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[Zhongfa Ma](#) and [Seryon Lee](#) *

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Article

An Exploration on International Legal Regime of Environmentally Sound Technologies Transfer for Combating Climate Change in Post Paris-Agreement Era

Zhongfa Ma ¹ and Seryon Lee ^{2,*}

¹ Professor of International Law, Fudan University Law School; zfma@fudan.edu.cn

² Professor of International Law, Chonbuk National University School of Law.

* Correspondence: seryon@jbnu.ac.kr

Abstract: The measures related to climate change and international technology transfer have been closely intervened as most international environmental instruments, including the United Nations Framework Convention on Climate Change and Kyoto Protocol as well as Paris Agreement which contain the provisions concerning environmentally friendly technology transfer. However, technologies have not been transferred adequately owing to the flaws in the relevant provisions and due to the fact that most technologies are possessed by transnational corporations and other private sectors. In order to undertake the commitment by the governments of developed countries and at the same time, to conform the commercial activities of their respective private sectors to the level of promised international obligation, an uniform international technology transfer agreement needs to be established separately, particularly under the World Trade Organization regime in Post Paris-Agreement era. This paper first explores the defects and challenges found in provisions related to technology transfer in existing environmental agreements, and examines the possibilities of concluding an international technology transfer agreement both from theoretical and practical perspectives.

Keywords: climate change; environmentally sound technology; international technology transfer; Post Paris-Agreement Era

I. Introduction

As the frequency and scale of natural hazards increase and threaten the sustainable development across the borders of different countries since 1980s, the various issues on climate change (CC) have become one of the greatest challenges encountered by international community. In particular, transfer of environmentally sound technologies (ESTs)[1] play a critical role in realizing global sustainability, and the rationale behind the significance of ESTs transfer is that international cooperation is vital to mitigate serious disruption of global and national socio-economic activities due to CC, and facilitating technology transfer (TT) [2] has been one of the focal points from very beginning of human's efforts to address CC from early 1990s .

Actually, TT has long been a vital component in the development agenda, and it first emerged as an international issue in 1961 as part of a request by some developing countries to the United Nations (UN) Secretary General to commission studies to ascertain the role played by international treaties in promoting the protection of intellectual property rights in developing countries; however, it was not fully materialized until it was included as an important agenda in Stockholm Conference in 1972. Since then, the importance of the TT issues has gained prominence as it was embedded as one of the major topics in a number of major international environmental instruments[3] and remained an important agenda item in international treaties related to global environmental

protection. Nevertheless, there has been no existing universal treaty on international technology transfer (ITT) and provisions on ITT are scattered throughout a number of treaties and documents related to environmental protection.

Currently, the legal sources for ITT include international treaties[4] administrated or made by the World Intellectual Property Organization (WIPO), UN system,[5] and the World Trade Organization (WTO) framework,[6] and the provisions from them collectively constitute the legal ITT regime.[7] According to the collection of international agreements on TT edited by UN Conference on Trade and Development (UNCTAD) in 2001, a total of 28 multilateral treaties existed, and 15 of which specifically related to international environmental protection concerning ITT issues.[8] The central idea of the provisions on ITT in these documents is that developed countries should transfer ESTs to developing countries, and provide developing states with facilities for and assistance with ITT. However, generally, the treaties made in UN framework attach more importance to general norms regarding ESTs transfer, whereas WIPO-administered treaties focus on granting and protecting the exclusive intellectual property rights that serve as the preconditions for ITT, and agreements under WTO concern the issues on trade and ITT. Briefly, the present regulations of promoting ESTs transfer mainly depend on the UN framework, particularly the UN Framework Convention on Climate Change (UNFCCC)[9], the Kyoto Protocol[10] and Paris Agreement.

Although there are many provisions on EST transfer in multilateral environmental treaties (METs) and other international legal instruments under the UN framework, in the past decades, ESTs have not been transferred smoothly, which, in conjunction with other relevant international obligations that have not been fully fulfilled, has exacerbated environmental problems, rather than successfully curbing the trend of global warming. In this context, since the 15th Conference of the Parties to UNFCCC (COP15, 2009) [11] in to COP27 (2022), 13 COPs have been held and almost every COP has caught the world's attention. During this period, the Copenhagen Accord (2009)[12], the Cancun agreement(2010)[13], the Paris Agreement (2015), and Glasgow Climate Pact (2021) have been adopted[14], and the provisions on TT have been highlighted in all of them. The other 5 conferences (COP17, COP18, COP19, COP20 and COP22) stressed the efforts to the implementation of the Copenhagen Accord, Cancun Agreement and Paris Agreement. At each conference from COP22 (2016) to COP26 (2022), the issue on TT discussed and there have been some decisions made to implement the provisions on TT in Paris Agreement and Glasgow Climate Pact, UNFCCC and other METs. However, although the COPs have done much to enforce the provisions on TT in these international treaties, there is still a long way to have the commendations developed in the decisions made by COPs become operable mechanisms or legally binding agreements.

In short, TT should be a key component of combating CC and effective GHG mitigation strategies, and comprehensive studies on TT issues are crucial to the related policy designs and their implementation,[15]especially after 2016, in which year Paris Agreement entered into force. Based on the difficulties and problems of ESTs transfer which the international community confronts when combating climate change, the authors will focus in this paper on ESTs transfer which may help developing countries obtain clean technologies or develop their own ESTs for economically and socially sustainable development. Our preliminary research objective is to find more pragmatic and effective ways to solve the problems associated with international ESTs transfer in order to facilitate smoother ESTs transfer, which may not only play an important role in combating climate change, but also contribute to global sustainable development.

2. The Provisions on ESTs Transfer in Related International Treaties

2.1. General Principles for Major Provisions on ESTs Transfer in METs and Other Treaties

The world began to pay much attention to environmental protection, TT and globalization in the late 1960s, and by 1990s, the inter-relationship of them became apparent. Efforts are now exerted to establish an international legal system to protect the environment. In fact, TT has been the focus of technology-related discussions in most METs.[16] This section discusses the provisions on ESTs

transfer concerning sustainable development in METs and related documents made at relevant COPs.

Since the 1970s, the following milestone conferences have set out processes of cooperation on protecting environment, including the UN Conference on the Human Environment (Stockholm Conference) (1972)[17], the UN Conference on Environment and Development (Rio Earth Summit)(1992)[18], the World Summit on Sustainable Development (Earth Summit 2002) and the UN Conference on Sustainable Development taking place in Rio de Janeiro in June 2012 (Rio+20,2012) [19]. These conferences produced a good many instruments on international environment protection, most of which contain provisions on ESTs transfer. For instance, the Stockholm Declaration said that "...the free flow of up-to-date scientific information and transfer of experience must be supported and assisted, to facilitate the solution of environmental problems, and environmental technologies should be made available to developing countries on terms encouraging their wide dissemination without constituting an economic burden on them." [20] The Rio Declaration (1992) stipulates that states shall cooperate in a spirit of global partnership to protect and restore the health and integrity of the Earth's ecosystem, and that in view of their different contributions to global environmental degradation, States have common but differentiated responsibilities.[21] These principles are the cornerstones of modern international environmental law and lay foundations for the provisions requiring developed countries to transfer ESTs to developing countries in METs and other legal instruments. In Agenda 21, the phrase "technology transfer" is mentioned 48 times and ESTs are mentioned 59 times, and the issues on ESTs transfer were discussed mainly in chapter 34 entitled "Transfer of EST, cooperation and capacity-building" and chapter 35 entitled "Science for sustainable development." The focus of these sections is to stress that technology, TT and technology-related issues are the keys to sustainable development.[22] The Johannesburg Declaration (2002) provides that "we'll work together to help one another...and make sure that there is TT, human resource development, education and training to banish underdevelopment forever," [23] implying that TT plays an important role in promoting sustainable development in the world. In the instrument "The Future We Want" adopted at Rio+20, the need to make progress in implementing previous commitments, especially those of TT, is emphasized.[24]

The above-mentioned provisions on ESTs transfer strengthen the role of transferring technology and related knowledge in protecting the environment, and stress what the international community should do about TT in the future. They provided foundations and a direction for further discussion, and influenced specific provisions on ESTs transfer in related instruments adopted at subsequent conferences on international environmental protection. However, it is not easy for these provisions without specific and mandatory descriptions of obligations states to be implemented.

2.2. *The provisions on ESTs transfer in Main Multilateral Environmental Treaties*

As for the provisions on ESTs transfer in METs, we will selectively analyze the following treaties:

(1) The provisions in the Energy Charter Treaty 1994[25]

The Energy Charter Treaty provides that: the Parties

- (a) agree to promote access to and transfer of energy technology on a commercial and non-discriminatory basis to assist effective trade in Energy Materials and Products and Investment ... and to the protection of Intellectual Property rights; (b) shall eliminate existing and create no new obstacles to the transfer of technology...[26]

The provision indicates that for realizing the objectives of the Charter, contracting parties shall cooperate with each other in the field of exploring and exploiting energy, and that TT is one of the most important aspects of such cooperation.

(2) The provisions in treaties protecting the Ozone Layer

There are two main treaties in this field: The Vienna Convention for the Protection of the Ozone Layer 1985[27] and the Montreal Protocol on Substances that Deplete the Ozone Layer 1987[28]. The former provides that "the Parties shall co-operate...taking into account in particular the needs of the developing countries, in promoting...the development and transfer of technology and knowledge. Such co-operation shall be carried out particularly through: (a) facilitation of the acquisition of

alternative technologies; (b) provision of information on alternative technologies and equipment, and supply of special manuals or guides to them; (c) supply of necessary equipment and facilities for research and systematic observations; (d) appropriate training of scientific and technical personnel." [29] The latter provides that "the Parties shall establish a mechanism for the purposes of providing financial and technical co-operation, including technologies transfer, to developing Parties to enable their compliance with the control measures set out in the Protocol; and each Party shall take practicable step...to ensure: (a) that the best available, environmentally safe substitutes and related technologies are expeditiously transferred to developing Parties; and (b) that the transfers occur under fair and most favorable conditions." [30] These provisions are more specific and operable than those in the above instruments made at 4 conferences and in Energy Charter, but there are rarely successful instances of TT in this field, and the provisions have largely not been carried out because of the lack of an effective dispute settlement mechanism, which will be discussed in Part 3.

(3) The provisions in Convention on Biological Diversity (CBD) 1992 [31]

In CBD, there is an article entitled "Access to and Transfer of Technology", in which it is *provided that* " (a) each Party, recognizing ...that access to and transfer of technology are essential elements for attaining the CBD's objectives, undertakes subject to the provisions of this Article to provide and/or facilitate access for and transfer to other Parties of technologies relevant to the conservation and sustainable use of biological diversity or make use of genetic resources... (b) access to and transfer of technology to developing countries shall be provided and/or facilitated under fair and most favorable terms mutually agreed... in the case of technology subject to patents and other intellectual property rights (IPRs) , such access and transfer shall be provided on terms consistent with the adequate and effective protection of IPRs; (c) each Party shall take legislative, administrative or policy measures, as appropriate, with the aim that Parties, which provide genetic resources, are provided access to and transfer of technology which makes use of those resources, on mutually agreed terms, including technology protected by patents and other IPRs... in accordance with international law; (d) each Party shall take legislative, administrative or policy measures, as appropriate, with the aim that the private sector facilitates access to, joint development and transfer of technology for the benefit of both governmental institutions and the private sector of developing countries ... (e) Parties, recognizing that patents and other IPRs may have an influence on the implementation of CBD, shall cooperate in this regard subject to national legislation and international law in order to ensure that such rights are supportive of and do not run counter to its objectives." [32] Besides this article, other articles in the CBD provide means of promoting ESTs transfer and allocate financial resources for ESTs transfer. [33] These provisions not only emphasize developed countries' obligations to transfer ESTs, but also note the relationships between TT and protections for IPRs. However, the obligations regarding TT are flexible and abstract, while the protection of IPRs is very concrete and operable; thus, while the provisions on TT in the CBD are detailed, they have not been executed effectively.

2.3. The provisions on ESTs transfer in the UNFCCC and Kyoto Protocol and COPs Documents

2.3.1. Direct Provisions on Technology Transfer in UNFCCC and Kyoto Protocol

The UNFCCC and Kyoto Protocol are the most important binding treaties with regard to combating CC. The UNFCCC's ultimate objective is to achieve stabilization of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the world's climate system, and such level is to be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to CC, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner. [34] To realize the objective, various provisions in the UNFCCC recognize the necessity of the rapid development of transfers and applications of ESTs that can effectively reduce GHG emissions. Transferring ESTs is seen as a crucial factor for reducing CC and enabling sustainable economic development to proceed. The UNFCCC specifically requires developed country parties to "take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, ESTs and know-how to other Parties to enable them to implement the provisions of the Convention"; and to "support the development and

enhancement of endogenous capacities and technologies of developing country Parties" in the process. Moreover, other parties and organizations in a similar position are also required to assist in facilitating transfer of ESTs.[35] These provisions provide a fundamental framework for provisions in other international legal documents concerning CC.

In order to implement UNFCCC and make its objective a reality, the parties, driven by common human interests, adopted the Kyoto Protocol as an addition to the UNFCCC after intense and furious negotiations at COP3 in Kyoto in 1997; and it entered into force in February, 2005.

The Protocol's provisions directly concerning TT are found in several articles, which mainly describe the obligations---to transfer technology to the developing countries---of the developed countries included in its Annex B. [36]It's provided that "developed countries, in fulfilling their quantified emission limitation and reduction commitments under Article 3 and in order to promote sustainable development, shall implement and/or further elaborate policies and measures, such as research, promotion, development and increased use of ...carbon dioxide sequestration technologies and of advanced and innovative ESTs." [37] Thus, developed countries must transfer technology in performing their obligations to craft and implement policies and measures on the increased use of ESTs. The Protocol also provides that "developed countries shall strive to implement the commitments to minimize adverse social, environmental and economic impacts on developing country Parties...and COP ...shall... consider what actions are necessary to minimize the adverse effects of CC and the issues involving the establishment of funding, insurance and transfer of technology." [38] This provision clearly expresses the duties of developed countries to exert their efforts to curtail the overall adverse impacts on developing countries and establish an effective institution to promote TT, funding and insurance. More specifically, the parties to the Protocol are required to 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, ESTs, know-how, practices and processes pertinent to CC, including the formulation of policies and programmes for the effective transfer of ESTs that are publicly owned, and the creation of an enabling environment for the private sector, to promote and enhance the transfer of, and access to, ESTs.[39]

The above provisions provide an explicit description of the commitments to ESTs transfer required under Kyoto Protocol. These provisions have facilitated TT in practice, to some degree, and are legally binding on all the parties to the Protocol. In short, the parties, especially industrialized countries, are required to perform their obligations of transferring ESTs and related know-how and knowledge to developing countries.

2.3.2. Stipulations on Technology Transfer at Different COPs after COP 3

After COP3, the issues on TT have almost been discussed at every COP and decisions made on "development and transfer of technology" appeared 16 times (all but COP6 and COP9), and among them, the following 6 sessions, that is, COP7(2001), COP13(2007), COP15 (2009),COP16(2010), COP21(2015), and COP26 (2021) produced more influence on TT.

At COP 7, the Parties reached an agreement on the implementation of a TT framework including five themes[40] and decided to establish an expert group on technology transfer (EGTT).[41] At COP 13, the Bali Action Plan (the Plan) was accepted by the Parties, which especially emphasized the parties' commitments to TT. It launched a comprehensive process to enable the full, effective and sustained implementation of UNFCCC through long-term cooperative action by addressing, *inter alia*: enhanced action on technology development and transfer to support action on mitigation and adaptation in 4 specific aspects. [42] Though this achievement was encouraging and the Parties demonstrated their cooperativeness and flexibility, the Plan was non-binding.

At COP 15, TT was one of the focuses of the conference, but the result on TT negotiations failed to meet the anticipation of conference, and the adopted Copenhagen Accord could not progress further than what the Plan had done. The Copenhagen Accord didn't have legal binding force on the Parties, but it specifies the measures on development and transfer of technologies and the fund mechanism which may found a solid base for future negotiations to reach an international agreement

concerning TT. It provides that the Copenhagen Green Climate Fund shall be established as an operating entity of the financial mechanism of UNFCCC to support projects and other activities related to mitigation including REDD[43]-plus, adaptation, capacity building, technology development and transfer. It also makes clear that the Parties decide to establish a Technology Mechanism to accelerate technology development and transfer in support of action on adaptation and mitigation that will be guided by a country-driven approach and be based on national circumstances and priorities.[44]

At COP16, technology development and transfer is addressed as a very important part in a balanced, integrated and comprehensive manner to enhance and achieve the full, effective and sustained implementation of UNFCCC up to and beyond 2012.[45]The central contents in the instruments adopted are: EGTT's mandate shall be terminated at the conclusion of COP16,[46] and a Technology Mechanism[47] shall be established to facilitate the implementation of actions for achieving the objective under the guidance of and accountable to COP, which will consist of two components: a Technology Executive Committee to undertake seven functions[48] and a Climate Technology Centre and Network to undertake four functions[49] with promoting and facilitating ESTs transfer as their fundamental mission.

At COP20, the parties agreed that the technology development and transfer has been regarded as one of the very important contents to be addressed in the negotiation for another legal instrument.[50]In the Annex of the Outcome--- "Elements for a draft negotiating text"---the Preamble describes that the parties reaffirm the need for developed country Parties to provide new, additional, adequate and predictable financial resources, including financial resources for the transfer of technology to and capacity-building in developing countries for addressing mitigation and adaptation needs and complying with their obligations under this agreement...; in the Part "Objective", one of the objectives is to promote technology transfer and capacity-building to developing countries on the basis of equity and common but differentiated responsibilities and respective capabilities.[51]These provisions focuses on the role of TT, and it is reasonable to assume that the new agreement will surely contain the provisions on TT.

At COP21,the adopted Paris Agreement has 4 articles concerning TT which require to strengthen cooperative action on technology development and transfer, and focus on the performance of the obligations of the developed parties in this field, such as taking full advantage of Technology Mechanism and providing financial supporting.[52] There is no more substantial or operable measure than those in other international instruments .

At COP26,the adopted Glasgow Climate Pact contains 6 articles concerning TT in five parts (there are 8 parts in all) which urges or emphasize developed country Parties to provide enhanced support, including through financial resources, technology transfer and capacity-building, to assist developing country parties with respect to both mitigation and adaptation, in continuation of their existing obligations under UNFCCC and the Paris Agreement, and encourages other Parties to provide or continue to provide such support voluntarily.[53] The enforcement of the previsions in other international instruments has been highlighted.

All of these stipulations follow a major logic clue, that is, to lay stress on the implementing the provisions on EST transfer described in UNFCCC and other important METs, for it may be easier for the parties to these treaties to reach agreements to promise to transfer ESTs, but it will be much more difficult to fulfill their promised obligations. The history of human development has repeatedly proven that it is the best way for technologically less-advanced countries to enhance their innovation capabilities that they shall accomplish such achievements by or through imitation innovation, and the only way to legally obtain advanced technology is to transfer technologies.

3. Defects in current Legal System on ESTs transfer and Challenges to Implementation

3.1. Defects of the provisions on ESTs transfer

International treaties and legal instruments on CC, and their relevant mechanisms, mainly aim at promoting ESTs transfer and providing the necessary financial assistance for TT. However, these

provisions and mechanisms are too vague and generic. The lack of “hard” (mandatory) international environmental law is often seen as a major obstacle to global environmental protection, [54] and this is obviously true to ESTs transfer. The words used in most METs, especially in UNFCCC, such as “appropriate”, “cooperate”, “encourage”, “facilitate”, or “promote”, “exert efforts”, and “assist,” have very broad meanings and lack clear definition, which are usually regarded as “advocacy terminologies” without compulsory legal binding. They allow for states to find loopholes with regard to ESTs transfer, as they do not impose definite binding commitments on countries against which compliance can be assessed, and they rely on every country’s domestic law or measures for their implementation, leaving individual countries with considerable discretion. Briefly, METs have inherent flaws such as lack of definite definition, non-binding character and vagueness of obligations. Thus, implementation of METs largely depends on the existing domestic laws and regulations of each party.

More seriously, most METs have a fatal weakness, namely that they lack effectively mandatory compliance mechanisms to ensure that the parties fulfill their obligations and if a party fails to perform its obligations, there’s no enforceable sanction mechanism. Regarding this issue, Kyoto Protocol stipulates that COP serving as the meeting of the Parties to the Protocol shall approve appropriate and effective procedures and mechanisms, as an amendment to the Protocol, entailing binding consequences to determine and to address cases of non-compliance with the provisions of the Protocol;[55] but it’s very difficult to get such an amendment concerning ESTs transfer because of the conflicts of the parties’ interests and the clashes between private enterprises’ interests and governmental intervening activities in a country, especially in developed countries. At the 2001 Bonn Conference, no agreement concerning this issue was reached, and to date, there have still been no such specific measures binding the Parties, let alone the sanctions for those parties who do not perform their obligations. Although the EGTT was established after COP 7, it’s very hard for the body to effectively promote TT, as it is confined by its structure to only providing consulting advice as appropriate to the subsidiary bodies, including SBSTA and the SBI-- Subsidiary Body for Implementation[56], and can, at most, raise suggestions on improving the international legal regime for TT. Owing to lack of enforceability, the provisions on TT obligations are severely impaired. Thus the provisions regarding ESTs transfer in METs are often regarded as those with the nature of soft law. Generally, the implementation of Kyoto Protocol and other treaties mainly depends on willingness and voluntariness of the parties to them and the private sectors. When refusing to perform their obligations, the parties are unlikely to be penalized or assume legal liabilities.

With the purpose of motivating the private sector to participate in project activities or emission trading in order to make a profit, [57] the three mechanisms (Clean Development Mechanism—CDM, Joint Implementation, and International Emissions Trading) which were theoretically envisioned in Kyoto Protocol to assist in TT leading to emission reduction have been demonstrated that they did not work effectively,[58] for developed countries tend to shift their pollution-prone industries to developing countries without transferring any ESTs, which results in no net reduction of emissions and no technological improvement. Without effective institutions and enforcement mechanisms, ITT is unlikely to take place on a scale sufficient to make any measurable difference. The obligations imposed on developed countries are simply “soft” law,[59] that is, the provisions on these obligations are too flexible to be implement, and will evaporate in the competitive environment of self-interest.

In summary, the provisions concerning TT in METs are so flexible that they could not effectively promote ESTs transfer.

As for funding mechanism, the flaws of the related provisions are similar to those of the provisions on ESTs transfer in METs; that is, the provisions are ambiguous, for though the funding obligations do not specifically require states to fund TT, on most occasions, the fund is used to promote TT and help build the capacity of developing countries. However, developed countries often impose strict restrictions on the categories and types of funds that can be subsidized, and thus enterprises in developing countries often cannot use the funds on TT or to realize the objectives of the treaties because of funding difficulties. [60] Without financial support, many developing countries cannot pay for licensing royalties, and thus cannot use technology and form technical capacity, so

that technological development in most developing countries remains in a vicious cycle. However, the way to solve the funding problem for TT is a part of TT regime for combating climate change, but it is distinct from the practical challenges in ESTs transfer,[61] and it has been developed into a separate mechanism under the framework of UNFCCC, and thus beyond the scope of the paper.

As for the most important documents, the Bali Action Plan, Copenhagen Accord, Cancun Agreement, Durban Platform, Agreed Outcome Pursuant to the Bali Action Plan (2012), Paris Agreement and Glasgow Climate Pact, which were formed at COP sessions after the Kyoto Protocol came into force, these documents include a number of substantive provisions on TT and produced breakthroughs on ESTs transfer. However, they are still simply expressions of consensus of the governments of different states, rather than legally binding treaties among them, and there is no timeline or indication of and whether and when they could become treaties. Thus, it is difficult to implement their provisions on TT. For example, compared with Copenhagen Accord, Cancun Agreement contains more regulations about the participation of private sectors in TT and institutional blueprints, but it just constitutes a primary consensus, and it's hard to anticipate when, if ever, these will become a legally binding agreement as a part of the legal regime on TT, for in Paris Agreement and Glasgow Climate Pact, participation of private sectors in TT is rarely mentioned. [62]Moreover, even if it became legally binding, without the safeguard of legal implementation system, it might be difficult to compel parties to implement their commitments effectively, just as occurring with Kyoto Protocol.

3.2. Challenges to Implementation of the Provisions on Technology Transfer

The superficial reasons why the provisions on international ESTs transfer in METs and other legal documents cannot be effectively implemented may be mainly attributed to their drawbacks, but the hidden key reasons behind are that governments' commitments to developed countries are often in conflict with the interests and needs of their domestic enterprises or other private sectors. The commercial activities of technology suppliers can pose a fundamental obstacle to TT. [63]Due in part to historical reasons, enterprises in developed countries possess more than 90% of global advanced technology. However, their profit-oriented intention of business activities always prevail over the international obligations of their governments when transferring their technology; that is, when there is no profit to gain, they will not transfer technology, no matter what obligations their governments shall assume in METs, for the decisive factor of private commercial activities is to pursue profit maximization, which means to maximize the profit of a "rational economic man", while the public interest in mitigating GHG emission is less compelling for private actors. Taking advantage of developing countries' urgent technological needs, enterprises in developed countries often increase technology licensing royalties, or raise sorts of restrictive conditions to make developing countries unable to accept, or refuse to transfer technology when finding it unprofitable. Governments of developed countries which emphasize the sanctity of people's private property rights will almost do nothing in this aspect, that is, they could not require private sectors to transfer technology to others just because they have to fulfill their international obligations, for their domestic laws prescribe IPRs as private property rights. Additionally, they exerted their efforts to turn this idea into international norm through Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement). Consequently, as an important part of IPRs, ESTs are no doubt in the scope of private property rights. Therefore, governments of developed countries often makes empty promises on ESTs transfer, and combined with the absence of an effective international dispute settlement system for obligations in this field, provisions on TT such as those in UNFCCC and Kyoto Protocol have largely not been successfully applied and implemented.

In short, the provisions on TT in METs have not been genuinely observed, the effects of GHG emission reduction is not as good as expected, and the targets for emission reduction have not been reached. This problem stems mainly from the ambiguity of the provisions on TT, the lack of a sanction mechanism to compel non-compliant parties, the inconsistency between profit-making interests of private sector actors and governments' commitments involving global public interest, and the conflicts between TT and enhancement of intellectual property protection. TT has been mentioned on

most occasions at 21 COPs and at more than forty meetings convened by its subsidiary bodies, but the fact that the improvements on TT have not been made is the best proof of the inadequacy of these references.

The above discussion indicates that if there is no rational and effective legal regime on ITT, in the absence of practical and mandatory monitoring mechanisms, under the existing legal frameworks in developed countries, governments cannot force the private sector actors who hold most ESTs to transfer technology, let alone persuade private sectors to voluntarily transfer technology without achieving commercial objectives. This makes the obligations of TT in METs not legally binding to developed countries. If so, it will be impossible to move forward to achieve the expected goal in field of international environmental protection.

Given these constraints and challenges, the most effective and fundamental way of combating climate change would be to make the activities of private sectors' ITT under a fair legal system consistent with the commitments of developed countries' governments made in treaties, so that environment-friendly technology can be efficiently promoted and applied throughout the world. Yvo de Boer, predicted at the Bonn Conference of UNFCCC subsidiary bodies in May 2010, that the main issue of Cancun conference would be how to make the private sector play an active role in TT; for example, according to TT mechanism mentioned in the Copenhagen Accord, the Climate Technology Centre will be established which will bring government the opportunity to establish a clear partnership with private sector at the regional, national and international levels. [64] This prediction was reflected in Cancun Agreement, which describes the dominant position, tasks and roles of private sector in TT and emphasizes the significance of active participation of private sector in TT. [65] What a pity is that in Paris Agreement, this point was not highlighted.

4. Proposal of the Legal Regime of International Technology Transfer

Despite all of the work relating to ITT over the past 40 years, it has proved hard to find an effective way to promote TT under the UN framework, including the UNFCCC, Kyoto Protocol and Paris Agreement. As analyzed previously, the main reason is that without the participation of private sectors who own the majority of advanced green technologies, it's impossible to enforce the provisions on TT in treaties, [66] for governments cannot perform their obligations under the UN treaties by forcing private sectors to transfer technologies to the enterprises in developing countries. This demonstrates that, in developed countries, the governments' commitments in form of approving or ratifying the treaties are completely different from private commercial activities. What's more, there is no effective dispute settlement mechanism within the UN framework. On the contrary, the achievements since the establishment of the WTO have shown that it can help parties to transform its rules into domestic laws of its members, and make private sectors actively participate in international trade. Moreover, the WTO dispute settlement mechanism can work more effectively to solve disputes between the parties, as it can take coercive measures to some extent against parties who fail to perform their obligations under WTO regime. [67] These two points explain why WTO agreements have been implemented much better than their UN counterparts.

Therefore, it is important to explore the relative issues surrounding the dilemma of international ESTs transfer relating to climate changing, and find a way out. To do so, we take performance of the obligations of TT in UNFCCC as starting point and look at the specific implementation of the Copenhagen Accord and legislation of the Cancun Agreement, Paris Agreement and Glasgow Climate Pact at the international level as an opportunity to promote new development of legal system on TT in the field of environmental protection, so as to break the deadlock of the present legislation relating to ITT, and then extend the results to other fields, and finally formulate a unified ITT legal institution which may make great contributions to mitigating GHG emissions and contain climate change. If the international community could innovate and advance in developing and applying international legal system on TT which helps to diffuse and transfer ESTs to developing nations to reduce GHG emissions, then ESTs and the regime on TT would play an very active role in protecting the environment and the climate. In the view of the authors, in forging a solution to the problem of TT to combat climate change, it is more practical and effective to conclude an ITT agreement under

WTO on the basis of relative provisions scattered in the existing treaties on environmental protection than to rely on UN system, and, to some extent, the necessities and the possibilities for concluding such an agreement have already been well prepared.

4.1. The Need to Conclude an International Technology Transfer Agreement under WTO

Climate change, environmental pollution, and other related issues have been caused by the improper use of technologies by some people under the guidance of the human "people-oriented" concept which is erroneous since the beginning of industrial revolution in the mid-18th century. Misguided by this idea, humans intended to utilize technologies to remake and conquer the nature, but failed to show their respects for the nature, that is, they have not followed the natural laws and rules. Today, the human development must be guided by the concept of sustainable development and follow the fundamental principle of "harmonizing the relationship of humans and the nature". Therefore, the legitimate and reasonable use of science and technology has become crucial. Due to uneven development in different countries, some countries may have more advanced technology while others may be relatively backward, which makes technology transfer and sharing inevitable.

4.1.1. Theoretical Problem on the Efficient Transfer of ESTs

The WTO mainly coordinates global trade activities through the functions of members' governments, and in essence, technology transfer is a particular mode or type of trade. The market mechanism, featured as free trade, is a relatively effective method to coordinate production and allocate resources, but it has natural defects. For instance, it can hardly do anything to control monopoly and extremely selfish private activities, to provide public product, and to surmount or avoid anarchy of production and negative externalities of market activities. Therefore, we cannot expect to achieve the best allocation of the whole social resources or sustainable development only through market mechanism.[68] Especially when it comes to environmental protection and pollution control in trading and production, the market economic mechanism will get nowhere. The existing problems of climate change and environmental pollution are mainly ascribed to the fact that trade liberalization had been over emphasized in the past. It has been accepted commonly that the international community should take measures to manage and control environmental problems concerning international trade activities in order to achieve trade ecologicalization. Trade involving environmental issues is a part of the WTO framework, the relationship between trade and environment is one of the main topics at WTO conferences, and the WTO system is being improved day by day. Therefore, theoretically, it is logical to incorporate ITT which has close relation with environment and climate change into the WTO system.

Although it has been over 30 years since the UNFCCC came into effect and 20 years since Kyoto Protocol became effective, most parties to UNFCCC reached consensus on TT and financial support with regard to GHG emission at the UN Climate Summit in 2009,[69] and Cancun Agreement reached in 2010 emphasized the status and role of private sectors in TT, and technology mechanism was established and CTCN has been operated, and in Paris Agreement, technology transfer was highlighted again in 2015, ESTs have not been transferred to the full extent expected. One important reason for this is that obligations of ESTs transfer have not been directly connected with international trade. The Doha Conference under WTO in 2001 listed "development" as its central topic, and a key point in development---technology transfer---became the focus of that conference. But until now it has not been feasible for many low-carbon technologies to be used by purely commercial channels, even if developing countries are required to obtain and use ESTs on fair and reasonable terms. The reason lies in the fact that the diffusion of many ESTs through commercial channels may be blocked by excuses made by developed countries, such as the risks caused by weak legal protection and defects of the domestic legal systems of developing countries and so on. Moreover, since many ESTs have been controlled by transnational companies aiming at gaining high profits and these profit-oriented entities rarely consider public interests, it is not practical to depend on the private sectors to voluntarily transfer ESTs in commercial way to realize the targets of GHG emission reductions, which is also the main reason why COPs have always indulged in empty talks on TT. Therefore,

theoretically, it is necessary to incorporate TT under the WTO framework, which may make enterprises' obligations of TT connected with their private activities through the treaties on international trade and the domestic legislations of their countries.

It is a great problem for the international community to make ESTs owned by private sectors actually work for targets of GHG emission reductions through the platform of governmental powers, and the main way to achieve this is to connect the obligations of TT with international trade to impact rights holders' interests by legal bindings. Governments, including both technology suppliers and receivers, can create an environment advantageous or favorable to private sectors and public departments for transferring ESTs with their reasonable domestic economic policies and legislative structures, and by improving the transparency and political stability. Governments also need to take necessary measures to simulate the diffusion of ESTs. In addition, by the relevant systems under the WTO, governments can promote the active participation of NGOs and the major social groups to work together with the relevant governmental departments and private enterprises and promote the use and transfer of ESTs in order to slow down the global warming; NGOs can also participate in the legislation nationally or internationally, or file litigations against the private enterprises that have made excess GHG emission to make them recognize their obligations of development and transfer of ESTs and their liabilities in related treaties. In this way, a benign interaction mechanism may be created in which governments play a leading role, enterprises participate in and market works smoothly, and ESTs transfer and application may be promoted effectively.

4.1.2. Practical Problems on the Efficient Transfer of ESTs

Although there have been plenty of the provisions on TT in different treaties, there has been no litigation concerning refusal to transfer ESTs between countries or between private enterprises at international level. However, the dispute settlement body (DSB) under WTO has filed 621 applications of the disputes on international trade (concerning trade on goods, services and IPRs, and so on) among the members up to October 5th, 2023, [70] but it has never dealt with any case involving TT. There exist various reasons for this phenomenon, and among them, unclear or flexible provisions under the current treaties concerning ITT, no specific ITT agreement and lack of mandatory dispute settlement mechanism on ITT disputes may be the most significant ones. It is believed that among the treaties on economy, society, environment and development, the agreements under WTO framework have been implemented the most effectively. This is closely connected with an institutional feature of these agreements, namely that the WTO framework is composed of a package of agreements of which no member can maintain the right of reservation. The dispute settlement mechanism is an inseparable part of the WTO and applied to each WTO member, and DSB has compulsory jurisdiction over all WTO members. Therefore, once the specific obligations of ESTs transfer is incorporated into WTO system, parties which fail to perform their obligations of ESTs transfer may be held liable through DSB, and may be compelled to adjust their domestic policies or amend laws to have private sector actors participate in ESTs transfer.

In brief, all the countries shall promote sustainable development, change their consumption and production modes, and reduce GHG emission to the greatest extent possible. Governments, international organizations, private enterprises and all the major communities or bodies shall establish partnerships to play active roles in changing the unsustainable consuming and production mode and in promoting TT. The international community should not only rely on governments to take actions, but also seek to inspire enterprises and other private sector actors, especially those who hold ESTs, and other non-governmental bodies to participate in mitigating emissions and transferring ESTs. ITT cannot be accomplished just by governments and it needs the participation of more actors such as international organizations like WIPO, social organizations like enterprises and individuals. Under the current conditions, among all the international organizations, only WTO satisfies such requirements and is capable of providing relatively good platform for negotiation and communication, which finally takes full advantages of "a package of agreements" to restrict the members with WTO rules and its dispute settlement system to promote ESTs transfer.

4.2. The Possibility of Concluding an “International Technology Transfer Agreement” under WTO

Although it is now confronting the great challenges which have been caused by the United States unwillingness to cooperate with other members by failure to appoint the members of the Appellate Body of the Dispute Settlement Body, WTO is still one of the most important organizations in harmonizing the international trade issues in the world. The agreements or the mechanisms under WTO framework may maintain great influence on world trade or at least expand their impacts on regional or bilateral free trade agreements. And thus it is still significant for us to make recommendations to discuss how to solve the issues concerning ITT for addressing climate change.

4.2.1. Possibilities in aspects of System of International Legislation and Theoretical issue

The relationship between ESTs transfer and IPRs is an unavoidable problem. TRIPS Agreement is the typical representative of an existing IPR system. The fundamental orientation of TRIPS Agreement is to stimulate competition. The content of TRIPS Agreement focuses more on ascertaining right-holders of and protection for IPRs, while neglecting technology transfer and diffusion and the realization of technology value. Although TRIPS Agreement contains provisions on balances of rights and obligations and TT - for example, it states one of the major objectives of IPR system is to promote the diffusion and transfer of technologies[71] and also provides that TT is one of its important basis and principles[72] - these provisions are so abstract and general that they are hard to be implemented, and the core content of TRIPS Agreement focuses on protecting right holders' interests. Nevertheless, most METs contain provisions on TT and require developed countries to transfer ESTs to developing countries, which seems contrary to TRIPS Agreement. Therefore, it is easy to understand why some scholars hold that TRIPS Agreement and CBD (which can be regarded as a typical case of METs) contain the seeds of potential conflicts with vast implications not only for the environment, but also for the biotechnology, pharmaceutical and agricultural industries.[73] But considering the features of the intellectual property system, and the generality and nature of IPRs, the so-called conflict can be avoided. IPRs are themselves statutory rights, and the intellectual property legal regime is the result of the balance of rights and obligations; although TRIPS Agreement defines IPRs as private rights, the objective and principle of TRIPS Agreement focus on promoting the flow and diffusion of technology and aim to increase the level of human living.[74] Moreover, there are many exceptional articles in TRIPS agreement[75] which leave much space for governments of developing countries to make laws which are favorable to TT. Therefore, governments should exercise their powers to take necessary measures or make laws on IPRs involving public interests to reach the goals set by TRIPS Agreement, and this may provide possibilities for making laws on TT out of IP laws domestically and TRIPS agreement internationally. Although there are some specific terms on TT in TRIPS Agreement, they just point to the situation in which technology is transferred from developed countries to the least developed countries, and there are no provisions on the situation of TT among developing countries or among developed countries, or from developed countries to developing countries. This leaves a possibility for making ITT agreement in international legislation.

Theoretically, it is relatively easy to deal with the tensions between the proposed ITT agreement and TRIPS Agreement by stating expressly the close connection between the two regimes in the text of ITT agreement. In aspect of contents, the preface and Articles 7 and 8 of TRIPS Agreement are the legal logic and principle base for making ITT agreement; and Articles 31, 40, 67 and Clause 66.2[76] would be important parts of the supposed agreement, which can be further refined in the agreement; the measures encouraging TT taken by developed countries[77] and other rules shall be concretized and institutionalized in ITT agreement. When considering compulsory license of ESTs, we can refer to the provisions on compulsory license of the pharmaceutical patents concerning public health[78], and make full use of national emergency and public interests to decrease the requirements for compulsory license for ESTs. The position of ITT agreement could be similar to that of GATT and GATS, while TRIPS Agreement focusing on intellectual property could be deemed as a common law of these agreements in aspect of intellectual property issue of each. In fact, TRIPS Agreement itself is an international treaty with many flexible provisions and the international community could take full

advantage of such regulations to clarify the relation between them. Through such legislative arrangements, we can make the best of the flexible provisions in TRIPS Agreement to offset the negative impacts on developing countries caused by its rather high level of protection, deal with the relationship between TT and the rational IPRs protection system, and balance the interests of the relevant parties, that is, neither ignoring protection for IPRs while transferring ESTs, nor allowing right holders to abuse their rights to avoid ESTs transfer because of excessive or undue protection.

The points above mentioned provide possibilities for making an ITT agreement relating to, while distinct from, TRIPS Agreement.

Considering the relations between this agreement and the provisions on TT in international treaties relating to environmental protection, the proposed solution for reconciling TRIPS Agreement and other international treaties on IPRs with ESTs transfer as a reference, that is, besides the content of principles and commonality in ITT agreement, the content relating to TT in different fields is allowed to be reserved in international treaties on environmental protection according to their own characters; and this agreement will introduce the obligations of TT provided in the relevant treaties into WTO framework through its quoting or citing terms. Thus, if a party fails to perform obligations on TT, other parties can utilize WTO dispute settlement mechanism through DSB to launch a complaint against them and compel them to make and implement domestic laws and regulations on environmental protection which promote ESTs transfer.

4.2.2. Possibilities in Practice

The characteristics of technology make it quite difficult to establish a technology trade system. Therefore, although technology is very significant to trade development, it has never been a priority in international trade negotiations in the past 50 years since World War II. [79]A great change took place in paragraph 37 of Doha *Ministerial Declaration* in 2001, which suggested the creation of the Working Group on Trade and Transfer of Technology (WGTTT) to study and analyze the relations between trade and TT and propose measures or any possible recommendations on steps that might be taken within the mandate of the WTO to increase the flows of technology from developed countries to developing countries within the scope of WTO compulsory rules.[80] WGTTT aims to review the relations between trade and TT from developed countries to developing countries and to study the approaches to increase the flow of technology to developing countries. WGTTT reports to the General Council of the WTO, and the General Council reports to the Ministerial Conference during the session.[81]WGTTT primarily deals with problems of how to carry out provisions on TT in practice and whether specific measures can be taken under WTO to promote flows of technology, for although the demands to transfer technology from developed countries to developing countries have been mentioned in certain WTO agreements and their related provisions on TT, they are quite unclear. Obviously, the WGTTT working range includes TT concerning environmental protection. Since WGTTT was founded in 2002, a series of activities to promote exchanges of technology between developed countries and developing countries have been launched, but there have been few outstanding achievements of its substantive work, which shows that WGTTT produced limited impacts on ITT and might not have enough power to promote ITT. On most occasions, the members share their experience with innovation, technology generation and its transfer domestically or globally, for example, how members pursued comprehensive technology policies to encourage institutional development, investment flows, international co-operations and establishing linkages between stakeholders. By October 5th, 2023, WGTTT held 69 meetings and completed 24 reports to the General Council[82]which provide much valuable experience for concluding an ITT agreement in the future. For instance, it is suggested that the ways on how WGTTT could benefit from synergizing its work with other WTO bodies should be discussed;[83]it is emphasized that technology transfer has been a collaborative process encompassing knowledge, skills and know-how, that it involved several actors including governments, academia, and industries; and that technology transfer had been providing a powerful tool to narrow the technological gap between developed and developing countries, and for integrating developing countries into the multilateral trading system.[84]It is also proposed that a dedicated WTO webpage on technology transfer be established,

and the webpage shall include the following information : (i) description of all technology and its transfer-related provisions in the WTO Agreements; (ii) reports on the nature of incentives provided by the governments to firms under Article 66.2 of the TRIPS Agreement; and (iii) links to IP information data bases, technology transfer offices, and technology and innovation research institutions across the globe.[85] These ideas may be regarded as the promotion power for concluding the ITT Agreement.

EGTT under the UNFCCC was established in 2001 and it aims to improve the enforcement of Article 4.5 of UNFCCC to identify the methods of helping and promoting TT activities, especially by analysis and recommendation to SBSTA;[86] its primary purpose is to promote TT in the field of international environmental protection. During the nearly ten years from the day when it was established, in the early five years the major mission of EGTT was to deepen the understanding of TT theoretically, while in the later five years EGTT mainly promotes TT in practice and make great effort to polish the TT legal system. For instance, it has put forward an result-oriented framework on TT which focuses on strengthening the implementation to help the smooth transfer in the specific industries and regions.[87] During EGTT'S first term of office from 2001 to 2007 , it held 12 conferences and submitted 6 annual reports on TT to SBSTA; during the second term of office, EGTT held 6 conferences and submitted 2 annual reports. The conferences and annual reports have provided an enormous variety of useful suggestions and contributed significantly to promoting ESTs transfer effectively, and accumulated experience for improving the TT legal regime.[88] According to the Cancun Agreement, the EGTT's mandate was terminated in 2010, and EGTT was replaced by "the Technology Mechanism". The core function of this mechanism is (i) to strengthen activities of technology development and transfer, and supporting the emission reduction and mitigation activities to perform the obligations under the UNFCCC entirely; and (ii) to further accelerate the activities in compliance with performing the international obligations on TT to mitigate GHG emission at different phases of the technological cycles (including promotion and dissemination of ESTs) .[89] This adjustment has promoted the position of the TT body in UNFCCC and broadened the scope and systems of TT, which may generate great significance for ESTs transfer. But in practice it may not work as effectively as expected if it is just under UNFCCC. However, this change creates a good opportunity for WTO and UNFCCC organs to cooperate on issues on TT. Since TT is more a kind of commercial activity with the major feature of private activities, it is relatively hard to promote TT with realizing commercial purpose just under UNFCCC, which has been illustrated by the practices since the entry into force of UNFCCC and Kyoto Protocol. Only by combining TT with international trade through the influence of domestic legislation which stimulates the private sectors to participate in TT, can the objectives expected be reached. WTO has been working particularly effectively in the present international legal system, Cancun Agreement actually discussed the position of the body concerning TT, and Paris Agreement with TT provisions has been adopted. These situations have created facilitating conditions for possible cooperation between WTO and UNFCCC bodies to solve the TT problem. As for a technology development mechanism, such a mechanism is more related to a country's policy, finance and so on and it will be more reasonable to leave it to be dealt with under UNFCCC framework.

For this sake, WGTTC can draw experience from EGTT'S works and cooperate positively with organizational body of the Technology Mechanism under UNFCCC to extend a WTO-leading coordinating mechanism for TT within WTO on the basis of the related provisions in Kyoto Protocol, TRIPS Agreement and other international instruments concerning TT, among which the WTO's dispute settlement mechanism has operated effectively and may work positively for the operation of TT mechanism in the future. TT in practice is complicated and involves almost all kinds of issues concerning trades, such as trade in goods, investment, service trade, intellectual property right protection, policies for fair competition, anti-trust and technical barriers to trade. The technology mechanism with its mission of accelerating technology development and transfer which was decided by Copenhagen Accord and Cancun Agreement needs to be guided by government-driving methods and based on related national activities, which provide a new starting point for establishing a universal TT agreement under WTO.

Furthermore, before COP13, the SBSTA appointed by COP had been responsible for the proposal of technology development and transfer, but its role was limited to providing advice on TT, while SBI was in charge of the substantial issues such as finance. Only by including the proposal of technology development and transfer within SBI's work scope, is there possibility to turn the discussion on TT into action. This proposal was put into SBI's work scope at COP13 and Copenhagen Conference also maintained the authorization of Bali Road Map; in this result, before the unified agreement on TT is passed, the international community can make full use of this achievement in flexible ways, and meanwhile provide concrete references and experiences for the supposed ITT agreement.

4.2.3. Nature and Expected Roles of Proposed International Technology Transfer Agreement under WTO

Countries must cooperate with each other to reduce GHG emission, as has been shown in the whole process of the international legislation and implementation of the environment laws. [90] To reach the goal of emission reduction, developed countries and developing countries must overcome their conflicts of technology, politics and economic interest to cooperate with each other. [91] For private sectors, pursuing maximum benefits tends to subordinate public interests to private interests, but the dilemma faced by human race requires a balance between private and public interests. In our proposal, all parties to UNFCCC shall cooperate with each other widely and deeply through the facilitation of Copenhagen Accord with the legalization of provisions on TT provided in Cancun Agreement and Paris Agreement as the core issue, give an impetus to the process of Doha Round under WTO which themes are trade, development and environment to link ESTs transfer with trade, and conclude an ITT agreement under WTO on the base of the current provisions to promote diffusion and transfer of ESTs. This agreement will bind governments and private sectors under their governance to state public powers and treaties concerning international trade to enforce private sectors to transfer ESTs, which may have historic significance to solve the problems involving GHG emission reduction, trade and sustainable development while complies with implementation of the provisions on TT [92] in Copenhagen Accord, Cancun Agreement and Paris Agreement.

The nature of the proposed ITT agreement is an agreement reached after multilateral negotiations at the WTO ministerial conference and it is a part of WTO rules by the form of a package of agreements, which is similar to that of GATT. In this way, the obligations of ESTs transfer concerning GHG emission reduction are linked with international trade system: on one hand it can share other mechanisms of WTO, especially DSB, [93] and improve the implementation of the rules of TT in the environment-related treaties, which means that the party that doesn't perform its obligations may face legal liability; on the other hand, it is convenient for the parties to coordinate in various fields to link TT with investment, trade in goods and service, and fair competition.

Such an agreement will generate binding effects on the parties after it comes into force. Because voluntary TT or technological assistance cannot generate legal obligations, neither governments nor enterprises who own ESTs are willing to share their technologies with others at free charge. Technologies can only be shared through a fair commercial mechanism under which the actors are driven by profits. If such an agreement making TT connected with trade between the parties is concluded and ratified, then when failing to perform its obligations of TT, a party may be sanctioned according to the relevant trading rules, such as being levied high tariffs or forbidden to import goods concerning TT, to force the parties and their enterprises to transfer ESTs, just as the regimes of trade remedy measures do with regard to anti-dumping and countervailing. Of course, ESTs transfer shall be accomplished under fair and rational commercial conditions. In this way the commercial activities of the corporations owning technologies are connected with ESTs transfer and the functions of ESTs can be exerted to the most degree. Such rules will make parties realize that TT is a substantial obligation but not just a scarecrow without any binding force, or a discretionary concept like comity of nations. Even if the development of ESTs is financed by governments, interest conflicts of countries may still happen in the process of ITT. This is an issue worth studying further, as well as whether governments can provide incentives through domestic policies to encourage transfer of ESTs.

4.2.4. Other Issues for the Proposed International Technology Transfer Agreement

4.2.4.1. Basic Framework

After studying and analyzing the relevant international treaties and related instruments, and taking the Draft of International Code of Conduct on Technology Transfer(1985) as a reference , we propose the following preliminary framework and content of the ITT agreement:

(i) Preface. It mainly includes the base of reaching this agreement, parties' consensus, motivations and backgrounds of ITT agreement.

(ii) General rules and basic principles. It mainly includes the nature of this agreement, the fundamental concepts (i.e. technology, technology transfer, etc.), relations with other international treaties, purposes of this agreement, intellectual property right protection and general principles(i.e. respecting sovereignty, national treatment, most-favored treatment, equality and mutual benefit and cooperation, etc).

(iii) Content and scope of parties' obligations(including restrictive clauses and compulsory licensing terms). In this part, Article 31 and 40 of TRIPS Agreement in the field of TT may be refined and deepened, and Article 4.5 of UNFCCC, Article or clauses 2.1(a), 14 and 10(c) of Kyoto Protocol may be embodied and specified, and the contents concerning TT in Bali Road Map, the Copenhagen Accord and Cancun Agreement will be adopted and legalized.

(iv) Implementation of this agreement by domestic law. In this part, the following point shall be focused: the governments of technology suppliers and receivers shall encourage private actors to transfer technology through their domestic legislations, for example, to offer privileges on tax, financing and import and export of relevant products concerning ESTs to create facilitating conditions.

(v) Favorable treatments to the developing countries. According to the common but differential responsibility, the articles in the other international treaties concerning environmental protection in the field of TT shall be refined, and Article 66.2 of TRIPS Agreement shall be extended to all developing countries and Article 67 of TRIPS Agreement shall be refined and clarified to make it more workable.

(vi) International cooperation. This part mainly regulates the cooperation between the governments, inter-governmental organizations, NGOs and specific private sector(i.e. multinational corporations) in the fields of TT; since climate change and environmental protection is related to the human's welfare and the specific entity is incapable of working independently within its own scope, the cooperation between different entities can deal with the problem more effectively.

(vii) dispute settlement mechanism, which can refer to the mechanism and DSB under WTO.

(viii) International standing body. Considering from the effort and working experience of WGTTT under WTO and EGTT under UNFCCC, the two groups can be integrated and a "Council of Technology Transfer" under WTO may be established to report the work of TT to the General Council; the position and functions of this council could be similar to other councils of WTO(such Councils of GATT, GATS and TRIPS).

(IX) Others. Amendment and ratification procedures of the agreement and reviewing procedures of the implementation by parties.

4.2.4.2. Barriers to Conclude the Supposed ITT Agreement and their Possible Resolution

The first major barrier to conclude such an agreement is the conflict between the maximum of private interest and the human public interests. Because of the decentralized nature of the international community anarchy and the countries existing as units of interest, the sense of rational economic man by Adam Smith[94]has been extended in the international community formed with entities of countries, and most countries pursue their own maximum of interest[95]but ignore the human common interest. The democratic system set up by the present structure in some western countries[96] has overprotected the private interest, in which their governments or organizations may become representatives of certain interest groups, such that it is nearly impossible for them to place the human common right prior to their private interest. According to the existing reality, TT basically

requires developed countries to contribute more for the human common interest, or in other words, asks multinational corporations to make concessions in gaining profits to some extent to improve technological level of developing countries and promote sustainable development. But it is very hard to achieve this under the present system.

On this issue, Stephen Hawking's comments in his interview with the famous video sharing website for the intellectual, BigThink, may provide a starting point. Hawking said that the earth would be destroyed in 200 years and there is only one way for human to go, that is, to emigrate to other planets. The reason was that human has stepped into a more and more dangerous period, and experienced a lot of events concerning life and death. Because of human's selfishness and greed inherent in his genetic code, the resources were exhausted little by little for the human's rapaciousness.[97] Although the authors don't agree with him completely, they recognize the rational part of his reasoning. If humankind cannot find positive countermeasures to control climate change and solve the problems on the resources shortage caused by abuse of water and non-renewable resources, and let human's selfishness and greed slide and spread thereby accelerating unbalanced development in the world, the destruction of all humankind will approach nearer and nearer.

Therefore, in the opinion of the authors, in short term, it's impossible to change fundamentally the phenomenon in most western countries where private rights are overprotected. Further systemic study is needed to find a fundamental resolution to this challenge in the long run. Presently, a relatively feasible way is to enhance the communication and exchange between countries through the daily activities of intergovernmental organizations and NGOs, and in this way build consensus through analyzing and summarizing the losses suffered from increasingly frequent extreme climate accidents, including earthquakes, tsunamis and hurricanes[98]. For the sake of humanity's long term interests, politicians and the entrepreneurs must realize that it is of vital significance to reach a technology transfer agreement to promote the transfer and share of technology, especially that of ESTs, and to help developing countries form their technological capability to realize sustainable development[99]to prevent them from over-exploiting their natural resources in case of losing the basis for human life. Though enterprises may have to give away part of their interests shortly, they can help to save the whole human race, and finally, in a long-range perspective, they save themselves. If doing so, we will move positively towards avoiding the further deterioration of global environment.

5. Conclusion

The GHG emission keeps on increasing and human beings have been in a much greater danger on this globe. In 2021, the global CO₂ emissions from fuel combustion rebounded by nearly 6%, returning close to the levels preceding the Covid-19 pandemic, and fossil fuels continued to represent 80% of the total energy supply globally, with oil comprising nearly 30%, followed by coal (27%) and natural gas (24%). Global emissions from fuel combustion were dominated by coal (44%), followed by oil (32%) and natural gas (22%), that is, almost 98% emissions from the utilization of fossil fuels. China and the United States together were responsible for 45% of the global fuel combustion emissions, followed by European Union, India, the Russian Federation and Japan. [100]Explore the evolution of GHG emissions from fuel combustion across a range of countries in 2018, among 7 top emitters, China, India, Russia and Brazil emitted about 40.3%; if they could get ESTs from developed countries by technology transfer, the emissions should be reduced on great scale.

Greenhouse Gas Emissions By Top Emitters, 2018 [101]

In China and India, the growth in GHG emission keeps on rising faster (5.4% and 3.5%), [102] and most of the emissions were caused by using fossil fuels in the fields of manufacturing industries, electricity and heat production, and construction; if they could get ESTs, the growth rate may decrease. For instance, in China, if the relevant enterprises had been successful in gaining ESTs in the industries of manufacturing cars and Electricity and heat production, the most part of GHG emissions would have been reduced. In the past 40 years, when the enterprises in Mainland China tried to establish joint ventures with the foreign automobile corporations, the latter were only willing to

transfer the technologies lagged behind about 5-10 years compared to their advanced technologies. This obviously not only produces adverse impacts on the GHG emissions in manufacturing but also brings very bad result of the emissions in transportation (more and more families in China now have their own cars while these cars are not produced by the cutting-edge technologies). In other industries, such as coal-fired power plant, when the enterprises in China tried to import advanced technologies - Integrated Gasification Combined Cycle (IGCC) from General Electric Company in 1990s, they failed because of different reasons (among which the most distinguished one is that so called "national securities of the U. S" and others). The statistics shows that the emissions from the industries of transportation and electricity and heat production have increased very fast and taken up the dominant part of the emissions in China. We can imagine that if China had utilized ESTs transferred from developed countries, what the result would have been today.[103]

Global climate change and GHG emissions are significant current topics of debate, and EST transfer is one of the focuses for tackling the problem on controlling climate change and mitigating GHG emission. Almost all the countries are launching various cooperation schemes and have signed a number of international treaties to contain climate change. But technology-related IPRs have been identified as private rights and over 90% of key technologies are owned by the multinational corporations in developed countries which emphasize the protection of private rights, while most environmental protection treaties concern the rights and obligations of governments, so conflicts between the government's international commitments and the protection of the private persons who hold technologies have frequently occurred. In the countries where governments are comprised of the representatives of private interest groups, the government commitment - made under the pressure from the international community - usually cannot be admitted and implemented by the multinational corporations and private sectors pursuing maximum private interests. This is the root reason why few successful cases of ESTs transfer could be found for a long time in the world. A universal international treaty that coordinates private interest and government promise may be an effective solution to this problem, which links ESTs transfer with international trade through the private interests of the trade to make international obligations performed. The relatively successful practice of the international treaties and agreements under WTO has offered good reference to making the ITT agreement. Therefore, in the authors' opinion, reaching an ITT agreement in the Doha Round on the base of the existing international treaties and legislation is a feasible goal, and this will be significant progress in combating the dilemma of global warming and in reaching the expected goal of GHG emission. It may be one of the distinguished human natures to attach more importance to short term interest between long-term interests and short-term interests. If the globe was not suitable for human to live, how would any man or any group of the men survive? So in a long run, those who hold the rights of ESTs to transfer ESTs to developing countries on fair and reasonable terms are also beneficiaries from their own conducts. It is time for all states to cooperate to fight against the climate change which is threatening our lives, and sharing ESTs and related knowledge may be first step for cooperation. This sharing may be fulfilled by a certain ITT legal regime, that is, International Technology Transfer Agreement under the framework of WTO, reached by the negotiations among the members of the world.

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1. For the definition of 'technology', see WIPO, Licensing Guide for Developing Countries, WIPO Publication, No. 62, 1977. p.28. Generally, "technology" in international technology transfer refers to EST.
2. For the definition of TT, see *Transfer of Technology and Knowledge Sharing for Development: science, technology and innovation issues for developing countries*, UNCATD Current Studies of Science and Technology and Innovation, No.8, 2014, p.1
3. Such as Stockholm Declaration 1972, Rio de Janeiro Declaration 1992, Agenda 21, etc.
4. "Treaties" in this paper includes agreements and other legally binding international instruments, and it may be replaced by agreements.
5. Such as UNFCCC and Kyoto Protocol.
6. In WTO framework, there are some provisions concerning TT in TRIPS Agreement ,TRIMS Agreement and others.
7. Treaties administrated by WIPO provide the prerequisite for TT primarily by provisions on ascertaining ownership of and protection for intellectual property right; treaties of environmental protection under the UN system directly specify the contracting states' obligations of TT, but they lack mandatory enforcement mechanism and effective means of sanction; the agreements under WTO mainly relate to trade-related TT, including provisions on banning abuse of rights and restrictive clauses. See Ma Zhongfa: *Theoretical Studies and Practical Research on the Legal System of International Technology Transfer*, Law Press China, 2007, pp. 97-131.
8. UNCTAD, Compendium of International Arrangements on Transfer of Technology , UNCTAD/ITE/Misc.5 ,2001
9. Up to June 17th, 2016, there are 197 Parties (196 States and European Union) to UNFCCC. See Status of Ratification of the Convention, http://unfccc.int/essential_background/convention/status_of_ratification/items/2631.php.
10. That is Kyoto Protocol to UNFCCC. The provisions and measures about TT on combating climate change seems the most operable and realistic among the METs, and more influential and legally binding than UNFCCC. See *The Convention and the Protocol* , UNFCCC ,http://unfccc.int/essential_background/items/2877.php,

11. The meeting has more than 40,000 participants, 192 countries attended, among them are more than 110 heads of state or government, which set a record of international conference.
12. 3 articles concern ESTs transfer. For details, see Articles 8,10,11 of *Copenhagen Accord (2009)*..
13. It's not a legally binding agreement but just a consensus. See the Outcome of the Work of AWG-LCA of COP16.
14. It entered into force on November 4th, 2016.
15. Zhang mengheng, Song xiaozhi,etc,(2001). *Exploration on the barrier of technology transfer in international environmental conventions*, *Journal of Natural Resources*,3.
16. ICTSD,(2008): Climate Change, Technology Transfer and Intellectual Property Rights; at http://www.iisd.org/pdf/2008/cph_trade_climate_tech_transfer_ipr.pdf.
17. For details see Report of the United Nations Conference on the Human Environment, at <http://www.unep.org/Documents.Multilingual/Default.asp?documentid=97>
18. The Rio Earth Summit broadened the scope of global environmental diplomacy by adopting the notion of sustainable development. See UN Conference on Environment and Development, Rio, http://www.unostamps.nl/subject_united_nations_conference_environment_development.htm
19. It's an historic opportunity to define pathways to a safer, more equitable, cleaner, greener and more prosperous world for all. See About 20+, at: <http://www.uncsd2012.org/about.html>.
20. Principle 20 of Stockholm Declaration 1972.
21. Principle 7 of Rio Declaration on Environment and Development.
22. For detailed contents, please see Section IV Means of Implementation of Agenda 21.
23. See para. 18 of Johannesburg Declaration on Sustainable Development, A/CONF.199/20, September 2002.
24. For details, see "The Future We Want", A/RES/66/288, 11 September 2012.
25. It was signed in December 1994 and entered into force in April 1998. See "About the Charter", <http://www.encharter.org/index.php?id=7>.
26. See Article 8 "Transfer of Technology" of *The Energy Charter Treaty 1994*.
27. It entered into force on 22 September 1988. See Treaties and Decisions at <http://ozone.unep.org/en/treaties.php>.
28. It entered into force on 1 January 1989. See Treaties and Decisions at <http://ozone.unep.org/en/treaties.php>.
29. Article 4 paragraph of *Vienna Convention for the Protection of the Ozone Layer 1985*.
30. Article 10 and Article 10A of The Montreal Protocol on Substances that Deplete the Ozone Layer (2000).
31. It entered into force on 29 December 1993, See Introduction, at <https://www.cbd.int/intro/default.shtml>.
32. Articles 16 of *Convention on Biological Diversity 1992*, <http://www.cbd.int/doc/legal/cbd-en.pdf>
33. Articles 20 and 21 of *Convention on Biological Diversity 1992*, <http://www.cbd.int/doc/legal/cbd-en.pdf>
34. Article 2 of *United Nations Framework Convention on Climate Change*, <http://unfccc.de/resource/>.
35. See Article 4, paragraph 5 of UNFCCC.
36. 37 countries and European Community were included in Annex B when Kyoto Protocol was adopted, and among them, 12 countries were undergoing the process of transition to a market economy.
37. See Article 2 of *Kyoto Protocol* at <http://unfccc.de/resource/>.
38. See Article 3, paragraph 14 of *Kyoto Protocol* at <http://unfccc.de/resource/>.
39. See Article 10 (C) of *Kyoto Protocol* at <http://unfccc.de/resource/>
40. They're Technology Needs Assessment, Technology Information, Enabling Environments, Capacity Building and Mechanisms for TT.
41. The Group was established according to the Decision 4/CP.7 which was made at the 7th Session of UNFCCC. See *Report of the Conference of the Parties on Its 7th Session in 2001*, FCCC/CP/2001/13/Add.1. EGTT didn't work as well as was initially expected..
42. See *Bali Action Plan*, Decision 1/CP.13 in Report of the Conference of the Parties on its thirteenth session, held in Bali from 3 to 15 December 2007, FCCC/CP/2007/6/Add.1, 14 March 2008
43. REDD plus refers to "Reducing emissions from deforestation and forest degradation, conservation of existing carbon stocks and enhancement of carbon stocks", <http://www.bioenergywiki.net/REDD>.
44. See Articles 8,10,11 of *Copenhagen Accord*, <http://www.thedailystar.net/newDesign/news-details.php?nid=118437>.
45. Para.1 of Outcome of the work of the Ad Hoc Working Group on long-term Cooperative Action under the Convention.
46. Para.124 of Outcome of the Work of AWG-LCA (2012).

47. Para.117 of Outcome of the Work of AWG-LCA (2012).
48. Para.121 of Outcome of the Work of AWG-LCA (2012).
49. Para.123 of Outcome of the Work of AWG-LCA (2012).
50. Lima Call for Climate Action, Decision -/CP.20 (2014).
51. See Annex of Lima Call for Climate Action, Decision -/CP.20 (2014).
52. See Articles 6, 10, 11 and 13 of Paris Agreement (2015)
53. See Articles 7, 15, 40, 60,63 and 85 of Glasgow Climate Pact (2021)
54. Itaru Nitta, Proposal for a Green Patent System: Implications for Sustainable Development and Climate Change, V, Sustainable Development Law & Policy, 2005, p. 62
55. Article 18 of *Kyoto Protocol*.
56. The SBI is the other permanent subsidiary bodies to UNFCCC established by the COP/CMP which supports the work of the COP and the CMP through the assessment and review of the effective implementation of UNFCCC and its Kyoto Protocol. See Subsidiary Body for Implementation (SBI), <http://unfccc.int/bodies/body/6406.php>.
57. Laura B.Campbell, Emission Trading, Joint Implementation and Clean Development Mechanism: The Role of Private Sectors and other State Actors in Implementation, 1998, <http://www.geic.or.jp/climgov/02.pdf>.
58. Stephen Seres, *Analysis of Technology Transfer in CDM Projects*, <http://cdm.unfccc.int/Reference/Reports/TTreport/TTrep08.pdf>, 2008, pp.4-7
59. Shi Xueying (2000), *New Analysis on the Legal System of International Technology Transfer*, Tianjin People's Publishing House, p244-248.
60. Zhang mengheng, Song xiaozhi, etc,(2001). *Exploration on the barrier of technology transfer in international environmental conventions*, *Journal of Natural Resources*,3.
61. There are several funds, such as the Global Environment Fund, the UNFCCC LDC fund, the UNFCCC Special Climate Change Fund and the Kyoto Protocol Adaptation Fund which may do much to combat climate change, and promoting ESTs transfer is a part of their functions. See About GEF at <http://www.globalenvironmentfund.com/>.
62. On most occasions, "private sectors" or "private entities" are mentioned in aspects of finance issues or trades of greenhouse gases.
63. Xu Xiangmin, etc., *The basic principles of international environmental law*, China Environmental Science Press, 2008, p310.
64. Boer,Yvo de,(2010). *Technologies & Targets on the Road to Mexico*, http://unfccc.int/files/press/news_room/statements/application/pdf/100602_speech_climate_group.pdf.
65. See paras 7, 116, 119,121,123 and Annex IV of *Outcome of the work of AWG-LCA*.
66. Some scholars have been carrying out valuable exploration on the status and function of private sectors in creating and implementing international law from the perspective of participation of private sector in the multilateral trade system. See Cai Congyan: *Private Structural Participation in the Multilateral Trade System*, Peking University Press, 2007.
67. In 2019, due to the lack of cooperation from the US government, the Appellate Body of WTO stopped working. On March 27, 2020, 16 members of WTO, including China and the European Union, jointly issued a ministerial statement agreeing to establish a Multi-Party Interim Appeal Arbitration Arrangement (MPIA) as a temporary mechanism for resolving trade disputes, in response to the suspension of the WTO dispute resolution mechanism's appellate body. But this is a temporary setback, and we firmly believe that the normal operation of the appellate body will resume in the very near future.
68. Cai,Shouqiu; Chang,Jiwen (2004).*International Environment Law*, Law Press China ,p. 304.
69. *Summary by the Secretary-General (22 September 2009)* , http://www.un.org/wcm/webdav/site/climatechange/shared/Documents/Chair_summary_Final_E.pdf.
70. Chronological List of Disputes Cases, at http://www.wto.org/english/tratop_e/dispu_e/dispu_status_e.htm
71. Article 8 "Objectives" of TRIPS Agreement.
72. Article 8 "Principles" of TRIPS Agreement.
73. Birnie, Patricia and Boyle, Alan (2002).*International Law & the Environment (2nd edition)*, pp732-734,ISBN:0-19-876553-3,Oxford University Press.
74. For details, see Ma Zhongfa (2009): *Reconsideration of the Objectives of Establishing Intellectual Property Legal System, and the Essence of a Patent and the Missions of its Institution*, *Intellectual Property Right*, 6.

75. For detailed contents, see Zhang Naigen (2006), On Exceptional Articles and Terms of TRIP, Zhejiang Social Sciences, 3.
76. The Preface expressively states that intellectual property right is a private right; Articles 7 and 8 provide respectively the objective and the principles; Articles 31, 40, 66.2 and 67 provides respectively “other use without authorization of the right holder”, “control of anti-competitive practices in contractual license”, “technology transfer to the least developed countries” and “technical cooperation”. See Articles 7, 8,31,40,66.2 & 67 of *TRIPS Agreement*.
77. A study by UNCTAD shows that the most common measures included support for training, foreign investment, matching services, venture capital support, financing of technology transfer and encouraging partnerships with local firms. See *Note on the Meeting of 10 November 2004*, WT/WGTTT/M/10,17 February, 2005
78. See *Implementation of Paragraph 6 of the Declaration on the TRIPS agreement and public health* WT/L/540, 1 Sept. 2003; *Amendment of the TRIPS Agreement*, WT/L/641, December 6th, 2005.
79. WGTTT (Working Group on Trade and Transfer of Technology),(2002).*Annex II of Note on the Meeting of 11 June, 2002*, , WT/WGTTT/M/2.
80. See *Doha Ministerial Declaration*, WT/MIN (01)/DEC/1.
81. *Working Group on Trade and Transfer of Technology*, http://www.wto.org/english/tratop_e/devel_e/dev_wkgrp_trade_transfer_technology_e.htm.
82. See Reports (2002-2022) of WGTTT to the General Council, http://www.wto.org/english/tratop_e/devel_e/dev_wkgrp_trade_transfer_technology_e.htm.
83. See Report (2015)of the Working Group on Trade and Transfer of Technology to the General Council, WT/WGTTT/17, 2 November 2015.
84. See Report (2022)of the Working Group on Trade and Transfer of Technology to the General Council, WT/WGTTT/24, 7 December 2022.
85. See Report (2016)of the Working Group on Trade and Transfer of Technology to the General Council, WT/WGTTT/18, 23 November 2015.
86. COP, (2002). *Report of the Conference of the Parties on Its 7th Session Held at Marrakesh from 29 October to 10 November 2001*, FCCC/CP/2001/13/Add.1.
87. see UNFCCC,Expert Group on Technology Transfer: Fve Years of Work, http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/egtt_en_070523.pdf.
88. See *Documents of the Expert Group on Technology Transfer*, <http://unfccc.int/ttclear/jsp/EGTTDoc.jsp>. See Paras 124, 113,115 & 117 of *Outcome of the work of AWG-LCA* , Decision 1/CP.16 , FCCC/CP/2010/7/Add.1
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93. The establishment of DSB is one of the reasons why TRIPS Agreement was created. See Daniel Gervais, *The TRIPS Agreement: Drafting History and Analysis*, Sweet & Maxwell Limited, 1998,pp.9-10.
94. Adam Smith, *The Wealth of Nations*, Books I-III. New York: Penguin Classics, 1986, pp110-119.
95. Hans J. Morgenthau, etc., *Politics Among Nations* (6th Edition) ,Knopf Doubleday Publishing Group, 1985, pp.4-17.
96. However, not all western countries have done in this way. For instance, most Scandinavian countries have been leading forces in climate change, and what follows in this paragraph is not applicable to them.
97. See “Stephen Hawking’s Warning: Abandon Earth—Or Face Extinction”, <http://bigthink.com/ideas/21570>.
98. Over 300 thousand people died in the Indian Ocean tsunami in December, 2004 and about 300 thousand people died in Haity’s 7.3 earthquake in 2011. These tragedies alarm us that there’s no reason for human to ignore the necessity and urgency of cooperation to combat climate change. Cooperation is a significant way to decrease disasters and the loss, among which cooperation of TT is of upmost importance.
99. M.Blakeney, *Legal Aspects of the Transfer of Technology to Developing Countries*, Oxford: ESC,1989, pp.60-66,73.

100. See Greenhouse Gas Emissions from Energy Data Explorer, <https://www.iea.org/data-and-statistics/data-tools/greenhouse-gas-emissions-from-energy-data-explorer>.
101. See Global Emissions, at <https://www.c2es.org/content/international-emissions/>
102. See CO₂ Emissions From Fuel Combustion Highlights 2015, <https://www.iea.org/publications/freepublications/publication/CO2EmissionsFromFuelCombustionHighlights2015.pdf>
103. It's known that China has exerted her efforts to reduce GHG emissions all the time; in the past 10 years, she has brought down energy consumption and CO₂ emission per unit of GDP by about 32%. See "Each District Eleven Five Energy Saving Target Completion Schedule", and "The 12th Five Year Plan" for Energy Development, the State Council No.2 (2013).

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