'. As far as problems with IPR enforcement in a large number of mostly developing countries are concerned, the European Commission's IPR Enforcement Report 2009 lists the complaints in this aspect, including 'injunctions or criminal sanctions often being difficult to obtain, civil procedures being lengthy and burdensome with high uncertainty of outcomes, involved staff being insufficiently trained, resources being lack to effectively prosecute and convict violators'.)

[117] Ibid.

incentives to enforce IPRs in the future'.[118] On the other hand, the enforcement of IPRs benefits clean and dirty technologies alike, but the pollution caused by the use of dirty technologies has adverse effect on total factor productivity and the incentive to enforce IPRs.[119]

Therefore, China's commitment to emission reduction and its strong actions in this aspect have much positive effect on the solution to the notorious problem with IPR enforcement. It is predictable that the prospects of the differentiated patent regime working in China are promising under the more of this kind of good exchange between the incentive to enforce IPRs and China's strong willingness to deal with emission reduction.

6.3.2 The Implication for the World

The enhancement of the quality of ESTs manufactured in China both from the perspective of environment and competitiveness has a special consequence for addressing climate change. Given the currently unshakable status of China as the world's factory, it will probably become the major supplier of environmentally-sound products to the whole world if this trend continues.[120] As for the manufacture of ESTs, China has never refused to shoulder its responsibility. For example, 40% of the world's solar photovoltaic panels, 30% of wind tribune generator systems and 77% of solar water heaters are manufactured in China.[121] However, the low quality of

[118] Ibid 461.
[119] Ibid.
[120] Paul Welfens, Raimund Bleischwitz, Yong Geng, 'Resource Efficiency, Circular Economy and Sustainability Dynamics in China and OECD Countries' (2017) 14 International Economics and Economic Policy 377, 380. (China is now viewed as 'quite a relevant player in all markets'. By following a double strategy, China absorbs advanced technologies from the North in order to compete on the market of the North and at the same time becomes lead supplier for countries of the South. As such, China is an important country to adapt knowledge from the North and the actual needs of the South.)
[121] Babette Never, 'Toward the Green Economy: Assessing Countries' Green Power' (2013) No. 226 German Institute of Global and Area Studies Working Paper on the Research Programme: Power, Norms and Governance in International Relations June 2013, 21. (Although it is hard to shake the dominant position of industrialized countries in the field of ESTs, some emerging countries perform

China's products is widely attacked. In view of the importance of ESTs export markets, it is necessary to improve the quality of ESTs based on feedback and demand of customers and users. This is extremely important to China's competitiveness in ESTs.

China's increasingly positive performance in the field of ESTs presents both challenges and opportunities for the international community. An interesting point to consider is that China's growing investment and increasingly active role in the development of ESTs has been matched by the increasing number of multinational companies' patent application for ESTs, which would be inconceivable without governments' intensive efforts to back up their cross-national companies.[122] The intensified competition has gradually created a situation in which the ESTs market is dominated by the U.S., Japan and Germany, thus decentralizing the production of clean energy technologies.[123]

The decentralization of ESTs manufacture has meant that the original advantage of patent owners will be neutralized.[124] This will be followed by a new round of competition in which new competitive advantages can be created and constructed. With competition being stiff, in the near future trade frictions will appear and there will be more opportunities for cooperation at different levels. Although the interest of cross-national companies lies in how to minimize costs by making use of China's market resources rather than capacity building of local innovation, healthy technology diffusion in informal means could be very helpful for technology catch-up of

noticeably well in some specific sectors. For example, China and India are prominent in the world's wind turbine manufacture with considerable share of market. In solar energy, some Chinese companies have edged themselves into the world top fifteen manufacturers of PV cells.)

[122] Ibid 21-22. ('China is the current leader in clean technology expenditure, followed by Germany and the US. In 2010, China invested nearly fifty billion USD in clean technology. While Brazil and India stand out among the emerging economies, China is the only country that is on its way to reaching the same levels of R&D expenditure as the industrialized countries.')

[123] Miranda Schreurs, Congcong Wang, 'Leadership Competition on Clean Energy and Green Technologies' (2012) 03 Green Leaves 85. (Even though some countries such as China, Britain, France, Canada, Korea, Italy and Russia are positive in the application activity of ESTs, US, Japan and Germany still inhabit the dominant position in the ESTs market.)

[124] Welfens, Bleischwitz and Geng (n 120) 380. (With the increasing role of China and other countries of the South, a segmentation of the market is witnessed 'with the low- and mid-tech green innovations in the South more likely originating in the South as well'.)

emerging countries.

As mentioned previously, international harmonization of IPRs in the context of climate change is not to examine conflicts between each single country and all other countries in this area of ESTs one by one, because obviously this is not going to work, but focuses on major concerns that have a significant impact on future development of the whole of human society.[125] From the perspective of China, as an example of developing countries under the dual pressure in patent protection and access to ESTs, it finds the differentiated patent protection for ESTs could have a positive impact on global fight against climate change and market competition for ESTs around the world.

[125] Elizabeth Burleson and Winslow Burleson, 'Innovation Cooperation: Energy Bioscience and Law' (2011) 2011 (2) University of Illinois Law Review 101, 121. ('Building international consensus is an arduous task across many sectors, yet momentum is building to try to resolve key areas of international concern—including transfer of environmentally sound technologies to least developed countries.')

Chapter 7 Conclusion and Prospects

7.1 Conclusive Statement

Global warming will get worse if emissions of GHGs rise over the maximum amount that the atmosphere can tolerate.[1] When this happens, punishment may await those who ignore it in the absence of effective man-made measures.[2] Global climate change brings back, in a highly visible and universally relevant way, the fact that it is a typical case of negative externality that can easily lead to insufficient supply of ESTs and free riding on the achievements of climate governance.[3] As a kind of technology which is helpful to reduce GHG emission, the application of ESTs is a well-accepted and effective way to protect the climate, the improvement of which is expected as its core return. However, most ESTs are held in the hands of private stakeholders who are concerned to create their own goods. It is therefore essential to strike a balance between exclusive monopoly rights and accessibility of ESTs in the context of climate change.[4]

The result of this study shows that it is feasible to design a differentiated patent regime for ESTs in the context of climate change, with the goal of facilitating access to ESTs. The role of ESTs has been well documented in the multilateral instruments on climate changes. The UNFCCC (Article 4.1 (c)) and the Kyoto Protocol (Article 10 (c)) specifically mention development, application and diffusion of ESTs relevant

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[1] Deborah Behles, 'The New Race: Speeding up Climate Change Innovation' (2009) 11 (1) North Carolina Journal of Law & Technology 1, 5. (Greater emission reductions than those which have already been proposed are strongly recommended by some scientists, because it is believed that GHG emissions 'may have surpassed a tipping point, causing irreversible results'.)

[2] Paul A Samuelson and William D.Nordhaus, *Economics* (Chen Xiao tr, 18th edn, McGraw-Hill Education 2005) 37. (Global warming, viewed as one environmental issue that worries scientists most, is a typical case of negative externality that commands 'most of the headlines' and government regulations.)

[3] Joshua D. Sarnoff, 'The Patent System and Climate Change' (2011) 16 (02) Virginal Journal of Law and Technology 302, 336. (It is believed by the author that in the context of demanding enlarging access to ESTs, investors and inventors do not need to keep results of creation for their own or completely control the spillover of their creation. Apparently, free riding is exaggeratedly criticized, which is fundamentally misguided and inappropriate.)

[4] See 2.3.1.1.

to climate change, including the know-how, practices and processes.[5] Clearly, it is often not conducive to, and even hinders the spread and pricing of ESTs, when consumers have an unclear environment-friendly concept in their minds.[6] There is no official definition of ESTs, although the term can be found in many documents issued by international organizations including WIPO, the UNEP and the OECD.[7] ESTs, also known as environmentally sustainable technologies, green technologies or clean technologies, are the beneficial application of environmental science, in order to protect the natural ecology and resources and ensure environmental sustainability by eliminating the negative effects caused by human activities.[8]

In this thesis, all technologies under discussion in the context of climate change are referred to as ESTs, which are those that can bring about the reduction of GHG emissions and those that can increase energy efficiency.[9] Before the devastating impact of GHGs on global climate is revealed and universally recognized, ESTs have already undergone spontaneous generation and growth, with a long process under the interaction between market rules and many other factors.[10] The owner of an invention

[5] The United Nations Framework Convention on Climate Change; Kyoto Protocol to the United Nations Framework Convention on Climate Change, Conference of the Parties, 3d Sess. U.N. Doc. FCCC/CP/1997/L.7/Add.1 (Dec. 11, 1997); K.Ravi Srinivas, 'Climate Change,Technology Transfer and Intellectual Property Rights'(2009) Research and Information System for Developing Countries Discussion Paper RIS-DP#153,2009.

[6] Daniel K.N. Johnson and Kristina M. Lybecker, 'Challenges to Technology Transfer: A Literature Review of the Constraints on Environmental Technology Dissemination' (2009) 07 Colorado College Working Paper in the Project Supported by the National Peace Foundation and the United States Chamber of Commerce 1, 4.

[7] See 5.3.2.1.

[8] Emma Barraclough, 'EPO Leads Debate on Patents and Climate Change' (2010) No.196 Managing Intellectual Property 32. (In the subsection 'the Green name game' of Patent Survey: Introduction, if the innovation or invention complies with the green or environmentally friendly technologies standard, it will be allowed by the UK IP Office to entered Green Channel; EU also make the promise to give the financial support to the eco-innovation projects which are centered on the technologies defined as any form with the significant success in achieving the sustainable development, by reducing the impact on environment or improving the efficiency and reasonable application of natural resources).

[9] See 4.1.1.3.

[10] Johnson, Lybecker, 'Challenges to Technology Transfer: A Literature Review of the Constraints on Environmental Technology Dissemination' (n 5) 7. (In this paper, it is concluded after the literature review of the factors that exert a great influence on the spreading process of environmental technologies that 'empirical studies have emphasized the roles of firm size, R&D expenditure, market share, market structure, input prices, technology costs, firm ownership, and other institutional factors including policy.')

is entitled to the exclusive rights on the use, production and marketing with legal protection against infringement of any private interest created by IPRs on their own products.[11] That is to say, IPRs make ESTs into market goods with clear property, competitiveness and consumption-exclusiveness.[12]

IP protection and climate mitigation, both of which are mutually independent, are connected by the emergence of climate crisis. Current ecological problems have gone beyond the traditional scope of global common issues, which means these problems are no longer just environmental issues but are closely related to economic and social development and human survival. The new development of international IP protection on ESTs in order to adapt to climate change could have an active impact, not only on the physical environment but also on social environment, such as utilization efficiency of technical information, social innovation capability and economic sustainable development.[13]

By analyzing the existing arrangements related to ESTs, disadvantages of the current international patent system become increasingly obvious when dealing with issues about climate change.[14] Projects built round motivated individuals are not sufficient to meet the special demand of ESTs for climate adaptation and mitigation.[15] It is often not easy to reach a balance between supply and demand due to the nature of ESTs as quasi-public products.[16] The environmental benefit of ESTs is greater than

[11] Cameron Hutchison, 'Does TRIPS Facilitate or Impede Climate Change Technology Transfer into Developing Countries?' (2006) 3 (2) UOLTJ 517, 527-528. (In the discussion about the effect of the regime created by TRIPS Agreement on local innovation, the legal rights of owners are helpful to prevent free riding by imitators and to promote further innovation by disclosure).

[12] See 2.1.1.2.

[13] See 3.2.2.

[14] See 3.1.2.

[15] Benjamin K. Sovacool, 'Placing a Glove on the Invisible Hand: How Intellectual Property Rights May Impede Innovation in Energy Research and Development' (2008) 18(2) Albany Law Journal of Science and Technology 381, 404. (It is noteworthy that in the case of energy efficiency practice, efforts needed to do a small project are frustrating with poor efficiency, leading to an ironic situation that 'the small the project, the less likely it will be undertaken'.)

[16] See 2.1.1.2.; see also Sarnoff (n 3) 316. (The Berkeley study indicates that 'on average, patents offer just above a 'slight incentive' to engage in invention, R&D, and commercialization, and between 'slight' and 'no incentive at all' to create internal tools and processes', coming to the conclusion that the patent system may not function well for many technological fields, including climate change technologies.)

their economic return at the initial operation stage, dampening the initiative of individuals.[17]

The influence of current patent systems on the environment and ecosystem is illustrated by the mode with institutional guarantees of patents for innovative activities first then to take environmental impacts into consideration. During this process, technologies play a crucial role in determining whether there is a positive or negative correlation between innovation and environment. Unfortunately, the general patent system treats different technologies no differently, and as a result protected non-ESTs will cause further damage to the environment.[18]

Science and technology themselves are value-neutral, but they acquire a dual attribute because of the different motives of their owners and users, according to which technologies can be roughly divided into three categories.[19] The first ones are those technologies that are neither good for economic development nor environmental protection and which are doomed to be legally prohibited. The second ones are those that are helpful to promote economic development and protect the environment by win-win solutions, which are called ESTs. The third ones are those transitional technologies that create temporary prosperity in spite of doing harm to the environment. The proposed patent regime in this thesis suggests that prohibition never cover all those in the third which need further analysis and identification, as one part

[17] David Ockwell, Jim Watson, Alexandra Mallett, Ruediger Haum, Gordon MacKerron, Anne-Marie Verbeken, 'Enhancing Developing Country Access to Eco-Innovation: The Case of Technology Transfer and Climate Change in a Post-2012 Policy Framework' (2010) No. 12 OECD Environment Working Papers 2010 < http://dx.doi.org/10.1787/5kmfplm8xxf5-en> accessed on 2 November 2014. (It is generally believed that new technologies cost more than existing ones until demand reaches the level where economies of scale are realized. For ESTs, due to the failure of markets, environmental benefits and environmental costs associated with many technologies are compounded, leading to incremental cost of ESTs that can only be addressed by various remedies, such as international policy mechanisms.)

[18] See 4.1.2.3.

[19] Mei Gechlik, 'Making Transfer of Clean Technology Work: Lessons of the Clean Development Mechanism' (2009) 11 San Diego International Law Journal 227, 242. (Similarly, three group of industrial sectors are identified by China's central government to promote the investment in clean technologies, including 'encouraged', 'restricted' and 'prohibited' industrial sectors. Encouraged sector refers to the production of environmentally sound goods and services. Restricted sector is one that is of vital importance to the national economy but arise environmental issues. Prohibited sector means one that is controlled by governments, for example the establishment of national preserves.)

of them can become environmentally friendly technologies when substantive upgrade is completed and the other part could be replaced by environmentally preferable technologies.[20]

This thesis demonstrates that due to strengthened private rights, the ever-changing balance is off-kilter, ignoring public interests involved in the global issue of climate challenge.[21] Though the principle of equilibrium can be found in international and domestic legislation, the attention to targets in the public domain is not enough, compared with the high level protection of private rights which are restricted through moderation.[22] It is obvious that one side of ESTs' dual nature as public goods is submerged in the excessive expansion of the other side of private attribute, reflected by the difficulty in access to ESTs resulting from serious regional imbalances of technical levels.[23]

The current patent system fails to perform its repair function in addressing climate change.[24] Confronted with increasingly serious social problems, patent systems are supposed to achieve the dual rehabilitation of function and efficiency by adjusting the relationship between some technological innovations and public policies, as everything that takes place in the public sphere eventually has impacts on private benefits in a complex and hidden way.[25] The function of patent systems is particularly reflected in encouraging innovation and protecting exclusive rights, but

[20] Stephanie Chuffart, 'Technology Transfer and Dissemination under UNFCCC: Achievements and New Perspectives' (2013) Electronic copy available at: <http://ssrn.com/abstract=2294642> accessed on 20 April 2015, 12. (Different from the traditional environmental goods and services that are 'a narrower category encompassing goods and services whose end-use, or main purpose, is environmental per se,' the new term of environmentally preferable products is introduced in the WTO negotiations on environmental goods and services whose rationale is to prove more environmentally friendly than alternative ones.)

[21] See 2.2.2.

[22] Jerome H. Reichman, 'Intellectual Property in the 21st Century: Will the Developing Countries lead or Follow?' (2009) 46 (4) Houst Law Review 1115, 1158. (From a broader perspective, a new equilibrium between private and public goods should be the objective of the establishment of an appropriate IP system because 'the last half of the twentieth century was so consumed with conflicts between public-centered and private-centered economies, insufficient thought was given to evaluating the proper and ever-evolving interrelationship between private and public goods, which the rise of knowledge economies has made so critically important'.)

[23] See 4.2.

[24] See 3.2.1.

[25] See 5.1.2.

its function of patching up some broken social relations in coordination of rights and responsibilities has not been exerted sufficiently, for example, to reduce poverty, protect public health and stave off human-induced climate change.[26] To be more precise, appropriate restrictions need to be set on private exclusive rights, such as the use of compulsory licenses in the Doha Declaration and the introduction of environmental impact assessments into the substantive review of patent applications.[27]

In this regard, this study indicates that the heated debate on drug patents and public health could offered valuable experience and lessons for resolving the conflicts between IP protection and measures against climate change. From the economic perspective, similarities and differences between ESTs and drugs are discussed and summed up.[28] ESTs and drugs belong to imperfect public goods with great positive externality, determining their potential for monopoly when the demand for them exceeds the supply.[29] In view of the differences between drugs and ESTs which subject to different standards of patent granting, it is believed that value-based differentiated protection of various types of ESTs is necessary and feasible.[30]

In the comparison between drug patents and EST patents, it may be reasonable to consider the question about what is the essence of public interests. Public interests are not a simple collection of private interests, and have a practical significance and more lasting stability only when they contribute to the survival and development of the overwhelming majority of people.[31] With its historical limitations, public interests

[26] Nuno Pires de Carvalho, 'The Primary Function of Patents' (2001) 1 Journal of Law, Technology & Policy 25, 44, 51. (A patent system is expected to be a system that runs efficiently from the social perspective and yet 'permitted the private appropriation of knowledge'. In some area, for example the health sector, the exclusive patent rights coexist with inventions funded by public investments, reflecting that patents and public interests are not necessarily incompatible. It is suggested that a balance between patentees' rights to recoup investment from inventions by monopoly and the full display of intrinsic values of inventions should be struck.)

[27] See 4.2.1.1 & 5.3.2.1.

[28] See 4.1.1.

[29] See 4.1.1.1 & 4.1.1.2.

[30] See 4.1.1.3.

[31] Jeanne C. Fromer, 'Patent Disclosure' (2009) 94 Iowa Law Review 539, 588. (Public interests are not necessarily consistent with the collection of private interests, and as a matter of fact, in most cases they contradict each other. In terms of patent rights, 'the public interests of allowing society some form of access to patented inventions' are the opposite of protecting exclusive patent rights that represent the interests of a small portion of people.)

interpreted on spatial basis have experienced great challenges in the era of globalization, blurring the line between public interests of individual countries or different regions in a way that has left laws struggling to keep up.[32] In spite of the different interests of each country, some widely-accepted interests beyond national and regional borders with identical direction do exist, for example, human rights such as right to life and health in the area of public health and environmental protection.

The function of public interests in the international IP system is to enable non-special, mass, diffused interests in a relatively stable state. The view that public interests should be introduced into legal patent protection has been widely supported theoretically and practically, but it is not clear to what degree and scope to define public interests within particular usage.[33] Transnational corporations who speak for patent owners of drugs and ESTs and developing countries that claim to represent their people take public interests as an omnipotent weapon against each other.[34] It is frustrating that the international patent system has not yet been able to do anything about it, even though public interests are mentioned in TRIPS without a clearly defined concept and scope, meaning that the arguments given are at variance with each other.[35] What has caused this phenomenon is the lack of relevant legal standards.

For the above reasons, this thesis holds that it is essential to introduce the clause

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[32] Mulugeta Getu, 'Accommodating the Interests of Developing Countries in the Climate Change Regime: Lessons from the Ozone Layer Regime' (2012) 6 (1) Mizan Law Review 1. (Some lessons from the Ozone layer regime tell us that limited to narrow understanding of public interests set upon spatial basis. In the past, focuses are placed on the polarized interests of the developed North and developing South, preventing the international community from protecting the 'global commons'.)

[33] Elizabeth Burleson, 'China in Context: Energy, Water and Climate Cooperation' (2010) 36(3) William Mitchell Law Review 101, 113. (According to Paul Joffe, global public interests in addressing climate change could be defined from a comprehensive perspective 'that combines treaties, policy initiatives and human rights together'.)

[34] Nitya Nanda, Nidhi Srivastava, 'Clean Technology Transfer and Intellectual Property Rights' (2009) 9 (3) Sustainable Development Law & Policy Spring 20009 42. (The developed countries hold the view that the lack of robust legal mechanisms and domestic institutions in developing countries is responsible for the slow and ineffective of ESTs, which obviously delays actions against challenges presented by climate change. 'On the contrary, from the perspective of developing countries, the failure of developed countries to meet their obligations under the UNFCCC and their lack of awareness and willingness to do so, are cited as primary reasons for inadequate technology transfer.')

[35] See 2.2.1.

of public interests into the rules of EST patent protection and substantiate the closely-related claims, since the profit-oriented innovation drive will not place public demands on the top priority.[36] In this regard, the concept of specialty interpretation is put forward, namely the interpretation of concrete public interests within a particular context.[37] The birth and development of the Doha Declaration represents significant progress that has been made in the maintenance of public interests with the protection of public health as the central task within the international patent system. Similarly, the study of the consequences of climate change on human health comes to the conclusion that 'almost no component of human health that will be untouched by climate change'.[38]

This thesis proves that the fundamental problem facing the establishment of an EST patent system is how to maintain a balance between breakthrough and inheritance of traditional patent laws, which lies in the change of the intention to design patent systems.[39] Accordingly, new rules of law need to be introduced that are not found in traditional patent systems.[40] These new rules are unusual in taking a perspective of environmental improvement and accessibility of ESTs, and proposing a new regime upon the fundamentals of patent laws.[41] With a particular regulative object, legal relationship and regulation method, the regime attempts to break through

[36] See 5.3.4.

[37] Henning Grosse Ruse-Khan, 'Sustainable Development in International Intellectual Property Law – New Approaches from EU Economic Partnership Agreements?' (2010) 29 ICTSD Programme on IPRs and Sustainable Development 1, 7-8. (The dubbed 'context' means 'a wider framework within which the promotion of innovation and protection of IP operates', supporting 'an implementation and interpretation of specific IP obligation that leaves reasonable policy space and flexibility to the domestic legislators'. 'It is useful to recognize the generally accepted overarching goal of IP protection and deduce its potential role to balance and individually tailor the scope and extent of protection to domestic needs (by means of interpretation and implementation of the broad and open terms in IP provisions.')

[38] Lisa Heinzerling, 'Climate Change, Human Health and the Post-Cautionary Principle' (2008) 96 Georgetown Law Journal 445, 448-449. (There is a long list of consequences of climate change that will harm human health, indicating that 'almost no component of human health that will be untouched by climate change', for example, vector borne diseases such as malaria, pulmonary and cardiovascular diseases, diarrheal disease, cholera, infectious diseases, skin cancer, cataracts, immune deficiency, pollen allergies, hunger and malnutrition.)

[39] See 5.1.

[40] See 5.1.1.

[41] See 5.2 & 5.3.

in the relationship between the innovation and accessibility of ESTs, by locating the emission commitment under the UNFCCC and Kyoto Protocol as the contact point on a quadrilateral platform under the WIPO, UNFCCC, WTO and WHO.[42] Based on their respective functions and duties in the field of IPRs, climate change, global trade and public health (all of which are closely related to the application of ESTs), consistency and continuity of climate change policies could be ensured through joint efforts in technical support and policy.[43]

In this new regime, an optimal patent protection for ESTs is considered from the perspective of social welfare. Based on the law and economics analysis, it justifies that the duration of EST patents has to be extended to give enough incentive to investment; the scope is narrowed to reduce social costs and also for the growth of green patent values; and the bar of substantive requirement needs to be raised on account of the eco-friendly feature of ESTs to guarantee the quality of patents.[44] Accordingly, the value-based differentiated protection of ESTs is a commendable choice to achieve optimal access to ESTs.[45] Though private rights are the nature of IPRs, which would never be changed whatever restrictions there were, EST-related patent rights exist as one of the means to provide various public goods and services, with the new responsibility of contributing more toward the global battle against climate change.[46] Given the dual attribute of ESTs, therefore, two aspects must be considered in the protection of EST patents, namely, the maximization of both technology supply and positive environmental externality of ESTs.[47]

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[42] See 5.4.1

[43] See 5.4.2 & 5.4.3.

[44] See 5.3.1.

[45] Ibid.

[46] Michael Hasper, 'Green Technology in Developing Countries: Creating Accessibility through a Global Exchange Forum' (2009) Duke Law & Technology Review 1, 3-4. (According to the hypothesis put forward by Michael Porter, environmentally-conscious practices including product differentiation, access to markets by a variety of channels, sales of ESTs and cost reduction in regulations and management can stimulate innovation and adaptation of ESTs. It is no wonder that many companies view 'product differentiation as a benefit of going green'.)

[47] John F. Duffy, 'Harmony and Diversity in Global Patent Law' (2002) 17 Berkeley Technology Law Journal 685, 694. (It is noted that though 'externalities provide a particularly powerful justification for transnational patent harmonization because one nation's patent law can create a global externality', the maximization of positive environmental externality of ESTs is limited to some extent by geography,

In other words, what needs to be considered is patentability of ESTs and the grant requirements which vary according to their categories.[48] As an integral part of national technology and industrial policies, patent laws are supposed to match public interests embodied in public health and environmental protection. In this thesis, the design solution is to turn a mechanism only focusing on technological innovation, into a system that aims to green the innovation environment and is suitable for technological diffusion, by using multiple variables such as the breadth, length and intensity of patent protection.[49] For a type of technology with specific function, a refined and differentiated legal system is necessary, particularly the scope of patent protection of ESTs.[50] With efforts appropriately targeted to address environmental problems, the new regime can make up for the flaws of traditional patent systems, so as to realize a balance between public and private interests in an optimal manner.

The study on the feasibility of the proposal is conducted in a reliable way which is conducive to solving practical problems of accessibility of ESTs and creates a new way to resolve the deteriorating negotiations on climate change.[51] Located in China, as one of the largest emitters of GHGs with a great potential for emission reduction, the discussion regarding how to flexibly apply this differentiated patent regime in different jurisdictions is based upon China's biased development of ESTs and actual demand for ESTs, against the background that the implementation of patent protection must work with characteristics of EST-related industries at a national level.[52]

Costs and benefits of investment remain the propelling force for EST innovation. So far, investment in new energy projects has been costly, and unless it falls significantly or the cost of traditional fossil energy jumps, the development and marketing of new energy will not compare favorably with that of traditional energy.[53] In the long run, the adoption of new energy-efficient technologies can reduce costs

which in many cases benefits 'only neighboring or downwind jurisdictions'.)

[48] See 5.3.2.1.

[49] See 5.3.2.

[50] See 5.3.2.3.

[51] See Chapter 6.

[52] See 6.1.

[53] See 2.1.1.1.

and create direct economic benefits for enterprises. Unfortunately, deficient innovation is quite normal in traditional manufacturing industries, because the investment in R&D of air pollution control technologies is believed to burden those companies that rely heavily on the use of fossil fuels in the short run.[54]

Under this background, this thesis insists that if there are proper legal means and national policies that can be resorted to in order to fully display potential advantages of ESTs, a win-win situation could be created both for economic growth and environmental protection.[55] As suggested, the limits of GHG emissions and other pollutants should be regarded as a regular and normal standard which aims at restricting the growth of non-environmentally sound technologies, by integrating environmental performance and impact of technologies into patent grant requirements.[56]

Further, specific emissions limits that differ from one industry to another should be clearly stipulated in patent law and modified as necessary with emissions monitoring and reporting from environment departments.[57] The proposition that technologies be excluded from the scope of patentable subject matter, if pollutants are discharged to a level above emissions standards in its operational process receives legal support from international public law, reflecting the duality of EST-related patent system.[58] That is to say, on the one hand to restrict or ban the use of

[54] Keith E. Maskus and Ruth L. Okediji, 'Intellectual Property Rights and International Technology Transfer to Address Climate Change: Risks, Opportunities and Policy Options' (2010) 32 ICTSD's Programme on IPRs and Sustainable Development Issue Paper 1, 14. (It must be said that firms will not automatically or immediately take environmental obligations to integrate ESTs into the production process, which absolutely increases cost for investors. It is further pointed out that as far as technology transfer is concerned, domestic firms' initiative to make their own contribution to much-needed investments in R&D will be depressed if obligations only imposed on foreigners.)

[55] Lesley K. McAllister, 'Adaptive Mitigation in the Electric Power Sector' (2011) 53 Brigham Young University Law Review 2115, 2138-2139. (Mitigation technologies that have the potential to 'moderate or counteract some of the impact of climate change' should be actively encouraged, and those technologies that cause pollution or habitat destruction, in contrast, should restrained by new regulatory requirements or price paid for environmental problems caused by themselves.)

[56] See 6.2.1.

[57] Ibid.

[58] Robert Fair, 'Does Climate Change Justify Compulsory Licensing of Green Technology' (2009) 6 International Law & Management Review 21. (The case analysis of Harvard/Onco-Mouse indicates that it is more reasonable to consider the patentability of inventions that could potentially harm the

non-environmentally sound technologies, and on the other hand to enhance economic growth and environmental quality by encouraging the development and application of ESTs.[59] Evidently, this study finds that differentiated patent protection is desirable for China in two main aspects, namely, the actual working and local innovation, and therefore could have a very positive impact on the building of China's green innovation environment, as well as enhancing market competition for ESTs around the world.[60]

Throughout, this study made full use of patent systems to increase access to necessary ESTs for emission reduction in key concerned industries. It comes to the conclusion that the proposed special patent regime under WIPO, together with the collective efforts of the UNFCCC, WTO and WHO, could be conducive to proper circulation of ESTs among countries and lead to positive results in response to climate change. Consequently, environmental systems and patent systems are proven not contradictory but complementary to each other, playing their own irreplaceable roles in meeting the various challenges of global climate change.[61]

7.2 The Implication of the Specially-designed Patent System on the International IPRs Movement

After hundreds of years of development, patent systems have provided technical support for the industrialized world. Nowadays, in face of a new situation and new challenges, exploratory efforts have been made for adjustment and reform of patent laws where necessary to satisfy the sustainable development in the post-industrial

environment than to refuse to grant patents to inventions that are deemed to benefit the environment.)

[59] Michael A. Gollin, 'Using Intellectual Property to Improve Environmental Protection' (1991) 4 Harvard Journal of Law & Technology 193, 193-194. (A far-reaching view is hold that 'environmental protection is best achieved by coupling incentives for innovation in beneficial technologies with restrictions on harmful technologies'.)

[60] See 6.3.

[61] See 3.2.2.

era.[62] The issue of climate change offers another important opportunity after the crisis of public health to the international community to take seriously with more than just words in order to reform the international patent system.

First of all, the concept of IP protection could be reaffirmed. Conventions under WIPO affiliated with the UN have a consanguineous relationship with the UNFCCC which was reached under the UN system through democratic procedures on a worldwide scale. The objects respectively regulated by WIPO and the UNFCCC won a place in international human rights law. Looking at IPRs both as private rights and human rights will make the value concept and social function of modern IP systems further understood.[63] A series of IP agreements under the jurisdiction of WIPO reflect the right of citizens to participate in cultural and spiritual life and enjoy the fruits of scientific and technological progress, as well as the right of use and profit, which is an important part of private rights taken as basic human rights. While, on the surface, what the UNFCCC is doing aims at solving environment problems notably characterized by climate change, the fact is that people are being urged to rethink rights and obligations of all parties that involve human rights to life, health and development.[64]

Private property right seems contradictory with the right to environment, health and development which are an integral part of human rights, but this is not the case.

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[62] Henning Grosse Ruse-Khan, 'Sustainable Development in International Intellectual Property Law – New Approaches from EU Economic Partnership Agreements?' (2010) 29 ICTSD Programme on IPRs and Sustainable Development 1, 16. (For the reform of the international IP system, the author stands for the proposition that all stakeholders including countries, international organizations as well as other participants should show due respect to and give full consideration of 'a comprehensive integration of economic, social and environmental concerns in all areas of decision-making'. 'Incorporating sustainable development as a treaty objective in international agreements on the protection of IP can function as a tool to overcome the structural bias and self-contained nature of international IP regulation, which requires action on the international and the national levels.')

[63] Elizabeth Burleson, 'Dynamic Governance Innovation' (2013) 24 The Georgetown International Environmental Law Review 477, 487. (The role of human rights as access to information and public participation in energy use decision and environmental impact assessment has been analyzed by Burleson, which are highly relevant of EST-related patents.)

[64] Ibid. (Since the 2010 Cancun climate conference, a clear mandate has been released to deal with the issue of ESTs in a manner that gives sufficient consideration of human rights. It is acknowledged that the Cancun Agreement represents a milestone by taking seriously the claim that human rights shall be respected in an appropriate manner.)

WIPO has been pushing hard for a more active role for the international patent system in meeting various global challenges, including how to realize public welfare, to promote innovation and access to key technologies, how to contribute to the fair distribution of investment benefits, how to protect public interests in an appropriate way when the general patent standard is applied to sensitive technologies, and how to build an alternative innovation structure in conformity with results that are in public interests.[65]

Second, the legal order of international IP protection could be restored. The disadvantage of competition in jurisdiction of IPRs between WIPO and WTO has been widely criticized for failing to consider practical difficulties of developing countries and always giving in to the will of developed countries, reflecting an unequal international economy and politics order.[66] There has been a lot of discussion about the relationship between WIPO and WTO. Jurisdiction over IPRs shared by the two organizations is difficult to appreciate for confusion, because there are conflicts between WIPO and WTO in terms of IP management, demonstrated by their respective IP protection idea, principles and contents.

From the point of view of WTO itself, its intervention in IP system has no valid reason as a justification. The more the agenda of WTO is controlled and distorted, the more it is weakened. There is no mention of jurisdiction over IP in the tenet of WTO, whose role in regulating technology trade is weakened and in IP management is imposed. It can be seen from content setting that TRIPS has made a niche for itself in the strengthened IP protection, rather than in conflicts in technology trade, which is

[65] In July 2009, WIPO held a conference on the topic of IPRs and public policies, covering multiple subjects involving climate change, pandemic, food security, biodiversity conservation, innovation and acquisition of technologies, distribution of social welfare, sharing of green patents.

[66] Thomas Cottier, Marina Foltea, 'Global Governance in Intellectual Property Protection: Does the Decision-making Forum Matter?' (2012) 3 (2) The WIPO Journal 139, 140. ('The minimal standards set out in the TRIPS Agreement have been criticized for being too rigid and for not sufficiently taking into account different levels of social and economic development. Power, in other words, has been unduly centralized in the World Trade Organization (WTO), and a more flexible mode emphasizing domestic legislation should be sought so that a fair vertical allocation of power between international and domestic fora could be facilitated.')

only mentioned and put to one side in the Agreement.[67]

The orthodox position of WIPO on IP management could be taken seriously. Before the establishment of WTO, there was an international economic organization, namely WIPO founded in 1970, with the principle purpose of promoting IP protection on a global scale by significant and deep cooperation between countries and with other organizations where necessary. The main function of WIPO is to seek cooperation between countries of IP protection, to provide administrative and legal support for twenty-three alliances, based on multilateral treaties about patents, trademarks and copyrights and so on.[68] Major activities of WIPO include encouraging conclusion of treaties, coordinating IP legislations between countries, collecting and spreading IP information, engaging in and promoting the study on IP topics, offering legal and technical assistance to developing countries as well as service to members at their additional requests.[69]

Given all of the above which established the status of WIPO as a dominant organization in IP field, TRIPS under the world trading system is definitely a challenge and shock to the function of WIPO. In this case, the competition between the two organizations has witnessed an ongoing trade-off of interests by individual countries, and a process full of right conflicts in which countries lagging in science and technology gradually lose the right to speak and are increasingly marginalized,

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[67] UNEP, EPO and ICTSD, 'Patents and Clean Energy: Bridging the Gap between Evidence and Policy: Final Report' (2010) 14 < http://www.ictsd.org/themes/innovation-and-ip/research/patents-and-clean-energy-bridging-the-gap-between-evidence-and-policy>accessed on 20 September 2014. (IP issue is not new or exclusive to the transfer of ESTs. Since the negotiation of the draft of the international Code of Conduct on the Transfer of Technology which needed the review the international economic relations, the role of IP became the focus of discussion in global trading system.)

[68] Gerald J. Mossinghoff, 'Patent Harmonization through the United Nations: International Progress or Deadlock?' (2004) 86 Journal of the Patent & Trademark Office Society 5. (A perfect example of WIPO's administrative capacity is its administration of the Patent Cooperation Treaty. It is believed that as long as an operational framework is reached through diplomatic channels, WIPO will display its impressive effectiveness.)

[69] Nandini Kotthapally, 'From World Intellectual Property Organization (WIPO) to World Innovation Promotion Organization (WIPO)? Whither WIPO?' (2011) 2011 WIPO Journal 1, 10. (WIPO has 'two distinctive mandates in the area of (1) norm-setting and provision of technical assistance and (2) provision of global IP services, treaty administration, dispute resolution, etc.' It is suggested that 'the separation of these two core functions would facilitate more streamlined functioning, less interference of one in the other, reduce conflict of interest and facilitate greater confidence and transparency'.)

and thus have no other choice but to accept unfair treatment.[70] International organizations are not supposed to set up just for the purpose of making profit but to constantly improve the organization level of international community, so that a healthy and stable international order can be maintained.[71]

Third, a great opportunity is offered to change the relationship between involved international organizations from competition to cooperation. While the issue of accessibility of ESTs is at hand, the relations between WIPO and other related organizations should be straightened out, so that their respective duties are well performed according to their own function. As a guiding document for addressing climate change, the UNFCCC and a series of legal documents under it set GHG emission standards and reduction targets, meeting the huge demand for ESTs. However, it is undeniable that international environmental rules are never encouraging enough to stimulate innovation of ESTs.

The specially-designed patent regime for ESTs creates motivations to realize intellectual achievements through the vehicle of ESTs and pays attention to environmental benefits as well, intensifying the incentive effect of environmental regulations and policies to maintain public interests maximally. The differentiated patent protection proposed in this regime has two senses: a system that discourages non-environmentally sound technologies and a system providing value-based protection for different types of ESTs. Its strong procedure and operability could

[70] Graeme B. Dinwoodie, Rochelle C. Dreyfuss, 'Designing a Global Intellectual Property System Responsive to Change: The WTO, WIPO and Beyond' (2009) University of Oxford Legal Research Paper Series Paper No.50/2009, 1. (Developed countries are criticized of not fulfilling their promise to facilitate technology transfer and provide technical assistance to developing and less-developed countries. Additionally, TRIPS did not pay due attention to provision of education and training for these developing and less-developed countries who are incapable of pushing forward tasks such as the development of leading-edge technologies. Contradictions are also demonstrated by the structural bias that traditional knowledge, folk arts and natural endowment, making up a large portion of the treasure of information of South countries, are not covered by TRIPS that is believed tailored for knowledge products from North counties.)

[71] Frederic M. Abbott, 'Distributed Governance at the WTO-WIPO: an Evolving Model for Open-Architecture Integrated Governance' (2000) 3 Journal of International Economic Law 63, 73. ('WIPO's approach was designed as: (1) multisectoral and international; (2) non- intrusive regarding IPRs standards-setting; (3) protective of non-IPRs based rights (e.g., human rights); (4) practical in the technological sense, and (5) dynamic in the sense of not constraining further technological development.')

provide safeguards for the provision of ESTs required by actual needs, encouraging the progress and reform of patent systems.

It should be noted that the focus of this study is only placed on invention patents, which are arguably of massive significance above all for ESTs that can make substantial contribution to addressing climate change. With respect to minor creations that could be deemed as environmentally friendly and protected as utility models or other forms of IP, it is worthwhile to explore how to harmonize protection of and access to these minor creations, so as to make their due contribution to environmental protection. It also should be pointed out that the data used in this thesis only indicates the trend of ESTs and technical needs in some key concerned industries, so the result of this study might be better convinced if detailed data from other industries is accessible. However, for such a large and arduous task, it is hard to do it alone. Therefore, more empirical research is welcomed to support the delimitation to an ideal range of environmentally friendly patents.

Besides, given the complexity of this study, involving as it dose many disciplines, this thesis concentrates on exploring the optimal rules regarding patent protection in the context of facilitating access to ESTs, and thus further studies are necessary to explore how to solve problems about international relations, public policies or international trades initiated by the topic concerning IP protection and climate change.

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