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The Legal Barriers to Technology Transfer under the UN Framework Convention on Climate Change

The Example of China

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This manuscript was accomplished with financial support from China Scholarship Council and Tilburg University PhD programme.

1. High Education for PhD Project (2008627095), China Scholarship Council (China), 2009.
2. China's Legal Countermeasures Addressing Global Climate Change in the Era of Post-Kyoto (11JJD820019), Ministry of Education Social Science Key Project (China), 2011.
3. Tilburg Sustainability Center, Tilburg University (The Netherlands), 2012.

ISBN 978-981-13-6138-8 ISBN 978-981-13-6139-5 (eBook)
https://doi.org/10.1007/978-981-13-6139-5

Library of Congress Control Number: 2019935894

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Acknowledgment

This thesis is the result of legal PhD research at Tilburg University, Netherlands, dealing with the following central research question: "what are the legal barriers to technology transfer for addressing climate change, and are there any implications for Chinese legislation and practice?" The research was jointly supported by the China Scholarship Council (CSC) and the Law School of Tilburg University.

Many people were involved in this PhD research during the years that it has taken me to write this book. I am grateful to the Law School of Tilburg University and the CSC for giving me the wonderful opportunity to carry out this research. I am particularly aware of the debt I owe my supervisor: Professor Jonathan Verschuuren. His inspiration and unrivalled understanding of the law and the context of environmental protection greatly enlightened me. Any weaknesses in the structure and style and any errors in the text are entirely my responsibility. Jonathan is also a close friend. I am impressed by his sincere commitment to scholarship, nature, and life. What a "rich" life he lives! His invaluable guidance, great patience, and consistent encouragement made my study life possible, fruitful, and enjoyable. I would also like to sincerely thank my second supervisor, Arie Trouwborst. As a doctoral student whose native language is Chinese, writing this thesis was certainly challenging, both for me and my supervisors. I am very grateful for the considerable time and effort they put into reading, discussing, and editing my work, which was essential for the completion of this thesis.

I would like to express my deep thanks to my colleagues at the International Public Law Department for giving me their confidence and making me feel at home in such an open and inspiring working environment. I would like to especially mention Kees Bastmeijer, Floor Fleurke, and Li Ji in the environmental law group, who discussed and shared their topics, opinions, and knowledge with me. Thanks to Tony Langham and Plym Peters for their professional and efficient editing to prepare this thesis for better quality. Thanks also to Femke for her efficient work to make the thesis timely print.

My heartfelt gratitude and appreciation go to Stefanie, Eefje, Bas, Anja, Antigoni, Zarif, Natalia, Jasper, Evgeni, Drazan, Saja, Boudewijn, and Truus. They have never failed to offer me relaxation, closeness, warmth, and laughter whenever I needed it.

Christmas dinners, a wedding, zoo trips, and parties have all given me great pleasure, reminding me that even so far away from home, I am not alone.

I also want to sincerely thank Nancy Chen and her husband Sietse Dost, who have treated me as part of their own family. Nancy is running a very successful international consultancy firm devoted to combating climate change in the Netherlands. As a practitioner in a related field, she has given me a unique insight into climate change-related technology transfer. Moreover, her wisdom and wide networking have helped me a great deal in the field research. Her lovely daughter, Susanna, has always been a great source of joy for me. I feel at home when I am with them.

I am grateful to the officers, professors, and all the other people I interviewed for their willingness to share their time, knowledge, and opinions. I should particularly like to mention the lawyer Hu Zhiyu, senior CDM consultant Lv Xuedu, Professor Nie Jianqiang, Professor Wang Canfa, Professor Cao Mingde, Professor Wang Can, and Professor Zou Ji for their significant help when I was carrying out field research in China.

Many others have been involved in every stage of my research and life. Li Mingliang, Liu Jing, Zhang Bosi, Wei Leijie, Guo Wu, Niu Zihan, Zhang Wei, Yu Xiaofeng, and Sun Zhanhu made contributions to this thesis, each in their own way. I am deeply grateful to them.

My thanks also go to my PhD committee members: Jonathan, Tianbao, Arie, Kees, and Panos. Their criticisms, questions, comments, and suggestions have enabled me to significantly improve this thesis.

Special thanks to Professor Qin Tianbao, who guided my way to the Netherlands – a quiet country where beauty can be easily discovered at every corner and everyone is smiling. It has been a life-changing experience. I am indebted for the limitless support and encouragement from Professor Qin, a mentor and a friend who occupies a very special place in my life and to whom I owe much of what I have achieved so far in my academic career.

Finally, I must express my gratitude to my father Zhou Baosheng and my mother Shi Guang. Although they did not have a chance to attend university and lived almost all their lives in a small, secluded village in Western China, they are very open-minded and have always encouraged me to be a person with knowledge since I was a little girl. My deepest love is reserved for them. Without their love, good companionship, and continual encouragement during the lengthy and difficult period of my research, this thesis would never have been completed.

Xiamen Chen Zhou
December 2018

Contents

Abbreviations and Acronyms

BIS	Bureau of Industry and Security
BRICS	Brazil, Russia, India, China and South Africa
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CESTT	Centre of Environmentally Sound Technology Transfer
CJV	Contractual Joint Venture
COP	Conference of Party
CSRs	Corporate Social-environmental Responsibilities
CTCN	Climate Technology Centre and Network
DSM	Dispute Settlement Mechanism
EB	Executive Board
EGTT	Expert Group on Technology Transfer
EJV	Equity Joint Venture
ESTs	Environmental Sound Technologies
GCF	Green Climate Fund
GEF	Global Environment Facility
GGER	Greenhouse Gas Emissions Reduction
IP	Intellectual Property
IPRs	Intellectual Property Rights
LDCs	Least Developed Countries
MCP	Multilateral Consultative Process
MDGs	Millennium Development Goals
MEAs	Multinational Environment Agreements
MNEs	Multinational Enterprises
MOC	Ministry of Commerce
MOEP	Ministry of Environmental Protection
MOFERT	Ministry of Foreign Economic Relations and Trade
MOST	Ministry of Science and Technology
MOWR	Ministry of Water Resource
MRV	Measurement, Reporting and Verification

NAMAs	National Appropriate Mitigation Actions
NCs	National Communications
NCCCC	National Coordinating Committee on Climate Change
NCPC	National Cleaner Production Centre
NDRC	National Development and Reform Commission
NIEO	Declaration on the New International Economic Order
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
PDD	Project Design Document
RBPs	Restrictive Business Practices
RTA	Regional Trade Agreement
R&D	Research and Development
SAIC	State Administration for Industry and Commerce
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body of Scientific and Technological Advice
SIPO	State Intellectual Property Office
SMEs	Small and Middle Enterprises
S&T	Science and Technology
TEC	Technology Executive Committee
TM	Technology Mechanism
TNAs	Technology Needs Assessments
TRIPs	Trade-Related Aspects of Intellectual Property Rights
TT Clear	Technology Transfer Clearinghouse
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
VAT	Value-Added Tax
WBCSD	World Business Council for Sustainable Development
WGTTT	Working Group on Trade and Technology Transfer
WIPO	World Intellectual Protection Origination
WTO	World Trade Organization

Chapter 1
Introduction

1.1 A Study of Climate Change-Related Technology Transfer and the Legal Barriers

1.1.1 Overview

Climate change is an unequivocal threat to humankind which is taking place more rapidly than many people expected.[1] To a large extent, the situation as regards the climate today is the result of the technological choices we made in the past; similarly, the climate in the future will largely be determined by the technology we choose now. The changes taking place in technology are particularly important over the long-term time scales that are characteristic of climate change.[2] As the term indicates, climate change technologies include climate mitigation technologies aimed at reducing GHG emissions and climate adaptation technologies for coping with the impact of climate change.[3] The more rapid and widespread transfer of

[1] See W. Collins, R. Colman, J. Haywood, M. Manning, and P. Mote, "The Physical Science behind Climate Change," *Scientific American*, August 2007, pp. 65–70.

[2] *IPCC Report 2007*, WGIII, Mitigation of Climate Change, Chapter 2, "Framing Issues." Decades, or longer time scales are typical of the gaps involved between technological innovation and its widespread diffusion, and of the capital turnover rates characteristic of long-term energy capital stock and infrastructures.

[3] For example, climate mitigation technologies mainly include renewable energy technologies (i.e., wind turbines, biomass fuels, nuclear energy, and geothermal heat), energy conservation & efficiency technologies (i.e., improved building materials, transport processes, advanced recycling technologies, heat recovery technologies, direct electrolytic) and others (i.e., carbon capture and storage), while climate adaptation technologies often occur as a result of government intervention in the common good and systems such as agriculture, water, biodiversity, ocean management and human health (i.e., better agricultural techniques and forest management, drought-resistant plant varieties and biogenetic materials, and desalinization plants). More details will be discussed in Chapter 1, "Basic concepts and background."

C. Zhou, *The Legal Barriers to Technology Transfer under the UN Framework Convention on Climate Change*, https://doi.org/10.1007/978-981-13-6139-5_1

them requires an inclusive set of processes in which equipment, know-how, experience and human resources flow from foreign suppliers to end-user recipients.[4]

As a positive measure to tackle climate change, technology transfer has both economic and environmental benefits. It is expected to improve efficiency in the use of energy, introduce less carbon-intensive sources of energy, develop renewable energy sources and thus achieve the transition to a low-carbon economy.[5] From a legal perspective, it has been recognized as an avenue for international cooperation in relation to the 'common concerns of humankind',[6] particularly cooperation between developed countries and developing countries. It is certainly true that a collective endeavour with regard to climate control and technological advance will benefit all nations more than any unilateral strategies.[7]

Recognizing that technology transfer is an integral part of the international dialogue on environment and development, the intergovernmental community has adopted a wide variety of provisions in multilateral environmental agreements (MEAs), including climate change agreements. Complementing the targets of GHG emission reductions, the transfer of technology serves to assist states to fulfil their regulatory commitments under the international climate framework, with developed countries taking the lead.[8] The broad institutional arrangements that consider technology transfer to be a crucial tool for achieving specific environmental objectives provide a solid foundation for the best possible global result in this interdisciplinary area, with varying degrees of success in practice. The increasing importance of technology transfer is even more apparent now in the light of the current post-Kyoto agreement negotiations.

"Despite the renewed efforts of the international community and the growing recognition of the importance of technology, the full potential for the development, deployment and transfer of these technologies remains unfulfilled."[9] In fact, the transfer of technology is not happening fast enough to aid developing countries in mitigating and adapting to their climate crisis.[10] In this respect, both suppliers and recipients are actually responsible for this. To a certain extent, they both fail to provide a favourable environment for an effective technology transfer in which the key

[4] *IPCC Report 2001*, WGIII, Methodological and Technological Issues in Technology Transfer, Chapter 1.2, "Basic Concepts."

[5] *Climate Change, Technology Transfer and Intellectual Property Rights*, International Centre for Trade and Sustainable Development (ICTSD), Switzerland, August 2008, pp. 1–8.

[6] The totality of the global atmosphere can now properly be regarded as the common concern of humankind. See Patricia Birnie, Alan Boyle, Catherine Redgwell, *International Law and the Environment*, Chapter 6, "Climate Change and Atmospheric Pollution," Oxford University Press, 2008, p. 339.

[7] See C. Kemfert: "Climate Coalitions and International Trade: Assessment of Cooperation Incentives by Issue Linkage," *Energy Policy*, 32(4), 2004, p. 457.

[8] Chapter 2, "The Legal Framework of Climate Change-related Technology Transfer."

[9] *The UN, Climate Change and Technology Development and Technology Transfer*, United Nations Economic and Social Affairs Department, 2008, p. 3.

[10] *The World Bank, Global Economic Prospects: Technology Diffusions in the Developing World*, Development Prospects Group Report 42,097, Washington DC 2008.

players are sufficiently incentivised and potential barriers are efficiently eliminated.[11]

There are numerous ways of increasing the flow of climate sound technologies and improving the quality of the transfer of technologies. However, basically the barriers can only be removed by the technology suppliers and recipients themselves. According to the IPCC, a barrier is referred to as "any obstacle to reaching a potential that can be overcome by policies and measures."[12] Policies and measures, whether international or national, can be designed well or poorly designed, stringent or loose, binding or non-binding, and politically attractive or unattractive.[13] The obstacles in this field are generally regarded to be the result of human factors.[14] Up to now, attention has been devoted to obstacles that hinder the improved access to climate mitigation and adaptation technologies in the international climate framework.[15] Unfortunately, these barriers have not been addressed in much detail. In general, they are centralized in practical areas. Scant weight has been given to legal barriers in rules, standards, regimes and institutions, and there is no tailored action because the identification, evaluation and prioritization of legal barriers are mostly context-based.

China

China is playing an increasingly important role in climate geopolitics. Being a victim of emissions imposed by its industrialised neighbours in the past, China is now seen as the new leading emitter linked to global warming.[16] In the past few decades, the mushrooming growth in GDP achieved at the expense of polluting the atmosphere has driven China to a historical and moral turning point.[17] Consequently, the

[11] *IPCC Report 2007*, WGIII, Chapter 11.7, "International Spillover Effect", Chapter 13.3, "International Climate Change Agreements and Other Arrangements." In fact, the IPCC devoted attention in its special 2001 report to the barriers which existed. The report contains an extensive overview of the most important barriers in developed, developing and transition economies that could impede the transfer of ESTs to mitigate and adapt to climate change. The coverage of identified barriers is quite broad, ranging from socio-economic aspects, human capacities to legal institutions.

[12] See *idem*, Chapter 2.4, "Definition of Barriers, Opportunities and Potentials." They can be either subjective like legal obstacles in codes, standards and procedures, or objective like social infrastructures and resource capacity.

[13] See *idem*, Chapter 13.3, "International Climate Change Agreements and Other Arrangements."

[14] See idem, Chapter 2.4.3. "Definition of Barriers, Opportunities and Potentials," which defines a barrier as "any obstacle to reaching a potential that can be overcome by policies and measures." Henceforth "policies" will be assumed to include policies, measures, programs and portfolios of policies.

[15] There are, for example, the *IPCC Report 2001*, the *IPCC Report 2007* and the Expert Group on Technology Transfer Five Years of Work; the *IPCC Report 2001*, WGIII, Chapter 1.5, "Barriers to the transfer of Environmentally Sound Technologies," *Expert Group on Technology Transfer Five Years of Work*, UNFCCC Climate Change Secretariat, 2007.

[16] See Jolene Lin, "Climate Governance in China: Using the 'Iron Hand'," in Benjamin J. Richardson (eds.), *Local Climate Change Law: Environmental Regulation in Cities and Other Localities*, Edward Elgar Publishing, 2012, pp. 3–4.

[17] See Xun Yan, *The Road to a Clean Future*, China Economic Publishing House, Beijing, 2009, pp. 41–44.

current local situation as regards climate tends to be characterised by high emissions and ecological vulnerability.[18]

More recently, the Chinese leadership has become aware of the climate situation, which indicates that China will suffer great damage from climate change, while at the same time it could itself gain greater net benefits from a good climate policy.[19] High emissions will not only affect domestic concerns such as public health and lead to political upheaval, but the shift in the Chinese strategy towards greater collaboration and reciprocity in the international world could also be adversely influenced.[20] The Chinese government recognizes this and has begun to take top-down actions for climate change, with comprehensive solutions, including technology.

Since early 1980, China has set on a peaceful-rise route by virtue of science and knowledge. Technology plays a central role in this, and the need for technology is becoming ever more urgent with the forecasts of the impact of climate hazards. Outdated technologies still dominate in indigenous industries, and the delayed transfer of advanced foreign technologies is leading to a lock-in effect of high emissions for decades to come.[21] Despite the technological changes taking place now, it will take a long time for the Chinese domestic energy system to diversify and to ultimately achieve clean industries. At the Copenhagen Climate Summit, President Hu Jintao declared that China will continue to integrate overcoming climate change in its socio-economic plan by taking measures: "… to step up efforts to develop green economy, low-carbon economy and circular economy, and enhance research, development and dissemination of climate-friendly technologies."[22]

At the international level, collaborating with other developing countries, China has conducted a proactive climate diplomacy, which has led to some tangible changes in the climate change lawmaking. As regards technology transfer, it is attempting to pursue a practical, problem-solving approach in order to achieve the accessibility, affordability, appropriateness and adaptability of technologies required for enhanced action on mitigation and adaptation.[23] To date, China has signed a series of climate change agreements.[24] Its accession to the WTO spells numerous opportunities for the future development and transfer of low carbon technologies. In the meanwhile, China has strengthened the relevant legal structures in

[18] *China's National Climate Change Program*, Prepared under the Auspices of National Development and Reform Commission People's Republic of China, 2007, pp. 4–9.

[19] See Jonathan B. Wiener, "Climate Change Policy and Policy Change in China", 55 UCLA *Law Review*, 2008, p. 1813.

[20] See *idem*, pp. 1820–1825.

[21] See Zou Ji, Wang Ke and Fu Sha, "Proposal on Innovative Mechanism for Development and Transfer of Environmentally Sound Technologies," Economic Science Press, 2009, p. 56.

[22] Chinese President Hu Jintao's Speech at the UN Climate Change Summit, 23 September 2009, available at http://dk.China-embassy.org/eng/News/t605967.htm

[23] *G77 & China for A Technology Mechanism under the UNFCCC*, 2007, available at http://unfccc.int/files/meetings/ad_hoc_working_groups/lca/application/pdf/technology_proposal_g77_8.pdf

[24] There are the 1992 UNFCCC, the 1997 Kyoto Protocol, and the 2007 Bali Roadmap.

order to enshrine the national commitments in its domestic legal system.[25] The most recent progress concerns the release of the first draft of the "Climate Change Act".[26]

In many respects, this sounds good. Chinese governments have made impressive attempts to move towards low carbon development through promoting technology innovation and transfer. The practical operation of this, however, gives rise to a completely different picture: in general the environment in China is not as hospitable for importing and investing in technology as was expected. In this respect, one commonly perceived barrier is law related, and there are regulatory, institutional and legislative obstacles. On the one hand, the market recognizes the cost of carbon where government intervention has a central role is vital to the transfer of climate technology.[27] Legal tools are intended to promote a full, sustainable and meaningful technology transfer. On the other hand, the draft legislation in China is rather thin and timid. The actual implementation and enforcement are far from ideal, in particular at the regional and sectional level, to achieve concrete mitigation and adaptation goals.[28] According to the IPCC, robust law must be passed to achieve environmental effectiveness, cost effectiveness, distribution considerations and institutional feasibility.[29] A substantive discussion on the barriers contained in Chinese legislation and practices associated with climate change technology transfer is imperative.

1.1.2 Definition of the Problem

In this context, this thesis will seek to provide answers to the core question:

What are the legal barriers to technology transfer for addressing climate change and are there any implications for Chinese legislation and practices?

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[25] *China's Policies and Actions for Addressing Climate Change: the 2009 Progress Report*, National Development and Reform Commission, November 2009. A series of laws including Energy Conservation Law, Renewable Energy Law, Cleaner Production Promotion Law, Circular Economy Promotion Law, and the formulation and implementation of some special or auxiliary regulations, such as the Regulations on Energy Conservation for Buildings, Administrative Measures for Electricity Conservation have been put in place as expected.

[26] *China's Draft Climate Change Law: Setting a Path Toward Emission Reductions*, 9 May 2012, available at http://www.pointcarbon.com/research/promo/research/1.1859181?&ref=searchlist

[27] See David Ockwell, Jim Watson and Gordon MacKerron etc., *UK-India Collaboration to Identify the Barriers to the Transfer of Low Carbon Energy Technology*, Final Report, Department for Environment, Food and Rural Affairs, 2006, p. 40.

[28] Centre for International Environmental Law (IEL), *Climate Change and Technology Transfer: Principles and Procedures for Technology Transfer Mechanisms under the UNFCCC*, Report of Side Event – UNFCCC Climate Change COP, Poznan, Poland, 2 December 2008.

[29] *IPCC Report 2007*, WGIII, Chapter 13.2.1 "Climate Change and Other Related Policies."

Four subsidiary questions must be dealt with to answer this central question:

1. What do we mean by technology transfer in a climate change context? What are the distinctive features in comparison with regular technology transfer and what is the theoretical basis behind this?[30]
2. What is the legal framework for climate change-related technology transfer? What specific principles, rules, institutions and mechanisms have been developed?[31]
3. What are the legal barriers in the process of supplying and receiving climate sound technologies in general and specifically how do they impact on international technology transfer? What kinds of solutions, if any, have been proposed to tackle these barriers?[32]
4. Has climate change-related technology transfer been regulated in China? What legal barriers exist specifically in Chinese legislation and practices?[33]

1.1.3 Methodology

Technology transfer in response to climate change is a sensitive subject, first, because climate-friendly technologies are not automatically transferred to developing countries[34]; secondly, the transfer does not take place as a charity, but on the basis of common interests and responsibilities.[35] Because of the complexity involved, the barriers which are present in this process tend to be formidable, multidimensional and difficult to detect. For example, different stakeholders involved in technology transfer perceive these barriers differently. "Views diverged in particular on the impact of different aspects of domestic regulation on technology transfer."[36] It is therefore a challenge to carry out an in-depth analysis of this interdisciplinary topic in a comprehensive, prudent and constructive way.

To deal with this successfully, this PhD thesis applies a combined methodology. The author reviews the general legislation and literature on the subject. In addition, there is a specific review of the literature on the Chinese situation as regards climate mitigation and adaptation technology transfer. For more information on what is hap-

[30] Chapter 1 "Introduction."

[31] Chapter 2 "The Legal Framework of Climate Change-related Technology Transfer."

[32] Chapter 3 "Legal Barriers to Supplying Climate Sound Technology"; Chapter 4, "Legal Barriers to Receiving Climate Sound Technology."

[33] Chapter 5 "Chinese Legislation and Practice of Climate Sound Technology Transfer."

[34] Basically, it is distinct from regular international technology cooperation, which is simply based on knowledge gaps and mutual benefits.

[35] See Hao Min, "The Analysis of the Relationship between Clean Technology Transfer and Chinese Intellectual Property Countering the Climate Changes,' Dir research series, Working Paper No. 147, 2011, p. 1.

[36] *Technology Transfer in the CDM Projects in China*, China-EU CDM EU-China CDM Facilitation Project, 2010, p. 15, available at http://www.euChina-cdm.org/

pening at ground level, field research is taking place in China which covers government officers, technology enterprises, financial agencies and scholars. Key persons in the field of technology transfer and climate change have been interviewed and the relevant reports will be added. These will all contribute to the PhD thesis to a greater or lesser extent. Specifically, the four subsidiary questions mentioned above will be dealt with in the following five chapters, after which a conclusion will be reached on the core question in the last (sixth) chapter.

The first subsidiary question will be answered in this chapter. The author will start by outlining and describing the basic concepts in general, particularly the key term "technology transfer". What is climate sound technology? In more substantive terms, what are climate mitigation and adaptation technologies? How can we distinguish climate sound technologies from ordinary technological products? On this basis, the exact meaning of climate change-related technology transfer will be presented from both a statutory and an operational perspective. The author will also demonstrate the necessary link between the distinctive characteristics of climate sound technologies and the dynastic process of transfer (the theoretical basis). A deeper understanding of the key concepts helps to narrow down the scope of the research, prioritise the main points and thus guarantee valid answers to research questions.

Chapter 2 will deal with the second question, on the relevance of the legal framework for climate change-related technology transfer. A normative analysis is carried out to provide an overview of what has been formulated on technology transfer in the international climate framework. In the theory-oriented research, the survey of normative resources can be of great help to create a system of legal theory, and furthermore, to develop and test this appropriately in due course.[37] Basically, the author will focus on the key work, the convention, and then describe the groundbreaking efforts in the United Nations Framework Convention on Climate Change (UNFCCC) related to technology transfer, for example, the Kyoto Protocol, the Bali Action Plan and the Copenhagen Accord. This chapter will systematically examine the principles, rules, standards, institutions and mechanisms. These are assumed to serve as a benchmark for assessing whether or not effective technology transfer has been achieved by means of domestic legislation and the corresponding implementation.

Chapters 3 and 4 focus on the third subsidiary question. Both Chapters address the legal barriers on the basis of a review of the literature, but from different perspectives. First, Chap. 3 contains a study of the instrumental barriers to the process of supplying climate sound technologies. In international practice most climate sound technologies originate in northern countries (Annex I countries).[38] Some of the common practices resulting from the public policies and institutions of these countries will be reviewed in broad terms. In view of the irreplaceable role of the private sector, especially multinational enterprises (MNEs), the second part of this

[37] See Piet Verschuren, Hans Doorewaard, "Design A Research Project," LEMMA Publishers, Utrecht, 2005, pp. 33–37.

[38] See Stephen S., *Analysis of Technology Transfer in CDM Projects*, Chapter 9: "Origin of Technology," The UNFCCC Registration & Issuance Unit CDM/SDM, Montreal, Canada, December 2008, p. 9.

chapter will take a closer look at their performance, focusing on the legal aspects. Secondly, in Chap. 4 the author will deal in detail with the legal barriers which exist for developing countries (Non-Annex I countries) on the demand side for technology. Because the available information is inadequate and there are enormous differences of opinion, there cannot be a "one-size-fits-all" approach.[39] Chapter 4 will mainly follow the outline of Chap. 3, which concentrates on general practices. However, unlike Chap. 3, it does not make a clear distinction between the public and private sectors. Instead, it gives weight to the barriers themselves. The reason for this is that when introducing climate sound technologies, the barriers in the private sector are not really legal in nature. To a great extent, they result from real problems such as the lack of capacity, and could be resolved with broad governmental policies.

Chapter 5 devotes special attention to the legislation and practices in China. As indicated above, climate change-related technology transfer is context based. Present day China serves as a significant and clear example of technology transfer used for climate mitigation and adaptation. The author will therefore start with a picture of the background to climate-related technology transfer, for example, the basic policies relating to climate change and the endogenous level of technology. This is followed by an extensive study of the relevant legalisation. On this basis, a range of regulatory barriers will be identified, prioritized and evaluated in accordance with the international climate framework, as well as the Chinese legislation and its practical implementation. The results of field research conducted in China have been incorporated in this study.

Chapter 6 draws conclusions, permitting the author to define the legal barriers in the transfer of technology for addressing climate change and the corresponding implications for China.

1.2 Basic Concepts

The term "technology transfer" is used very frequently in the climate change negotiations.[40] A range of definitions has been given to technology transfer with potential for climate mitigation and adaptation, but only a few are recognised as a standard term by the various stakeholders or at the operational level.[41] Up to now, the climate

[39] See Bernard M. Hoekman, Keith E. Maskus and Kamal Saggi, "Transfer of Technology to Developing Countries: Unilateral and Multilateral Policy Options, Research Program on Political and Economic Change," Working Paper PEC2004-0003, 2004, p. 17.

[40] See David Popp, "International Technology Transfer, Climate Change, and the Clean Development Mechanism," *Review of Environmental Economics and Policy* 5(1), 2011, pp. 137–139.

[41] As will be discussed below, there are, for example, the MEA's definition, such as the Montreal Protocol, the Agenda 21 definition, the IPCC definition, the TNA's definition, the CDM project design document definition, the WIPO definition, and the GEF definition. In addition, a number of academic definitions have been provided, the best known of which are those of Matthew Littleton, 2008; Collins William, 2007; David Haug, 1999; Gaëtan Verhoosel, 1998, etc.

change agreements themselves have not given a definition of the terms "climate sound technology" or "technology transfer". The interested parties, particularly the key players and broad policymakers, have a different perception of these concepts. For example, some OECD countries regard the concepts as a form of international technology cooperation, while most developing countries insist on the expression "technology transfer" which they consider to reflect the essence of the obligation of solidarity and assistance.[42] In practice it is difficult to define technology transfer with measurable indicators which could be used to identify, streamline and evaluate the specific performances concerned.[43]

The ongoing discrepancy in the definitions is indicative of some tension in this respect.[44] Therefore it is very important to eliminate the disagreement about the concept and to introduce a normative, pragmatic and reliable definition of technology transfer in order to promote post-Kyoto climate coordination and cooperation. Up to now, the transfer of technology has fallen short of the goals set by the Parties to the UNFCCC.[45] The international community is urgently seeking a new global regime for technology transfer.[46] A clearly defined regime for technology transfer will provide a solid basis for effective action. In addition, to deeply explore concepts such as climate sound technology and technology transfer has an immediate impact: it helps to narrow down the scope of research, prioritize the main points and therefore guarantee valid answers to research questions. Consequently, the research questions for this chapter ask:

> What do we mean by technology transfer in the context of climate change? What are the distinctive features in comparison regular technology transfer and what is the theoretical basis behind this?

The author will start with a general description of basic concepts such as climate sound technologies, in particular the key term "technology transfer". The precise meaning of climate change-related technology transfer will be presented on this basis, both from the statutory and operational perspective. The author will then reveal the link between the distinctive features of climate sound technology and the

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[42] See Sect. 2.2.1, "Technology transfer commitments." Climate sound technologies suppliers in the international market prefer the expression "technology cooperation" to "technology transfer", as the latter instinctively emphasizes the solidarity obligation to provide their technologies on favourable terms, with concessions, and therefore reduce the net profit they expected from the regular commercialized channels which could be achieved by technological cooperation. On the other hand, as far as technology recipients are concerned, a solid pattern of technology transfer characterized by the "common but differentiated environmental responsibilities of states" and an affordable pricing system are very warmly welcomed. For them this is the only way in which they can fully and more effectively participate in the global endeavours to combat climate change.

[43] These indicators generally include: geographical origin, level of innovation, environmental effectiveness, capability building.

[44] *Technology Transfer in Chinese CDM Projects* 2010, (no. 36), p. 7.

[45] *Climate Change and Technology Development and Technology Transfer*, the United Nations Economic and Social Affairs Department, 2008, p. 3.

[46] *Expert Group on Technology Transfer Five Years of Work*, UNFCCC Climate Change Secretariat, 2007, p. 4. More details can be found in Sect. 2.4.3, "Recent developments."

dynastic process of the transfer of technology, viz. the theoretical basis. Finally, the remaining part will give an overall view of the actual as well as the potential transfer of technology in the context climate change. Hopefully a common framework of definitions will be established to serve as a basis for an overarching theoretical analysis.

1.2.1 Technologies, Environmentally Sound Technologies (ESTs) and Climate sound Technologies

Technology refers to the application of science and engineering to study problems and provide solutions to overcome the physical limitations of human beings.[47] The fundamental role of new technology is to lower costs and achieve society's goals by reallocating resources.[48] Whether technology serves us collectively or individually, it is greatly dependent on the particular social environment of which it is an integral part.[49] There are rarely technological means without a certain cultural background and social values, and similarly the structure of a society in a particular historical period is bound to influence our perception of the actual significance of technology.

ESTs

As we saw above, the history of human consciousness and civilization is a history of adaptation, transformation and harmonization with the natural environment in which advanced technologies achieve progress through innovation and diffusion, and accelerate that progress. However, the interaction between technological change and environmental management is not always positive.[50] The state of the environment today is a result of the technological choices we made in the past; history teaches us that technology, on its own, is a tool we can put to good use or bad use. Similarly, the earth that human beings will inhabit in the future will be largely determined by our choices and our use of technology now.[51] The environmental consequences of technological options must be explicitly recognized.[52]

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[47] *Transfer of Environmentally Sound Technologies for Sustainable Forest Management, Department of Economic and Social Affairs*, United Nations Forum on Forests Secretariat, Framework and Applications, December 2005, p. 5.

[48] *IPCC Report 2007*, WGIII, Chapter 2, "Framing Issues," pp. 148–150.

[49] *WIPO Handbook on Industrial Property Information and Documentation*, part 1, Introduction.

[50] Technologies typically have a negative impact on the environment. For example, they utilize non-renewable resources and generate waste and pollution. See Sustainability Concepts: Environmentally Sound Technologies, at http://www.gdrc.org/sustdev/concepts/10-est.html

[51] Ontario Centre for Environmental Technology Advancement, *Advancing Tomorrow's Technologies* – 2001/02 Annual Report, 2002.

[52] *Environmentally Sound Technologies for Sustainable Development*, International Environmental Technology Centre, Division of Technology, Industry and Economics United Nations Environment Program, 21 May 2003, pp. 2–10.

Environmental concerns have reached a defining moment in history. Due to the increasing transboundary environmental problems,[53] technological solutions have necessarily acquired an increasingly international character. The movement of technology, typically from developed countries to developing countries, has important spillover effects which are considered a critical factor in the assessment of environmental policies in global economies.[54] These technologies, which are characterised as being for the public good, are specifically defined as

> … technologies that protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substitutes…. Environmentally sound technologies in the context of pollution are 'process and product technologies' that generate low or no waste, for the prevention of pollution. They also cover 'end of the pipe' technologies for treatment of pollution after it has been generated.[55]

According to Agenda 21, ESTs are intended to solve all sorts of environmental problems such as a reduction in pollution, the use of resources, the handling of waste and clean production methods where the ideal of sustainable development is a central concern.[56] It is clear that the definition of ESTs has a relative nature. Defining them in an absolute sense is difficult, as the environmental soundness of a technology can be influenced by temporal and geographical factors.[57]

Climate Sound Technologies

The terms "ESTs" and "climate sound technologies" (also referred to as climate-related technologies, climate-friendly technologies and climate-responsive technologies) are often used interchangeably, for example, in the IPCC reports.[58] However, without specifying what constitutes a climate sound technology, the IPCC adopts ESTs as a term of general reference.[59] Accordingly, as their name indicates, climate sound technologies are those with the potential to significantly mitigate and

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[53] At least in the context of global environmental issues such as ozone depletion and climate change, and the MEAs address those issues. There can therefore be no doubt that broad definitions are appropriate. See James Shephard, "The Future of Technology Transfer Under Multilateral Environmental Agreements," 37 *ELR*, 2007, p. 10548.

[54] *IPCC Report 2007*, WGIII, Chapter 11.7.6, "Technology Spillover," p. 668.

[55] UN Conference on Environment and Development (UNCED), Earth Summit 1992, Chapter 34 of Agenda 21.

[56] As defined in the *Brundtland Report* in 1987 by the United Nations World Commission on Environment and Development, "(…) sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations".

[57] United Nations Environment Program Division of Technology, Industry and Economics, Phytotechnologies, *A Technical Approach in Environmental Management*, Freshwater Management Series No. 7, available at http://www.unep.or.jp/Ietc/Publications/Freshwater/FMS7/2.asp

[58] It is worth noting that technologies which address climate change, i.e., which are climate-friendly and climate-responsive, are not necessarily always environmentally sound.

[59] *IPCC Report 2001*, WGIII, Chapter 1.2, "Basic Concepts."

adapt to global climate change. It might be fair to say that climate mitigation and adaptation technologies are, to a large extent, environmentally sound.[60]

As an inclusive concept, climate sound technologies comprise two major categories of technologies: mitigation technologies and adaptation technologies. Mitigation technologies focus on slowing down climate change and mainly include energy conservation technologies, renewable energy technologies and clean production technologies, while adaptation technologies cope with the effects of climate change in key sectors such as agriculture, forestry, biodiversity, ocean management and human health.[61] From the perspective of dynastic technology transfer, mitigation technologies are aimed at reducing GHG emissions, in which carbon market plays a central role.[62] However, adaptation technologies occur mainly as a result of development objectives and government interventions for the collective good in systems.[63] Furthermore, adaptation technologies usually address site-specific issues and the supposed benefits are more locally oriented in comparison with mitigation technologies which are expected to benefit the whole world.[64]

Despite differences regarding some aspects, mitigation technologies and adaptation technologies are treated uniformly in the UNFCCC context; otherwise the range of issues would become too loose, vague and indeterminate. Mitigation is essential and adaptation is inevitable.[65] The corresponding technologies are closely intertwined as two processes in the regulatory framework.[66] Similarly in this PhD study, the author will deal with both these technological changes, focusing in particular on mitigation technologies, but also highlighting those areas in which the transfer of adaptation technologies could be promoted.

According to the international climate framework, the concept of climate sound technologies has numerous significant characteristics. First, although a large number of climate sound technologies are generated by private innovation, they have characteristics of being for the public good because of their potential contribution to the atmosphere which has been acknowledged as "public property" and a "common concern of mankind."[67] Essentially climate mitigation and adaptation technologies are aimed at overcoming global environmental externalities.[68] However, this

[60] Wang Canfa, "The Field Research on Technology Transfer in Addressing Climate Change and its Implication for Chinese Legislation and Practice," PhD Research Program, 2011.

[61] *Idem.* Specifically, there are technologies dealing with dykes, sea-walls in coastal management, fertilizers, irrigation, reservoirs in agriculture, sanitation systems and health-care infrastructure for heat waves, droughts, floods and windstorms, etc.

[62] Ockwell, Watson and MacKerron 2006, (no. 27), p. 11.

[63] *IPCC Report 2001*, WGIII, Chapter 1.2, "Basic Concepts."

[64] *IPCC Report 2007*, WGIII, Chapter 13.2.2, "Linking National Policies."

[65] *Technologies for Adaptation to Climate Change*, Adaptation, Technology and Science Program of the UNFCCC Secretariat, Climate Change Secretariat of UNFCCC, Bonn, 2006.

[66] See T. Barker, *Representing Global, Climate Change, Adaptation and Mitigation, Global Environmental Change*, 2003, pp. 1–6.

[67] Birnie, Boyle and Redgwell 2008, (no. 6), pp. 338–339.

[68] Zou, Wang and Fu 2009, (no. 21), p. 19.

socio-environmental function does not always coincide with commercial interests in reality, and is likely to be undermined by a highly competitive market that focuses on maximizing the economic function of a technological product.[69] Secondly, climate sound technologies are designed to cover the full spectrum of the technological cycle, and require a system that involves institutional, manageable and prudent coordination, rather than a single piece of know-how, equipment, machinery or product such as specific and tangible hardware. "Both the development of the hybrid car engine and the development of the internet retailing mechanism represent technological changes.'[70] Finally, the definition of climate sound technologies has an abstract, indeterminate and rather unlimited scope. Like ESTs, it is difficult to define climate sound technologies in an absolute sense.[71] What could be a climate sound technology now, in one country or region, might not be so somewhere else 10 years later. Therefore it is necessary to evaluate the feasibility of technologies in a changing context.[72] However, unlike other ESTs (e.g., biomedicines), climate sound technologies are highly diverse in character. As mentioned above, it is possible to make a distinction between climate mitigation and adaptation technologies.[73] Even within mitigation technologies, the emphasis on the stages of innovation, diffusion and assimilation differ.

1.2.2 Technology Transfer

1.2.2.1 Technology Transfer in Traditional Business

Technology transfer is difficult to define as it happens in many different ways.[74] In the original sense, it refers to "the diffusion and adoption of technology and know-how between parties, typically private companies, universities, financial

[69] *IPCC Report 2007,* WGIII, Chapter 13.1.2, "Criteria for Policy Choice."

[70] *IPCC Report 2007*, WGIII, Chapter 2, "Framing Issues," p. 148. Achieving this will add essential value to promoting technology transfer in the international climate framework. The extremely broad definition of climate-related technologies adopted by the second Conference of the Parties (COP2) of UNFCCC in 1996 identified: practices and processes such as "soft" technologies, for example, capacity building, information networks, training and research, as well as "hard" technologies, for example, equipment to control, reduce or prevent anthropogenic emissions of greenhouse gases (GHG) in energy, transport, forestry, agriculture, and industry sectors, to enhance removals by sinks, and to facilitate adaptation.

[71] *Environmentally Sound Technologies for Sustainable Development* 2003, (no. 52), pp. 16–14.

[72] International Environmental Technology Centre, UNEP, Technology Transfer: *The Seven Cs for the Successful Transfer and Uptake of Environmentally Sound Technologies,* 22, 2003. However, worldwide they are not yet viewed as being acceptable.

[73] Climate adaptation technologies are closely linked to ethical/human rights: the rights to health, food and shelter.

[74] See Matthew Littleton, "The TRIPS Agreement and Transfer of Climate Change-Related Technologies to Developing Countries," DESA Working Paper, No. 71, 2008, p. 2.

institutions, governments and non-governmental organizations."[75] The traditional model of technology transfer which originated in the 1950s was based on large-scale foreign investment in developing countries, but did not comprise much domestic capacity building and focused almost exclusively on the procurement of hardware and machinery, without regard for human resource development.[76] Traditional technology transfer predominantly takes place in the private marketplace in two forms: (1) internally between headquarters and subsidiaries of MNEs, and (2) externally between foreign and domestic enterprises. Technology transfer is an important factor in strategic alliances, based on foreign investment, to maintain a competitive edge in the globalized market. Meanwhile, it is also a major pillar of support for the intellectual property system (IP).[77]

To be applied, the spillover of technologies relies on particular political, economic and social backgrounds, which means that innovations produced by one country in one industry will consciously or unconsciously become standard practice for that industry worldwide.[78] The globalization of technologies is an irreversible trend, leaving little opportunity for individual societies to decide whether they wish to accept it. Furthermore, they may or may not have the capability to accept it. In traditional business, the transferability of technology was originally based on the mobility of international elements. As one part of this dynastic process, technology was often linked to other elements, such as capital, products and human resources. Taking human resources as an example, this not only involves micro-level skills such as operation and maintenance, but also the macro-level social capacities to understand, utilize and replicate technology.[79]

So what do we mean by the term "transfer" in the context of MEAs? What is the role of climate sound technologies in determining technology transfer and what is the best way to transfer mitigation and adaptation technologies using a common, normative and reliable framework of definitions?[80]

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[75] Shephard 2007, (no. 53), p. 10547.

[76] See Gill Wilkins, "Technology Transfer for Renewable Energy: Overcoming Barriers in Developing Countries," the Royal Institute of International Affairs Sustainable Development Program 42, 2002.

[77] According to WIPO, General knowledge or IP rights involved in technology transfer are: (1) licensed in the form of intellectual property; (2) the subject of formal consulting or training agreements; (3) communicated in the work place or research settings; (4) diffused by publication or other means. See Technology Transfer & Licensing, IP Strategies and Innovation of WIPO, at http://www.wipo.int/ip-development/en/strategies/technology.html

[78] *Environmentally Sound Technologies for Sustainable Development* 2003, (no. 52), p. 7.

[79] The reason for this is that the mobile process of technology transfer will temporarily or ultimately come to an end in an exogenous context. See Hitoshi Kondo, "International Factor Mobility and Production Technology," *Population Economics*, Vol. 2, No. 4, 1989, pp. 290–299.

[80] WIPO, "The Climate of IP and the IP of Climate: an Overview of the Policy Issues Technology Transfer, the IP system and climate change: challenges and options," Side Event, UNCCC COP 14, Poznan, December 2008, p. 12.

1.2.2.2 Climate Change-Related Technology Transfer

Technology transfer is an important subject in debates on climate change policy, but often proves to be a source of confusion.[81] On the whole, the endless confusion originates from the fact that is there no uniform, workable and comprehensible definition of technology transfer related to climate change.[82] In reality there are various viewpoints and interpretations of the concept of technology transfer: some are rooted in existing statutes; others have developed from practice in the field.

(1) **Statutory Definition**

Almost all MEAs and climate change agreements are very cautious with regard to describing technology transfer in their provisions. Instead of a direct definition, the legal meaning of technology transfer remains concealed, leading to various interpretations.[83] Two examples can be illustrated in this respect: Agenda 21 and the IPCC Report.

The Definition in Agenda 21

At a conceptual level, Agenda 21 plays an irreplaceable role by providing a basis for the definition of ESTs and pursuing technology transfer – on a global scale. It elaborates the dynastic process of technology transfer on the basis of the definition of ESTs.[84] Several important statements are thus contained "to guide interpretation of this definition with emphasis on facilitating the accessibility and transfer of technology, particularly in developing countries, as well as the essential role of capacity building and technology cooperation in promoting sustainable development."[85] Although it is rather simple, Agenda 21 serves as a clear example for understanding technology transfer which addresses environmental problems, and has frequently been cited in the international negotiations associated to environment and development.[86]

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[81] See Taishi Sugiyama, *Climate Change, Energy and International Environmental Issues, Cooperative Climate*, Chapter 1, Cutler J. Cleveland (ed.), November 2008, available at http://www.eoearth.org/article/Cooperative_Climate:_Chapter_1

[82] See Gaëtan Verhoosel, "Beyond the Unsustainable Rhetoric of Sustainable Development: Transferring Environmentally Sound Technologies", 11 *Geo. Int'l Envtl*. L. Rev. 49, 1998, p. 62.

[83] Many MEAs, including the Montreal Protocol, Cartagena Protocol on Bio-safety, the UNFCCC and the Kyoto Protocol, etc., which contain requirements for the transfer of ESTs, without defining the term "transfer", for example, the UNFCCC, Article 4.

[84] Agenda 21, Chapter 34.1, Chapter 34.3.

[85] Agenda 21, Chapter 34.3. "…this implies that when discussing transfer of technologies, the human resource development and local capacity-building aspects of technology choices, including gender-relevant aspects, should also be addressed. Environmentally sound technologies should be compatible with nationally determined socio-economic, cultural and environmental priorities". Also see UNDP, *Definition of Environmentally Sound Technologies*, available at http://www.unep.or.jp/maestro2/ESTdefinition.asp

[86] Environmentally sound technologies protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substitutes; Chapter

The Definition in the IPCC 2001 Report

Of all the official definitions of technology transfer, the most representative tends to be the definition adopted by the IPCC. According to the IPCC 2001 Report, technology transfer is defined as:

> A broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, NGOs and research/education institutions…The broad and inclusive term 'transfer' encompasses diffusion of technologies and technology cooperation across and within countries. It covers the transfer of EST processes between developed countries, developing countries and countries with economies in transition, amongst developed countries, amongst developing countries and amongst countries with economies in transition. It comprises the process of learning to understand, utilize and replicate the technology, including the capacity to choose it and adapt it to local conditions and integrate it with indigenous technologies.[87]

A closer examination indicates that the wording used above refers to three key points for an understanding of technology transfer related to climate change. These are: (1) highly interdisciplinary: a range of perspectives based on different views of climate sound technology transfer: as a technological product originating from the private sector, as a public commodity for global climate welfare and as a socio-economic process in changing technology[88]; (2) systematic project: technology transfer is not a one-off transaction independent of the recipients, but a fundamental part of \learning.[89] Total technology transfer includes capacity building, which calls for a universal effort from both developed and developing countries, public and private sectors; (3) relative concept: technology transfer is mostly context-based, the regime is drawn up in a bottom-up manner, simply codifying the pledges that countries are willing to take domestically, in which international law plays a very small role.[90]

The IPCC makes an important contribution to standardising the term of technology transfer. It has a good understanding of the basics of multifaceted technology

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34.3, Environmentally sound technologies are not just individual technologies, but total systems which include know-how, procedures, goods and services, and equipment as well as organizational and managerial procedures. This implies that when discussing transfer of technologies, the human resource development and local capacity-building aspects of technology choices, including gender-relevant aspects, should also be addressed. Environmentally sound technologies should be compatible with nationally determined socio-economic, cultural and environmental priorities.

[87] *IPCC Report 2001*, WGIII, Chapter 1.2, "Basic Concepts."

[88] *See idem*, Chapter 2.7.3, "The International Dimension in Technology Development and Deployment: Technology Transfer."

[89] In this respect, some people propose making a simple distinction between two types of technology transfer: (1) all those that end up in deployment and diffusion of climate-related technologies; (2) all those that lead to local production of climate-related technologies in developing countries. See Takahiro Ueno, "Technology transfer to China to Address Climate Change Mitigation, U.S. Global Leaderships: an Initiative of the Climate Policy Program at RFF," Issue Brief #09–09, 2009, pp. 2–3.

[90] See Michael Grubb, "Copenhagen: back to the future?" 10.2 *Climate Policy*, 2010, pp. 127–130.

transfer and could help to achieve the full potential of climate sound technologies.[91] Because it is frequently referred to and widely accepted, this concept serves as guideline for scientific literature and climate negotiations. Nevertheless, the success of the IPCC definition of technology transfer should not be overstated. According to the definition, the technologies under the UNFCCC are much less specific and are in fact unlimited. "Only when the technologies to be transferred are very specific and readily identifiable will developed countries be able to make concrete commitments and to effectively monitor compliance with the resulting obligations."[92] There is no all-encompassing theory which covers such a broad definition of technology transfer, though numerous frameworks and models have been put forward in existing climate change agreements.[93] More importantly, although the IPCC definition is acknowledged to be a useful guide in a general sense, it turns out to be rather limited in practice, because of the lack of operability that is required. The CDM's project designs document is a prime example.[94] When registering a project, the CDM participants are asked to present a description in their project design documents of "how environmentally safe and sound technology and know-how to be used is transferred to the host Party."[95] According to some technology transfer assessments conducted in the CDM projects,[96] realistic technology transfer happens at a low level because market participants' perceptions of technology transfer vary.

The IPCC definition has come up against numerous challenges, as well as undergoing improvements, during the progress of climate change negotiations. In 2009, the UNFCCC published a handbook to launch a technology needs assessment for climate change, in which technology transfer was described as "the flow of experience, know-how and equipment between and within countries, which would typically combine market and non-market based technologies."[97] In the handbook, the origin of technologies is highlighted for the purpose of a needs assessment. Notably, the handbook definition in particular sheds light on non-market based technologies.

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[91] There are more opportunities and mutual benefits for technology transfer as defined by its broad definition. In other words, if a country is asked to pass on certain technologies for free, the volume of potential activities would be limited. However, if countries cooperate to create an appropriate "enabling environment" for the diffusion of energy efficiency technologies, the implications of such a coordination system could be substantial. See Sugiyama, 2008.

[92] Verhoosel 1999, (no. 82), p. 65.

[93] *IPCC Report 2007*, WGIII, Chapter 2.7.3, "The International Dimension in Technology Development and Deployment: Technology Transfer."

[94] PDD refers to project design documents, used in the application for CDM projects (cleaning development mechanism). Most CDM projects under the framework of the Kyoto regime contain requirements for the transfer of clean technologies to the local recipients.

[95] UNFCCC 2006b, *Background paper – Impacts, Vulnerability and Adaptation to Climate Change in Latin America,* UNFCCC Secretariat, Bonn, Germany. p. 16.

[96] *Technology Transfer in CDM Projects in China* 2010, (no. 36), pp. 1–11. The CDM glossary of terms does not define technology transfer and relevant participants almost universally interpret technology transfer as meaning the use by the CDM project of equipment and/or knowledge not previously available in the host country.

[97] *UNFCCC Handbook for Conducting Technology Needs Assessment for Climate Change*, UNFCCC Expert Group on Technology Transfer (EGTT), September 2009, p. 20.

The recent trend in long-term cooperative action on climate change shows that non-market approaches are likely to contribute to enhancing cost-effectiveness and promoting emission reductions.[98]

(2) **Operational Definition**

"A workable definition of technology transfer must be functional rather than formal."[99] Concrete performance indicators are needed to make the term "technology transfer" less abstract and closer to daily legal practice. In line with the basic definition laid down by the IPCC, there are four elements which account for operational technology transfer: origin, innovation, improvement and capacity.

Geographical Source
Either the components of technologies (major or essential equipment) or the rights to technologies (patents, licences, copyrights, trademarks) must originate from abroad. Actual physical movement is not always necessary, because there is no tangible exchange across international borders when rights originate abroad. For example, foreign enterprises could give recipients the right to manufacture related equipment in host countries, or provide on-site technological assistance to local operators. It is argued that importing foreign expertise with experience of technology production, operation and maintenance is just as important as importing foreign equipment.[100]

Degree of Innovation
The imported technologies should not already be in use in the receiving markets, or in any specific regions or industrial sectors as a result of research and development (R&D). Nowadays many counties are engaged in R&D at the same time; mitigation and adaptation technologies exist in domestic markets, but are not commonly commercialized or used.[101] Therefore, it is important to identify technology options in advance. In the portfolios of identified technologies, "new" technologies are considered to be those with which stakeholders are not yet familiar.[102]

Potential Improvements
Compared with alternative technologies, technologies to be transferred are more environmentally-sound and in the case of climate change, should contribute to reducing the intensity of CO_2 in the atmosphere or should adapt to the impact of climate change. Basically, technologies that fulfil the requirement of innovation and

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[98] FCCC/AWGLCA/2011/MISC.3, *Views on the Elaboration of Non-market-based Mechanisms*, 21 March 2011, p. 5.

[99] See David M. Haug, "The International Transfer of Technology: Lessons that East Europe Can Learn from the Failed Third World Experiences," *Harvard J.L. &Tech.*, 1999, p. 212.

[100] *Technology Transfer in CDM Projects in China* 2010, (no. 36), p. 15.

[101] FCCC/SB/2009/INF.6, *Report of the Expert Group on Technology Transfer for 2009*, p. 11.

[102] *UNFCCC Handbook for Conducting Technology Needs Assessment for Climate Change* 2009, (no. 97), p. 24. With this identification and categorization, core stakeholder groups and wider policymakers could acquire an overview of new technologies in the priority regions and sectors.