ARTICLES

IPR Management in International Cleantech Cooperation

JOY Y. XIANG*

ABSTRACT

Rapid development and global deployment of clean technologies, also known as "cleantech," is important for climate action and sustainable development. Meanwhile, developed countries own a majority of the existing cleantech; developing countries need to access and implement cleantech to address climate change and to develop their economies in a sustainable way. Since the 1970's, the global community has focused on developed countries' voluntary transfer of cleantech to developing countries. However, this focus has not been effective.

Aiming to enhance global development and deployment of cleantech, this Article explores an alternative–mutually beneficial international cleantech cooperation–which means organizations or countries working together to develop and deploy cleantech on mutually agreeable terms. This Article argues that to be successful and sustainable, the cooperation between a cleantech owner and a cleantech seeker needs to be a win-win arrangement, with just compensation and proper treatment of intellectual property rights ("IPR"). This Article proposes that, besides attempting to reform existing IPR regimes for cleantech, which can be time-consuming, we should take the existing IPR regimes as they are and manage IPR for cleantech creatively or collaboratively. This Article examines available IPR management models in international cleantech cooperation. This Article is the first to specify ways to optimize the WIPO Green program by transforming it into a global platform for mutually beneficial international cleantech deployment.

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* Assistant Professor of Law, Peking University School of Transnational Law (PKU-STL). The author thanks the input from all participants of the 2018 Junior IP Scholars Workshop at Northwestern University, the participants of the 2018 IP Scholars Conference at University of California, Berkeley, and my colleagues at PKU-STL, especially input from Professors Francis Snyder, Philip McConnaughay, Mark Feldman, Stephen Minas, Yi-Seul Kim, Joshua Sarnoff, Jorge Contreras, Phillip Boxell, Robert Merges, and Mark Cohen. Thanks also to the able research assistance from Charlie Xu and Corrine Ni, and the editorial input from the Georgetown Environmental Law Review.

TABLE OF CONTENTS

INTRODUCTION

"The global nature of climate change calls for the widest possible cooperation by all countries."[1]

Climate change is a challenge, and the global community has set up ambitious goals for addressing it. In December 2015, 195 member countries of the United Nations Framework Convention for Climate Change ("UNFCCC")[2] gathered in Paris and negotiated the Paris Agreement, the latest milestone of the global community's efforts in addressing climate change.[3] The Paris Agreement commits the global community to limiting the average global temperature increase to less than a 2°C above pre-industrial levels[4] by the year 2100 while asking the global community to limit the temperature increase to 1.5°C above pre-industrial levels.[5] The global community has regarded this commitment as a key accomplishment of the Paris Agreement.[6] Without such a commitment, letting things go as they are, the annual average global temperature could rise 5°C or more above pre-industrial levels by the year 2100.[7]

To achieve the 1.5°C target, clean technologies[8] play a key role. Clean technologies, i.e., cleantech, can be diverse, including a wide range of technological

1. United Nations Framework Convention for Climate Change, para. 6 (June 4, 1992) https://perma.cc/HH6H-HH46 [hereinafter "UNFCCC"].

2. The UNFCCC is the main international treaty designed for addressing climate change. The goal of the UNFCCC is to stabilize "greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." The UNFCCC has become the main framework under which global negotiations on addressing climate change occur. *See* Background on the UNFCCC: The International Response to Climate Change, U.N. FRAMEWORK CONVENTION ON CLIMATE CHANGE, https://perma.cc/N2LX-P2MG.

3. *Paris Agreement*, United Nations Framework Convention on Climate Change, Apr. 22, 2016, https://perma.cc/K2DR-YHSL [hereinafter "Paris Agreement"].

4. This means to above the global average temperature prior to the advent of the Industry Revolution that occurred from 1750 to 1850.

5. Paris Agreement, *supra* note 3, art. 2.1.(a).

6. *See. e.g.*, PATRICIA FERRERIA, THE PARIS AGREEMENT ON CLIMATE CHANGE: ANALYSIS AND COMMENTARY 666 (Klain et al. eds., Oxford University, 2017); Henrik Selin & Adil Najam, *Paris Agreement on Climate Change, the good, the bad, and the ugly*, THE CONVERSATION (Dec. 14, 2015), https://perma.cc/4YGQ-F3VU.

7. Jen Christensen & Michael Nedelman, *Climate Change Will Shrink U.S. Economy and Kill Thousands, Government Report Warns*, CNN (Nov. 26, 2018), https://perma.cc/WJ6D-MCKB.

8. This Article uses the terms cleantech and "clean technology" interchangeably; they are equivalent to or encompass terms such as "green technology," "climate change technology," "climate technology," "environmentally friendly technology," or "environmentally sound technology."

sectors and markets.[9] For this Article, clean technology or cleantech includes "any equipment, technique, practical knowledge or skill to reduce greenhouse gas ('GHG') emissions or adapt to climate change;"[10] in other words, any technology that is capable of mitigating or adapting to climate change.[11] Exemplary climate-change mitigation technologies include renewable energy technologies that utilize renewable energy sources—for example, solar, wind, biomass, geothermal, and hydro energy—to produce electricity, clean coal technologies that reduce GHG emissions from fossil fuel burning, and technologies to improve energy efficiency.[12] Exemplary climate change adaptation technologies include technologies to produce seeds that can survive flooding caused by rising sea levels, irrigation technologies for resisting droughts, and early-warning or defense systems for extreme weather, or technologies that address climate change-induced water stress or to adapt fisheries and aquaculture.[13] Cleantech also includes information technologies that are indispensable for managing environmental resources and cleantech operations such as smart electricity grids.

In its 2018 report on climate change, the Intergovernmental Panel on Climate Change ("IPCC")[14] called for radical efforts by the global community, especially concerning cleantech.[15] This means, for example, renewable energies need to increase their share of electricity generation from today's 25% to at least 75% and internal-combustion engines, which power 499 out of 500 cars on the road today, will all need to be replaced by clean alternatives.[16]

Aside from the IPCC, other key players in the global community aside from the IPCC have also emphasized the importance of clean technology development

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9. Joanna I. Lewis, *Managing Intellectual Property Rights in Cross-Border Clean Energy Collaboration: the Case of the U.S.-China Clean Energy Research Center*, 69 ENERGY POL'Y 546, 547 (2014) https://perma.cc/FVX3-DPBD.

10. UNCFCC, ENHANCING FINANCING FOR THE RESEARCH, DEVELOPMENT AND DEMONSTRATION OF CLIMATE TECHNOLOGY 6 (2017), https://perma.cc/SB2E-64RW.

11. The UNFCCC defines mitigation as "a human intervention to reduce the sources or enhance the sinks of greenhouse gases," and adaptation as "an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities." *Glossary of Climate Change Acronyms*, UNFCCC (Dec. 10, 2018) https://perma.cc/7VZN-Q4RR.

12. TARIQ BANURI ET AL., WORKING GROUP III OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2001: MITIGATION 26 (2001), https://perma.cc/B5MF-VUDK.

13. UNFCCC, TECHNOLOGIES FOR ADAPTATION TO CLIMATE CHANGE, 9, 25 (Peter Stalker ed. 2006), https://perma.cc/6Z4G-Q756.

14. Intergovernmental Panel on Climate Change [hereinafter "IPCC"], jointly established by United Nations Environmental Programme and World Meteorological Organization in 1988, is the most authoritative agency in providing objective and scientific view of climate change and its political and societal impact. *See* IPCC, *About the IPCC* (last visited Dec. 9, 2018), https://perma.cc/A7J4-EKXT.

15. IPCC, GLOBAL WARMING OF 1.5°C - HEADLINE STATEMENTS D5. (Oct. 6, 2018), https://perma.cc/38JG-SS3Z.

16. *Why the IPCC Report on Global Warming Matters*, ECONOMIST (Oct. 13, 2018), https://perma.cc/557N-C9XQ.

and deployment in addressing climate change.[17] For example, the UNFCCC explicitly recognizes clean technologies as an important route for addressing climate change.[18] The United Nations General Assembly has also adopted resolutions recognizing the fundamental role played by innovative clean technologies in addressing climate change.[19]

However, due especially to differences in countries' economic development levels, a significant asymmetry exists in the worldwide distribution of existing clean technologies. According to data[20] on global patent filings for cleantech, developed countries[21] own a majority of the patents on existing key clean technologies. Meanwhile, it is essential for developing countries[22] to utilize clean technologies fully to achieve sustainable development and mitigate or adapt to climate change.

Therefore, developed and developing countries need to cooperate in leveraging clean technologies to address climate change. This Article uses the expression

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17. Catherine Saez, *Human survival depends on shared technology, says new UN climate chief*, INTELL. PROP. WATCH (Mar. 9, 2010), https://perma.cc/9KF5-P45D. ("[S]urvival depends on improvement of technology."). Ahmed Abdel-Latif et al., OVERCOMING THE IMPASSE ON INTELLECTUAL PROPERTY AND CLIMATE CHANGE AT THE UNFCCC: A WAY FORWARD 1 (Dec. 1, 2011), https://perma.cc/7MP6-U59D ("The rapid development and diffusion of these technologies is a key component of the global response to climate change.").

18. UNFCCC, *supra* note 1, at para. 22.

19. *See, eg*., UN General Assembly Resolution on Protection of global climate for present and future generations of mankind, adopted Dec. 22 1989, A/RES/44/207, available at: https://perma.cc/8Q6V-H29Y (last visited Sept. 25 2019); *Promotion of New and Renewable Sources of Energy*, UNITED NATIONS GEN. ASSEMBLY (Aug. 15, 2011), https://perma.cc/Y9Y8-UAHA.

20. THOMAS FRANKLIN & KATE GAUDRY, INDUSTRY-FOCUSED PATENT TREND STUDY 42 (Apr. 30, 2019), https://perma.cc/2ZXM-FJPH (showing that during 2011–2018, the U.S., EU, Japan and South Korea together each year took up at least 80% of cleantech patent filings in the U.S.). *See also*, COPENHAGEN ECONOMICS & THE IPR COMPANY, ARE IPR A BARRIER TO THE TRANSFER OF CLIMATE CHANGE TECHNOLOGY? (Jan. 19, 2009), https://perma.cc/X2EF-CUR3; UNEP ET AL., PATENTS AND CLEAN ENERGY, BRIDGING THE GAP BETWEEN POLICY AND EVIDENCE 4 (2010), https://perma.cc/3PCC-QP5R [hereinafter "UNEPP, EPO, and ICTSD (2010)"]; UNEP & EPO, PATENTS AND CLEAN ENERGY TECHNOLOGIES IN AFRICA 7 (2013), https://perma.cc/Y77M-XBQX; UNEP & EPO, PATENTS AND CLIMATE CHANGE MITIGATION TECHNOLOGIES IN LATIN AMERICA AND THE CARIBBEAN (2014), https://perma.cc/M4LA-FSQA [hereinafter "Various Cleantech Patent Studies"]. These three studies of climate change mitigation technology patent filings during 1980-2007 reveal that the U.S., the U.K., Germany, France, Japan and South Korea dominated such patent filings, while China has risen to take up 28% of such patent filings in 2011, while African countries took up less than 1% and Latin American countries took up less than 3%.

21. Developed countries are nations that rank highly in the United Nations developed indicators such as GDP, industrialization, life expectancy, and education level. The U.S., Canada, and the U.K. are typical examples. International groups, like the WTO, do not have an official definition. This Article regards high-income countries in the United Nations' 2014 countries classification as developed countries. *See* UNITED NATIONS, WORLD ECONOMIC SITUATION AND PROSPECTS 2014 145 (2019), https://perma.cc/5WXG-LHKX.

22. In this Article, developing countries are countries other than developed countries. They are the upper middle-income countries (e.g., China, Mexico, Thailand, South Africa), lower middle-income countries (e.g., Egypt, India, Morocco), and low-income countries (e.g., Bangladesh and Zimbabwe) in the UN classification. *See id*. at 145.

"international cleantech cooperation" to denote such cooperation. Such cooperation is critical, necessary, and may create game-changing solutions.[23] Yet, how can such cooperation proceed successfully?

The global community has been emphasizing the voluntary transfer of clean technologies from developed countries to developing countries since at least 1972.[24] Yet, such an emphasis has not been effective. Data show that most cleantech transfers have occurred among developed countries themselves; when cleantech transfers did occur between developed countries and developing countries, almost all of the transactions were between developed countries and a handful of emerging economies.[25]

In trying to find solutions for obtaining access to cleantech, some developing countries have sought to weaken or remove intellectual property rights ("IPR") for clean technologies. Developed countries, however, insist on strong IPR for clean technologies, viewing IPR as indispensable for incentivizing the development of such technologies and facilitating their deployment. Debates on these contradictory approaches to IPR for cleantech have continued but so far have not produced substantial changes.[26]

Theoretically, countries should have an incentive to cooperate in addressing climate change, as countries share the same atmosphere and the impact of GHG emissions is global. However, the benefits of cooperating to address climate change may not look significant enough at the moment to motivate entities in developed countries to transfer cleantech to developing countries voluntarily. For example, climate change's negative impacts are unequally distributed.[27] While the 2018 IPCC report shows that increased global average temperatures will eventually affect all countries severely, some studies have shown that the impact of climate change will be worst in Africa and South Asia, while Europe and North America will experience less impact.[28] Furthermore, the worst effects of

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23. CHRIS SWORDER ET AL., UNITED NATIONS INDUSTRY DEVELOPMENT ORGANIZATION, THE GLOBAL CLEANTECH INNOVATION INDEX 2017 10 (2017), https://perma.cc/99Q4-5ZRK.

24. *See* UNITED NATIONS, THE DECLARATION OF THE UNITED NATIONS CONFERENCE ON THE HUMAN ENVIRONMENT, Principle 20 (1972), https://perma.cc/6PTN-3MBD; UNITED NATIONS, THE 1992 RIO DECLARATION ON ENVIRONMENT AND DEVELOPMENT, Principles 7, 9, 14 (1992), https://perma.cc/T32L-64KF; the UNFCCC, *supra* note 1, art. 4.5.

25. Antoine Dechezleprêtre et al., *Invention and Transfer of Climate Change-Mitigation Technologies: A Global Analysis*, 5(1) REV. ENVTL. ECON. & POL'Y 109, 109–10, 121–122 (2011), *available at* https://perma.cc/Y54G-ZA7W (examining the cleantech flows among developed and developing countries during year 2000–2005). The emerging economies are the advancing economies among developing countries; they typically include China, India, Brazil, and South Africa.

26. According to participants of recent UNFCCC global negotiations, discussions regarding treatments of IPR re cleantech have stalled negotiations and eventually were pulled off the negotiation items in order for the negotiations to proceed.

27. Peter Drahos, *The IP regime: are there lessons for climate change negotiations?*, *in* RESEARCH HANDBOOK ON INTELLECTUAL PROPERTY AND CLIMATE CHANGE 92, 93 (Joshua D. Sarnoff ed., 2016).

28. *Id.*

climate change have not yet arrived.[29] The 2018 IPCC report indicates that the worst effects of climate change are likely to be felt only in the mid or second half of the 21st century.[30] Consequently, the current perception of climate change's negative impact has not prompted entities in developed countries to transfer cleantech voluntarily en masse merely based on a sense of urgency, goodwill, or moral obligation.

With this reality, how do we promote effective international cleantech cooperation to transfer cleantech from developed countries to developing countries? This Article suggests that one plausible solution at this stage is for the cooperation to provide timely and visible benefits to entities—cleantech owners such as public research institutions and businesses—from developed countries. Such benefits include just compensation and proper treatment of IPRs associated with the cleantech involved. Currently, entities in developed countries—especially those in the private sector—own the majority of the patents in cleantech; yet, the data also show that the emerging economies among developing countries are rapidly increasing their share of cleantech patents.[31] As developing countries move up the development ladder, they will find the need to provide IP protection for their own intellectual assets. Observing the rights of intellectual asset owners will not only help developing countries attract foreign investment and foreign cleantech now, but will also help developing countries build their domestic cleantech IP portfolios in the future.[32] It is therefore necessary to manage IPR issues properly in international cleantech cooperation.

In the following discussion, this Article first reviews the current legal framework and the existing major efforts concerning international cleantech cooperation (Part I). This Article next analyzes the advantages and disadvantages of available IPR management models for international cleantech cooperation (Part II). This Article then proposes how we should proceed with international cleantech cooperation and the associated IPR management (Part III).

Ultimately, this Article proposes that, at the stage where entities in developed countries are yet to perceive the threat of climate change as imminent, international cleantech cooperation needs to be mutually beneficial to engage cleantech owners from developed countries. This Article also proposes that while efforts to reform IPR regimes for cleantech may continue, we should also take the existing IPR regimes as they are and manage IPR issues concerning cleantech creatively

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29. *Id*.

30. IPCC, *Global Warming of 1.5℃ - Headline Statements* 1 (Oct. 6, 2018), https://perma.cc/MVD8-C36B.

31. Various Cleantech Patent Studies, *supra* note 20, at 60.

32. However, implementing international-standard IP regimes in some developing countries will limit their abilities to copy and imitate advanced technologies, hence may slow down development of some domestic industries at least in the short term. Therefore, the author has suggested that developing countries need to provide adequate IPR protection; but their IPR systems need also to consider the local realities. *See* Joy Y. Xiang, *Addressing Climate Change: Domestic Innovation, International Aid and Collaboration*, 5:1 N.Y.U. J. OF INTELL. PROP. & ENT. LAW 196, 199–200 (2016).

and collaboratively. Specifically, this Article proposes we optimize the existing WIPO Green program[33] by transforming it into a global platform that supports mutually beneficial international cleantech deployment. This Article is the first to suggest concrete features for expanding and enhancing the WIPO Green program as a global platform for mutually beneficial international cleantech deployment. This Article also suggests using a concrete IP management framework for managing IPR issues arising during international collaboration for cleantech development, such as the one developed by the United States and China in their collaboration for developing clean energy technologies. Overall, this Article provides a comprehensive review of current major international cleantech cooperation efforts and an analysis of different IPR management models for international cleantech cooperation.

I. THE NEED FOR MUTUALLY-BENEFICIAL INTERNATIONAL CLEANTECH COOPERATION

The emphasis on one-way voluntary transfer of cleantech from developed countries to developing countries has produced limited results. This reality makes it necessary to explore an alternative—mutually beneficial international cooperation for cleantech development and deployment. The global community has provided this alternative in international agreements and has been exploring it at different levels, including the multilateral, regional, bilateral, and sub-national levels.

A. THE FAILURE OF ONE-WAY VOLUNTARY INTERNATIONAL CLEANTECH TRANSFER

Global spending on research and development ("R&D") has been increasing. For example, by 2017, global R&D spending reached about $1.7 trillion USD.[34] According to data provided by the United Nations ("UN"), in 2017, at least 85% of the global R&D spending occurred in developed countries.[35] Of existing key clean technologies, developed countries own at least 80% of the patents.[36] Since developed countries currently own the majority of the existing clean technologies, transfer of clean technologies from developed countries to developing countries has been a focus of the global effort to address climate change via clean technologies. Yet, such an emphaisis has producted limited results. The possible reasons for this include: (1) cleantech owners in developed countries have yet to

33. WIPO Green is a online marketplace established by the World Intellectual Property Organization for cleantech seekers and cleantech providers to connect and independently form cleantech transactons. *See WIPO Green – the MarketPlace for Sustainable Technology*, WIPO (Dec. 12, 2018) https://perma.cc/B35R-VWGS.

34. *Research and Developent Spending*, UNISECO INST. FOR STAT. (June 2019), https://perma.cc/G75U-WTM9.

35. *Id.* (The number 85% is derived from the sum of available data on R&D spending from high-income countries divided by the sum of available data on global R&D spendings in year 2017.)

36. *See* FRANKLIN & GAUDRY, *supra* note 20, at 42.

actively participate in one-way voluntary international cleantech transfers, (2) developing countries need to adapt and implement cleantech from developed countries and may lack the capacity for such adapatation and implementation, (3) cleantech in developed countries may not be suitable for the cleantech needs or development priorities in developing countries, and (4) breakthroughs in cleantech needed by developing countries are still on the way.

Multiple international agreements have mandated one-way voluntary international cleantech transfer. For example, the UNFCCC has noted that developed countries bear the largest historical and current share of global GHG emissions.[37] In contrast, developing countries still have a relatively low per capita emission rates, and their share of the global GHG emissions will grow with development needs.[38] The UNFCCC therefore requires governments of developed countries to take "all practicable steps to promote, facilitate and finance, as appropriate, the transfer of or access to environmentally sound technologies and know-how" to other nations, particularly developing countries.[39] The UNFCCC also conditions developing countries' effectiveness in addressing climate change on their effectiveness in fulfilling the above-mentioned obligation of facilitating and financing cleantech transfer or access.[40] However, such a requirement has no teeth; that is, the UNFCCC has no mechanism to enforce the requirement on developed member countries—the implementation of the requirement depends on each country's voluntary compliance.

The Agreements on Trade-Related Aspects of Intellectual Property Rights ("TRIPS Agreement"), which entered into force eight months after the UNFCCC agreement, also requires governments of developed countries to promote and encourage technology transfer to the least-developed country ("LDC") members.[41] Specifically, the TRIPS Agreement requires developed countries to "provide incentives to enterprises and institutions in their territories" so as to promote and encourage technology transfer to the LDCs to "enable them to create a sound and viable technological base."[42] In contrast to the UNFCCC's lack of an enforcement mechanism against non-compliance, the World Trade Organization ("WTO") system under which the TRIPS Agreement belongs allows a WTO member to hold another WTO member responsible for its non-compliance of a WTO requirement via the WTO dispute resolution system.[43] If the WTO dispute

37. UNFCCC, *supra* note 1, para. 3.

38. *Id*.

39. UNFCCC, *supra* note 1, art. 4.5; *see also* UNFCCC, *supra* note 1, art. 4.1, 4.3, and 4.7.

40. UNFCCC, *supra* note 1, art. 4.7.

41. Agreement on Trade-Related Aspects of Intellectual Property Rights, art. 66.2, Apr. 15, 1994, 1869 U.N.T.S. 299 [hereinafter "TRIPS Agreement"].

42. *Id*.

43. *Dispute Settlement*, WORLD TRADE ORG. (Dec. 10, 2018), https://perma.cc/USP7-X68W.

resolution system deems a WTO member in non-compliance, that member may need to change the non-complying law, pay compensation, or suffer retaliation.[44]

In reality, actual international transfer of clean technologies to developing countries has been limited. Data[45] show that international transfer of clean technologies mostly occurred between developed countries, making up 73% of the overall exported inventions. Exports of clean technology inventions from developed countries to emerging economies—such as China, Brazil, and India—are growing rapidly, making up 22% of the overall exported inventions.[46] The data also show that the flow of clean technology inventions from developing countries (including emerging economies) to developed countries took up 4% of the overall global flow of exported inventions, while the flow between developing countries took up only 1%.[47] The sum from the above figures accounts for the overall international cleantech transactions covered by the data. Therfore, the data indicates that cleantech transfer transactions from developed countries to developing countries, which are not emerging economies, are very rare.

There seem to be certain misconceptions in relying on the voluntary one-way transfer of cleantech from developed countries to developing countries. First, even though governments of developed countries agreed (for instance, in the UNFCCC) to promote the transfer of cleantech to developing countries, this does not necessarily mean that such agreements are automatically aligned with the interests of cleantech owners. Cleantech owners may include public universities and research institutions, but they mostly consist of entities in the private sector, such as multinational corporations. Data show that private sectors in developed countries invest the most in cleantech R&D, not the governments of developed countries. For example, in the United States, the private sector's investment in the cleantech R&D is nine times that of the U.S. government.[48] Data also suggest that while the G8 countries[49] provide 80% of the global R&D investment in

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44. However, WTO member countries have rarely used the WTO dispute resolution mechanism to complain that a developed member country has not fulfilled the technology transfer requirement. As of June 2019, the WTO dispute settlement mechanism has received only one complaint concerning technology transfer: the, European Union's complaint concerning China's legal measures regarding transfer of foreign technologies into China. *See DS 549, China–Certain Measures on the Transfer of Technology*, WORLD TRADE ORG. (July 3, 2019), https://perma.cc/8SAY-CD4Q.

45. Antoine Dechezleprêtre et al., *Invention and Transfer of Climate Change-Mitigation Technologies: A Global Analysis*, 5 (1) REV. OF ENVTL. ECONS. AND POL'Y 109, 122 (2011), https://perma.cc/Y54G-ZA7W (examining cleantech flows among developed and developing countries during year 2000-2005).

46. *Id.*

47. *Id.*

48. Nat'l Sci. Found., *Industry Technology and the Global Marketplace, in* SCIENCE AND ENGINEERING INDICATORS 6, 6-6 (2014), *available at* https://perma.cc/4TNP-X2L3.

49. *The Group of Eight (G8) Industrialized Nations*, COUNCIL ON FOREIGN REL. (Mar. 3, 2014), https://perma.cc/ZX77-QC3E.

cleantech, the private sector accounts for almost 70% of the investment.[50] Hence, the governments of developed countries could not easily force cleantech owners to surrender the rights over their technologies without fair and just compensation. Meanwhile, as I will discuss in Part II.A, governments of developed countries respect IPRs and have been reluctant to overrule them using means such as compulsory licensing.

Second, unlike pharmaceutical technologies that mostly do not need adaptation for local implementation, cleantech needs to be adapted to local circumstances.[51] For example, cleantech needs to be adapted to meet the climatic conditions of the area in which it is used. Cleantech developed for the electricity grids in the United States may not be useful in developing countries that do not have electricity grids or have different electricity grid infrastructures. In addition, the local implementation of cleantech also needs to meet the implementation priorities and capabilities of developing countries, which may differ from those of developed countries. For example, a developing country's technology priority at a given time may not be specific cleantech such as smart grid technologies. Instead, it may be specific agricultural technologies to increase crop output. Furthermore, its domestic manufacturers and engineers may not have the capacities to localize smart grid technologies.

Third, not all needed cleantech advancements are available and ready for international deployment. Different clean technologies may be at different stages of technology development, such stages include initial R&D, demonstration, and deployment or diffusion. Breakthroughs in cleantech are still necessary, at least for bringing cleantech to an affordable level to compete with polluting technologies.[52] For example, breakthroughs are necessary for scaling up wind and solar energy storage, and for extensive incorporation of information technologies into the energy infrastructure.[53] The UNFCCC indicates that further breakthroughs are necessary in the areas of carbon capture and storage, hydrogen and fuel cells, biofuels, power storage systems and micro-generation, clean energy technologies, early warning systems for extreme weather events, and biotechnology.[54]

Consequently, it is not surprising that the volume of the voluntary one-way transfer of cleantech from developed countries to developing countries has been small. With this context, this Article looks for alternative solutions. This Article

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50. Addressing the Challenges of Climate Change: Innovative Technology Developed by the Private Sector, GE (2009) (on file with author.)

51. Ilian Iliev & Karsten Neuhoff, *Intellectual Property: Cross-Licensing, Patent Pools and Cooperative Standards as a Channel for Climate Change Technology Cooperation*, *in* CLIMATE STRATEGIES 24 (2009), https://perma.cc/8C65-CL56.

52. David Biello, *Accelerated Innovation is the Ultimate Solution to Climate Change*, SCI. AM. (Dec. 11, 2015), https://perma.cc/U9WB-FU9F.

53. *Id.*

54. *Fact sheet: Why technology is so important*, UNFCCC (Dec. 10, 2018), https://perma.cc/DTX4-GXCM.

proposes that we explore an alternative option—mutually beneficial international technology cooperation.

B. THE NECESSITY OF MUTUALLY BENEFICIAL INTERNATIONAL CLEANTECH COOPERATION AND PROPER TREATMENT OF IPR

The failure of one-way voluntary cleantech transfers makes clear that, at this stage, mutually beneficial international cleantech cooperation is necessary for attracting cleantech owners' active participation in the global development and deployment of cleantech. Properly addressing IPR issues involved is a crucial factor in engaging cleantech owners and in making the cooperation sustainable and successful.

While both the UNFCCC and the TRIPS Agreement specify national government obligations, the roles of sub-national governments and non-state actors, especially those in the private sector, in climate actions are gaining more attention.[55] As illustrated in Part I.A, private sectors in developed countries have been the main forces for cleantech development and deployment to date and are likely to remain so in the near future. Therefore, for international cleantech cooperation to supply sufficient cleantech for developing countries, the global community must actively engage the private sector in developed countries. Consequently, it is important to create incentives for the private sector in developed countries to cooperate with developing countries in developing and deploying cleantech.

To incentivize private entities or even public entities from developed countries to engage in international cleantech cooperation, the terms of the technology transactions need to be mutually beneficial so that partnerships may be formed and sustained. Mutually beneficial cooperation means that parties from both developed countries and developing countries agree that the terms are acceptable. For entities from developing countries, this includes that they get to access the cleantech they need, as well as the associated know-how and background information which is essential for understanding, adapting, and implementing the technology, but often is not disclosed in a patent. For entities from developed countries, especially the private sector entities, mutually beneficial cooperation includes, at a minimum, fair compensation for the cleantech involved and proper respect and enforcement of IPRs.

Cleantech owners in developed countries consider multiple factors in deciding whether to engage in a technology transaction with developing countries;

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55. Meinhar Doelle, *The Paris Climate Agreement – Assessment of Strengths and Weaknesses*, in THE PARIS AGREEMENT ON CLIMATE CHANGE - ANALYSIS AND COMMENTARY (Daniel Klein et al. ed., 2017). *See also*: Anna Davies, *Partnership and Sharing: Beyond Mainstream Mechanisms*, in ENVIRONMENTAL TECHNOLOGIES, IP AND CLIMATE CHANGE 108, 110 (Abbe E.L. Brown ed., 2013); Jon P Santamauro, *Failure Is Not An Option: Enhancing The Use Of IP Tools To Secure Wider And More Equitable Access To Climate Change Technologies*, *Environmental Technologies, IP and Climate Change*, *in* ENVIRONMENTAL TECHNOLOGIES, IP AND CLIMATE CHANGE 84, 93 (Abbe E.L. Brown ed., 2013).

developing countries' treatment of IPR is one of them. Incentives such as tax breaks or subsidies offered by their own countries or the technology recipient countries may help cleantech owners to engage in cleantech transfer to developing countries.[56] However, capacities in the technology recipient countries, such as clear and enforceable rules and a consistent application of those rules, are also important considerations for the cleantech owners.[57] This means that the technology recipient country has clearly defined IPR rules and respects and enforces IPRs. To motivate cleantech owners and make them feel comfortable in selling or licensing cleantech to developing countries, the recognition and the respect of their IPRs, which are private property rights granted by national governments and recognized by international treaties (for example, the TRIPS Agreement), is clearly important.

C. THE INTERNATIONAL LEGAL FRAMEWORK FOR CLEANTECH COOPERATION

The global community has considered international cleantech cooperation. The UN, the UNFCCC, and the TRIPS Agreement all command international cooperation for technology development and deployment. Before examining the international legal framework for cleantech cooperation, This Article first examines what international cleantech cooperation is. This Article regards "international cleantech cooperation" as organizations or countries working together to develop and deploy cleantech globally for addressing climate change and for sustainable development. "Developing and deploying cleantech" refers to one or more phases in the technology cycle of R&D, demonstration, deployment, diffusion, and transfer. Often, the word "collaboration" is used interchangeably with the word "cooperation," though some do argue that they have distinct differences.[58] This Article treats these two terms as the same.

Some developing countries have provided their view of international cleantech cooperation. During the 2009 UNFCCC global negotiation at Bali, several Central and Latin American countries asked for greater international cooperation for cleantech R&D. Their concept of international cleantech cooperation includes, first, "capacity building and enabling environments for all the technological cycle phases" on behalf of developing countries and, second, support for developing countries' "technology acquisition, including the purchase of or the access to the use of patents through flexibility options."[59] This concept is specific

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56. Krishna Ravi Srinivas, *Climate Change, Technology Transfer And IP Rights: A Modest Exercise In Thinking Outside The Box*, *in* ENVIRONMENTAL TECHNOLOGIES, IP AND CLIMATE CHANGE 152, 152–155 (Abbe E.L. Brown ed., 2013).

57. WIPO FOURTEENTH SESSION OF STANDING COMMITTEE ON THE LAW OF PATENT, TRANSFER OF TECHNOLOGY 22, 56 (Rev. 2 2011), https://perma.cc/6U6U-YVPF.

58. *Cooperation vs Collaboration*, CLOUDHEAD (Dec. 10, 2018), https://perma.cc/7D4F-U64A.

59. NICARAGUA ON BEHALF OF GUATEMALA, DOMINICAN REPUBLIC, HONDURAS, AND PANAMA, TECHNOLOGY DEVELOPMENT AND TRANSFER PROPOSAL ON THE LONG-TERM AGREEMENT WITHIN THE FRAMEWORK OF THE BALI ACTION PLAN 1 (Dec. 10, 2018), https://perma.cc/V7X3-HBQR.

and precise, and offers developing countries' perspective on international cleantech cooperation.

So far, however, there does not seem to be a corresponding definition offered by developed countries; hence, this Article presumes the general definition offered in the previous paragraph—organizations or countries working together to develop and deploy cleantech globally—is acceptable to developed countries.

Both the general definition and the definition provided by some developing countries on international cleantech cooperation include cleantech transfer from developed countries to developing countries. Such cooperation can happen in various forms; for example, via joint R&D or deployment activities, or through commercial transactions such as cleantech sales or licensing. Such cooperation ideally should be based on terms agreeable to all parties involved in the cooperation, so to make the cooperation sustainable for all parties involved.

As previously mentioned, the UN, the UNFCCC, and the TRIPS Agreement all mandate international technology cooperation.

In 2015, the UN adopted Agenda 2030 for global sustainable development[60]—a development that not only addresses our present needs but also leaves room for future generations' needs.[61] Agenda 2030 predicts actions on climate change will drive sustainable development, and progress in sustainable development will help address climate change, for example, through improving the global community's overall climate resilience and reducing GHG emissions.[62] Agenda 2030 calls for the global community to act toward fulfilling seventeen sustainable development goals by the year 2030.[63] Goals 9, 13, and 17 are relevant to the discussion of this Article—Goal 9 calls for innovation, Goal 13 calls for actions to address climate change, and, in particular, Goal 17 recognizes global partnership is necessary for realizing all the other sixteen goals.[64]

While emphasizing the transfer of cleantech from developed countries to developing countries, the UNFCCC also requires all participating parties to "*promote and cooperate* in the development, application and diffusion, including transfer, of technologies" relevant to GHG emissions (emphasis added).[65] The 2015 Paris Agreement emphasized international cooperation by requiring its members to cooperate on cleantech development and transfer: "Parties, noting the importance of technology for the implementation of mitigation and adaptation actions under this Agreement and recognizing existing technology deployment

60. G.A. Res. 70/1, at 1 (Oct. 21, 2015).

61. *Report of the World Commission on Environment and Development: Our Common Future*, UNITED NATIONS (Mar. 1987), https://perma.cc/4Z8P-M5VV.

62. *The Sustainable Development Agenda*, UNITED NATIONS (Dec. 10, 2018), https://perma.cc/79GH-PL7A.

63. *Id.*

64. *Id.*

65. UNFCCC, *supra* note 1, art. 4.1.

and dissemination efforts, *shall strengthen cooperative action* on technology development and transfer" (emphasis added).[66]

Meanwhile, the TRIPS Agreement also mandates technical cooperation between developed countries and developing countries, and that the cooperation is on terms and conditions that are mutually agreed to, though in favor of developing countries. "In order to facilitate the implementation of this Agreement, developed country Members shall provide, on request and on *mutually agreed terms and conditions*, technical and financial *cooperation in favor of* developing and least-developed country members" (emphasis added).[67]

Given that major international instruments have commanded internatonal cleantech cooperation, This Article next examines the global community's current efforts in international cleantech cooperation.

D. CURRENT MAJOR INTERNATIONAL CLEANTECH COOPERATION

International cooperation on cleantech development and deployment has been occurring at different levels: multilateral, regional, bilateral, and subnational. This section provides an overview of the major international cleantech cooperation efforts and discusses how they manage IPR issues if sufficient data are available.

International cleantech cooperation occurs among entities—public and private—in different countries. Since developed countries own a majority of the existing clean technologies, this Article focuses on how to enhance international cleantech cooperation between developed countries and developing countries. A key issue for such cooperation is that developing countries (except the few emerging economies) often lack the bargaining power in negotiating cooperation with developed countries. Thus, in reality, such cooperation occurs mainly between developed countries and a few emerging economies. Meanwhile, international cleantech cooperation is starting to occur between emerging economies, such as China and India, and the rest of developing countries, including some least developed countries ("LDCs") or small-island developing states.

1. Multilateral Cooperation

At the multilateral level, multiple mechanisms facilitate cleantech cooperation. This section reviews the mechanisms that help enhance cooperation between developed and developing countries. Since 1972,[68] international cleantech

66. Paris Agreement, *supra* note 3, art. 10.2.

67. TRIPS Agreement, *supra* note 41, art. 67 (". . . Such cooperation shall include assistance in the preparation of laws and regulations on the protection and enforcement of intellectual property rights as well as on the prevention of their abuse, and shall include support regarding the establishment or reinforcement of domestic offices and agencies relevant to these matters, including the training of personnel.").

68. *See* THE DECLARATION OF THE UNITED NATIONS CONFERENCE ON THE HUMAN ENVIRONMENT, Principle 20, *supra* note 24.

cooperation has focused primarily on cleantech transfer from developed countries to developing countries. The support or emphasis on activities outside cleantech transfer—for example, on cleantech development and commercialization—has been random but is becoming increasingly systematic.

International cleantech cooperation at the multilateral level has been ongoing within the UNFCCC regime and beyond.

a. The UNFCCC

The UNFCCC has established several technological and financial mechanisms for enhancing international cooperation for addressing climate change.

i. Technological Mechanisms

Since its establishment in 1992, the UNFCCC has provided several mechanisms for encouraging international cleantech cooperation. This Article will focus on the most important mechanisms: the Clean Development Mechanism, the Technology Need Assessment, and the Technology Mechanism.

The UNFCCC Kyoto Protocol (signed in 1997)[69] engages the private sector and provides member countries the ability to mitigate costs of meeting emission targets by implementing emission reduction projects in other countries (such as developing countries) where the implementation can be more cost-efficient.[70] Specifically, the Clean Development Mechanism ("CDM")[71] offered by the Kyoto Protocol allows the government or private parties of a nation with an emission-reduction or limitation commitment under the Kyoto Protocol to implement an emission-reduction or removal project in developing countries. Such projects can earn the providing nation emission reduction credits that count toward its binding commitment under the Kyoto Protocol.[72]

In theory, CDM projects may involve the transfer of cleantech from the providing countries (which mostly are developed countries) to the receiving developing countries.[73] In reality, it is unclear how much cleantech has been transferred, how much of the transferred cleantech is IP-protected, and whether or how the associated IPR was addressed during the transfer.[74] During the first decade of CDM implementation, the largest and most advanced emerging economies in Asia and Latin America, such as China, India, Mexico and Brazil, had major use of the CDM, hosting 75% of the overall CDM projects. In contrast, countries in Africa

69. *What is the Kyoto Protocol?*, UNFCCC (Dec. 1997), https://perma.cc/FD4W-9CJL.

70. Kyoto Protocol to the UNFCCC, 2303 U.N.T.S. 148; U.N. Doc FCCC/CP/1997/7/Add.1. [hereinafter "Kyoto Protocol"].

71. *Id*. at art. 12.2-3.

72. *Id*. at art. 5-6.

73. Sanford E. Gaines, *International Law and Institutions for Climate Change*, *in* RESEARCH HANDBOOK ON INTELLECTUAL PROPERTY AND CLIMATE CHANGE 33, 45 (Joshua D. Sarnoff ed., 2016).

74. *Id*.

hosted only 2.7% of the overall CDM projects.[75] Hence, in 2010, UNFCCC adopted new policies designed to steer the CDM projects toward the LDCs. The effect of such a policy shift has yet to be documented.

In 2001, UNFCCC parties established a technology transfer framework.[76] The framework includes several components.[77] A particular achievement of the framework is the technology needs assessments ("TNA") component, according to which member nation parties of the UNFCCC identify and determine priority clean technologies needed as well as major barriers for inbound transfer of clean technologies.[78] By 2009, sixty-nine developing countries participated in the TNA processes. By 2013, countries completed another thirty-one TNA processes. TNA is a lengthy and costly process, taking typically one year to complete and requiring the UNFCCC to provide financial help.[79] The TNA does help clarify the cleantech needs of a developing country, hence identifying concrete opportunities for international cleantech cooperation. Along with this framework, UNFCCC parties also called for an enabling environment for developed countries to fulfill their obligation for facilitating and financing the transfer of cleantech to developing countries.[80] The enabling environment includes developing countries enhancing their protection of intellectual property rights, as well as developed countries promoting technology transfer by offering export credits or tax credits/preferences.[81]

Next, in the 2010 Cancun Declaration, UNFCCC parties established a Technology Mechanism to help member countries develop and transfer clean technologies.[82] The Technology Mechanism has the potential to be a good platform for bringing developed countries and developing countries together to accelerate the development and deployment of clean technologies. The Technology Mechanism includes a Technology Executive Committee ("TEC") that sets the general policy for the Mechanism and provides guidance support to UNFCCC parties for cleantech development and deployment.[83]

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75. *Id*.

76. Tech. Exec. Comm., *Technology Transfer Framework*, UNFCCC (Dec.10, 2018), https://perma.cc/Y8TQ-S755. The Technology Transfer Framework was established at COP7 and is part of the Marrakesh Agreement.

77. The Technology Transfer Framework includes Technology Needs Assessments, Technology Information, Enabling Environments, Capacity Building, Mechanism for Technology Transfer, and an Expert Group on Technology Transfer. *See id*.

78. *See* Tech. Exec. Comm., *Good Practices of Technology Needs Assessments*, UNFCCC (Oct. 6, 2015), https://perma.cc/Z7NX-U4T9.

79. Tech. Exec. Comm., *supra* note 76 (For example, in 2009, USD 11 million to 36 developing countries for TNAs; in 2013, USD 8.2 million to 28 developing countries for TNAs; in 2016, USD 6.7 million to 23 small island countries and least developed countries for TNAs.)

80. UNFCCC, *supra* note 1, art. 4.5.

81. *The Marrakesh Accords and the Marrakesh Declaration*, UNFCCC (Oct. 11, 2001), https://perma.cc/P8QL-H9SN.

82. *The Technology Mechanism of the Convention*, UNFCCC (Dec. 10, 2018), https://perma.cc/CW7S-H6Q8.

83. Tech. Exec. Comm., UNFCCC (Dec.10, 2018), https://perma.cc/J5W6-JTLE.

The Technology Mechanism also includes a Climate Technology Center and Network ("CTCN") as the operational arm of the Mechanism. The CTCN offers three core services: (1) providing technical assistance at the request of developing countries; (2) creating access to knowledge on climate technologies; and (3) fostering collaboration among climate technology stakeholders.[84] The CTCN manages a worldwide network of organizations (mostly in developed countries) that have cleantech expertise and function to respond to technical assistance requests from the governments of developing countries.[85] For example, a developing country may identify its needs for cleantech development. The CTCN then helps identify an organization in a developed country that is interested in working with the developing country to co-develop the clean technology needed or adapt and deploy the clean technology if the technology is already available. By September 2017, the CTCN had more than 377 organizations in the worldwide network that respond to the requests of developing countries.[86] Furthermore, eighty-two developing countries submitted 190 cleantech assistance requests to CTCN, and responses to twenty-four of these requests had been successfully implemented.[87] The CTCN has operated without any obligation on developed countries to transfer intellectual property rights to developing countries.[88] A detailed study has yet to be done on how parties manage IPR issues arising during cooperation via the CTCN.

In 2015, the Paris Agreement also established a Technology Framework, which guides the work of the Technology Mechanism and aims to encourage, enable, and accelerate cleantech innovation.[89] UNFCCC parties also decided to strengthen the Technology Mechanism, with further emphasis on cleantech research, development, and demonstration. A notable change starting from the Paris Agreement seems to be the added emphasis on innovation, and attention on both cleantech development and transfer, rather than merely on cleantech transfer alone.

ii. Linkage of UNFCCC Technology Mechanism with UNFCCC Financial Mechanism

Following the UNFCCC's mandate that developed countries provide developing countries financial resources for addressing climate change, "including for the transfer of technology,"[90] UNFCCC parties also established the UNFCCC

84. Evaluation of the Poznan strategic programme on technology transfer: final report by the Technology Executive Committee in its Forty-Third Session, U.N. Doc. FCCC/SBI/2015/16, at 28 (2015).

85. *Climate Technology Center and Network*, CLIMATE TECH. CTR. & NETWORK (Dec. 10, 2018), https://perma.cc/59EW-8T2Y.

86. *Joint annual report of the Technology Executive Committee and the Climate Technology Centre and Network for 2017, in its Forty-Seventh Session*, FCCC/SB/2017/3, at 14-16 (2015).

87. *Id.*

88. Stephen Minas, *Marine Technology Transfer under a BBNJ Treaty: A Case for Transnational Network Cooperation*, AMERICAN J. OF INT'L L. UNBOUND 147 (Volume 112, 2018).

89. Paris Agreement, *supra* note 3, art. 10.4.

90. UNFCCC, *supra* note 1, art. 4.3.

Financial Mechanism to support the financial need of developing countries incurred in mitigating and adapting to climate change. The UNFCCC Financial Mechanism current two operational entities are the Global Environment Facility ("GEF") and the Green Climate Fund ("GCF"). Established in 1994, the GEF administers several funds for the UNFCCC, such as the Least Developed Countries Fund, the Special Climate Change Fund, and the Adaptation Fund.[91]

Since it was established in 2010, the GCF's purpose has been to operationalize UNFCCC developed country parties' commitment to mobilize US $100 billion per year by 2020 to address developing countries' needs in mitigating or adapting to climate change.[92] In 2015, the Paris Agreement expanded the scope of GCF by stating that non-developed country parties are "encouraged to provide or continue to provide such support voluntarily."[93] This expansion implies that developing countries such as the emerging economies (China, India, Brazil, etc.) are welcomed to contribute to the GCF.

After the 2015 Paris Agreement, UNFCCC parties decided to further link the Technology Mechanism with the UNFCCC Financial Mechanism.[94] They requested the TEC and the CTCN of the Technology Mechanism, the GEF, and the GCF to cooperate further to facilitate developing country parties' access to cleantech and to undertake collaborative R&D for enabling developing countries to enhance their climate change efforts.[95] In further discussions, UNFCCC parties asked the GCF to identify concrete collaborative R&D options that it can support in developing countries.[96]

In linking the UNFCCC Financial Mechanism with the UNFCCC Technology Mechanism, the effort to increase international cleantech cooperation between developed and developing countries would have substantive financial support. Thus, some of the financial and legal issues (such as IPR issues) may be resolved. For example, developing countries may leverage the financial support of the GEF and the GCF to properly license needed cleantech from private sectors in developed countries. In this way, international cleantech transfer may comply with norms of commercial technology transactions. Therefore, increasing the participation of private sectors, especially major cleantech owners in developed countries.

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91. *Conventions*, GLOB. ENVTL. FACILITY (Dec. 10, 2018), https://perma.cc/UN2Y-QJPH.

92. *See* Report of the Conference of the Parties on its fifteenth session, held in Copenhagen from 7 to 19 December 2009, FCCC/CP/2009/11/Add.1, at 7 (2010). Subsequently, developed country parties expressed the intent to continue such collective financial mobilization goal through 2025; *See Report of the Conference of the Parties on its twenty-first session, held in Paris from 30 November to 13 December 2015*, Decision 1/CP.21, paragraph 53, UNFCCC (Jan. 29, 2016), https://perma.cc/VF24-LGMT.

93. Paris Agreement, *supra* note 3, art. 9.

94. Report of the Conference of the Parties on its twenty-first session, held in Paris from 30 November to 13 December 2015, FCCC/CP/2015/10/Add.2, at 28 (2016).

95. *Id.*

96. *Support for facilitating access to environmentally sound technologies and for collaborative research and development*, Green Climate Fund Board decision B.14/02, GCF/B.14/02, 8 (2016).

b. Beyond the UNFCCC

Beyond the UNFCCC, international organizations have also been establishing platforms for enhancing international cleantech cooperation. For example, the aforementioned UN Agenda 2030 formed a Technology Facilitation Mechanism ("TFM") for fulfilling the seventeen Sustainable Development Goals ("SDGs").[97] The TFM aims to facilitate multi-stakeholder collaboration and partnerships through information sharing, experiences, best practices, and policy advice among stakeholders in global sustainable development.[98] The TFM includes three components: 1) a United Nations Interagency Task Team on Science, Technology, and Innovation for the SDGs ("IATT"),[99] 2) a collaborative Multi-stakeholder Forum on Science, Technology, and Innovation for the SDGs ("STI Forum"), and 3) an online platform as a gateway for information on existing STI initiatives, mechanisms, and programs.[100] Like the UNFCCC Technology Mechanism, the TFM seems to focus on inter-governmental cooperation, rather than cooperation between individual cleantech seekers and cleantech owners.

2. Regional Partnerships

Besides the technological and financial mechanisms provided by different international organizations at the multilateral level for international cleantech cooperation, regional cooperation on cleantech development and deployment also has come through multiple channels. The section highlights three of them: the Poznan Strategic Program on Technology Transfer, Mission Innovation, and Breakthrough Energy Coalition.

a. Poznan Strategic Program on Technology Transfer

In 2007, UNFCCC parties requested that the GEF set up a program for promoting investment in technology transfer and for helping developing countries address their cleantech needs.[101] The GEF did so by setting up the Poznan Strategic Program on Technology Transfer ("PSP"). The PSP is a regional program. It has thus far established four regional climate technology centers in Asia-Pacific, East-Europe, Latin America and the Caribbean, and Africa, as well as a climate technology network.[102] The PSP pilots technology projects to foster

97. *Technology Facilitation Mechanism*, UNITED NATIONS (Dec. 12, 2018), https://perma.cc/JMD3-UEMM.

98. *Id.*

99. Including a ten-member group of representatives from civil society, the private sector, and the scientific community. *See id.*

100. *Id.*

101. The Technology Mechanism discussed previously came two years after the PSP and is administered by UNFCCC parties directly via the UNFCCC Conference of Parties, not by GEF.

102. *Evaluation of the Poznan strategic programme on technology transfer: final report by the Technology Executive Committee*, *supra* note 84, at 9.

cleantech innovation and investment, sponsors the afore-mentioned technology needs assessments of developing countries, and functions as a catalytic supporting institution for international cleantech transfer.[103]

After the establishment and operation of the Technology Mechanism in 2010, UNFCCC parties have been discussing building coordination and synergies between the activities of the PSP and the Technology Mechanism.[104] Such linkage is expected to enhance information-sharing and create synergies so as to accelerate regional cleantech development and transfer.[105]

b. Mission Innovation

Mission Innovation ("MI") is a cooperative effort started in the year 2015 among the governments of twenty-three countries and the European Union.[106] The MI aims to provide affordable and reliable clean energy solutions by drastically accelerating clean energy innovation so to achieve performance breakthroughs and cost reductions.[107] One of MI's near-term goals is to double government spending on clean energy R&D over five years (2016-2020).[108] The MI's member countries include the world's top three GHG emitters: China, the United States, and India. The MI considers the private sector to be the essential link in commercializing new technologies and explicitly enlists private sector entities and business elites as its support.[109]

c. Breakthrough Energy Coalition

Formed in 2016, the Breakthrough Energy Coalition ("BEC") is one of the regional private sector partnership enlisted by the MI.[110] It consists of a coalition of more than two dozen wealthy investors who plan to accelerate the commercialization and deployment of clean energy technologies by pooling investments in early-stage clean energy technology companies.[111] This investment group aims to bring advanced government-funded research to market earlier through patient and risk-tolerant investment.[112] The BEC started with a $2 billion pledge that is expected to reach $20 billion by 2025.

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103. Evaluation of the Poznan strategic programme on technology transfer, *supra* note 84, at 5.
104. *Id.* at 26.
105. *Id.*
106. *Overview*, MISSION INNOVATION (Dec. 12, 2018), https://perma.cc/T9AB-QPYV.
107. *Id.*
108. *Id.*
109. Gaines, *supra* note 73, at 48.
110. *Private Sector Engagement*, MISSION INNOVATION (Dec. 12, 2018), https://perma.cc/TW23-7W8K.
111. *Commercializing More New Clean Energy Technologies, Faster*, BREAKTHROUGH ENERGY (Dec. 12, 2018), https://perma.cc/2EG4-EQEH.
112. *Breakthrough Energy Ventures*, BREAKTHROUGH ENERGY (Dec. 12, 2018), https://perma.cc/Z7XS-ZGUD.

Both the MI and the BEC launched into existence at the 2015 UNFCCC Paris Conference that also formed the Paris Agreement. The MI and the BEC together formed a desirable collaboration between the public sector (for example, via MI member governments investing in the R&D of cleantech) and the private sector (for example, via BEC private investments accelerating the commercialization of R&D results funded by the public sector).[113]

Other regional partnerships include International Solar (Energy) Alliance[114] that brought more than 120 sunshine-rich countries together to promote solar technologies and the EU-Africa Energy Partnership[115] that commits to improving the use of sustainable transportation energy by arranging for the EU to import biomass grown in sub-Saharan Africa.[116]

3. Bilateral Collaborations

Meanwhile, bilateral collaboration for cleantech development and deployment has been in progress. For example, the United States established bilateral collaborations with Australia,[117] China,[118] and India[119] to develop clean energy technologies. Additionally, Canada and China have formed a cleantech collaboration partnership,[120] as have the EU and India.[121]

Thus far, most of these bilateral cleantech cooperation relationships are between a developed entity (e.g., Canada, the EU, or the United States) and an emerging economy (e.g., China or India). Such cooperation is important, as emerging economies such as China and India are major GHG emitters and need cleantech for sustainable economic development. Such cooperation can be a "win-win solution," especially given that emerging economies have been

113. Ahmed Abdel-Latif, *the Rise of Public–Private Partnerships in Green Technologies and the Role of Intellectual Property Rights, in* THE CAMBRIDGE HANDBOOK OF PUBLIC-PRIVATE PARTNERSHIPS, INTELLECTUAL PROPERTY GOVERNANCE, AND SUSTAINABLE DEVELOPMENT, 223-243, 227 (Margaret Chon et al ed., 2018).

114. *International Solar Alliance*, UNFCCC (Mar. 11, 2016), https://perma.cc/U6KA-NNJS.

115. *The Africa-EU Energy Partnership*, AFRICA-EU ENERGY P'SHIP (Dec. 12, 2018), https://perma.cc/TQ5A-6U5U.

116. Michael B. Charles et al, *the EU–Africa Energy Partnership: Towards a mutually beneficial renewable transport energy alliance?*, 37 ENERGY POL'Y 12 (Dec. 2009), https://perma.cc/95Z8-MS9Z.

117. Steven Bushong, *Australian and U.S. Partnership to Develop "Over the Horizon" Technology*, SOLAR POWER WORLD (Jan. 7, 2013), *https://perma.cc/46HL-YND7*.

118. *U.S.-China Clean Energy Collaboration*, U.S. DEP'T OF ENERGY (Dec. 12, 2018), https://perma.cc/N4ZW-7UWK.

119. *U.S.-India Energy Collaboration*, U.S. DEP'T OF ENERGY (Dec. 12, 2018), https://perma.cc/SND2-778Z.

120. *Joint Declaration on Canada-China Clean technology Cooperation*, CANADA CLEANTECH (Sept. 13, 2016), https://perma.cc/62N4-VF3Q.

121. *EU and India Agree on Clean Energy and Climate Partnership*, EUROPEAN COMMISSION (Mar. 31, 2016), https://perma.cc/CL9S-F8K2.

drastically increasing their R&D expenditures.[122] For example, China will be the global leader in clean energy R&D spending 2019, exceeding that of the United States, EU, or Japan.[123] Part II.D below will discuss the U.S.-China bilateral collaboration in detail, as this relationship has created a unique framework for managing IPR issues that have arisen during the collaboration.

Meanwhile, South-to-South cleantech cooperation has recently emerged.[124] For example, China has been cooperating with countries in Africa, such as Zambia and Ghana, on various renewable energy projects. These projects involve wind, solar panel, and hydropower technologies.[125] China's Belt & Road Initiative would further extend such cooperation with other developing countries. South-to-South cleantech cooperation is a trend in international cleantech cooperation that is worthy of further exploration. Some of the South-to-South cooperation even expands a bilateral to a triangular; that is, the cooperation involves the participation of a developed country or an international agency, such as the United Nations Development Program.[126]

In summary, given the limited success of voluntary one-way international cleantech transfer since 1972, the global community should pay more attention to mutually-beneficial international cleantech cooperation. International instruments such as the UNFCCC and the TRIPS Agreement have mandated such cooperation, and the global community has been collaborating in developing and deploying cleantech at the multilateral, regional, and bilateral levels. Mutually-beneficial internatonal cleantech cooperation helps incentivize cleantech owners' active participations in global cleantech development and deployment. Such incentives include proper respect and enforcement of IPRs.[127]

II. ANALYSIS: AVAILABLE IPR MANAGEMENT MODELS FOR INTERNATIONAL CLEANTECH COOPERATION

This Part explores IPR management models for international cooperation in cleantech development and deployment. These models include ones that

122. Maria van der Hoeven & Didier Houssin, *Energy Technology Perspectives 2015: Mobilising Innovation to Accelerate Climate Action*, INT'L ENERGY AGENCY (May 4, 2015), *https://perma.cc/JFE4-LJ3D*.

123. *Id.*

124. *Potential of South-to-South and Triangular Cooperation on Climate Technologies for Advancing Implementation of Nationally Determined Contributions and National Adaptation Plans*, UNFCCC (2018), https://perma.cc/GV5N-BY8K.

125. Ulrich Elmer Hansen, *South-South technology transfer: the role of China in the renewable energy sector in Africa*, *available at* https://perma.cc/KD7T-292M.

126. *Potential of South-South and Triangular Cooperation*, UNFCCC (Jan. 26, 2019), https://perma.cc/TQR8-8W2Y.

127. Though businesses in developed countries have been experimenting with non-IPR innovation models such as open-source software movement and open innovation, technology transactions based on the proper observance of IPRs are still the mainstream practice. Therefore, proper management of IPR issues occurring during international cleantech cooperation remains important in the foreseeable future.

various countries have proposed, ones that are possible approaches, and ones that are in practice already. The purpose of this section is to understand the options and to identify best IPR management practices that would make international cleantech cooperation mutually beneficial, successful, and sustainable in the long term.

The term "intellectual property" refers broadly to the creations of the human mind. IPR protects the interests of the creators by giving them property rights over their creations.[128] The major forms of IPR include patents, trade secrets, copyrights, and trademarks. Patents generally protect innovative technical improvements; trade secrets protect confidential information that likely includes innovative business or technical know-how; trademarks protect the distinctive symbols identifying the source of a product or service; and copyrights protect the artistic expressions of ideas.

When discussing the development and deployment of technologies, patent rights are the most relevant, and then trade secrets, which come into play when confidential information associated with a technology or business practice is involved. In the following discussion, unless indicated otherwise, IPR generally refers to patents. Trade secret laws may be discussed in relation to the transfer of confidential business or technical know-how. Other intellectual property forms, such as trademarks and copyrights, will be discussed as needed.

One fundamental concept is that IPR is territorial. IPR is effective and enforceable only within the territory where the government issuing the IPR has jurisdiction. For example, if a cleantech owner applies for patent protection for the cleantech in a developing country, the patent right granted by the government of the developing country is only effective in the developing country; no one can use the cleantech in the developing country absent the cleantech owner's permission. However, anyone can use the cleantech in the developing country for free if the cleantech owner does not apply for or fails to obtain patent protection in the developing country, or if the patent right over the cleantech is expired or exhausted in the developing country.[129]

One ongoing debate concerning IPR is how to balance its social benefit and its social cost. IPR's social benefit is that it likely incentivizes investments in innovation by granting inventors a limited time of monopoly over their intellectual work. However, IPR's monopoly, albeit limited in time, constricts the public's access to the protected intellectual work. That is the social cost—the public

128. *What is Intellectual Property?*, WIPO (Dec. 12, 2018), https://perma.cc/JRF6-JZNK.

129. The IP right over a technology is exhausted over a product or service containing the IP-protected technology upon an authorized sale of the product or service. The TRIPS Agreement does not address the IP exhaustion issue. *See* TRIPS Agreement, *supra* note 41, art. 6. Therefore, each WTO member may decide whether the exhaustion of the IP right over the product or service occurs, and whether it occurs only within the domestic jurisdiction where the authorized sale of the IP-protected product or service takes place, or whether authorized sale abroad also exhausts the IP rights in the domestic jurisdiction.

cannot access the intellectual work during the effective term of the IPR without the IPR owner's permission, which often comes with a condition, such as a payment.

Of the various IPR management models discussed below, Approach A, advocates for discarding or weakening IPR for cleantech, emphasizes public access to cleantech protected by IP, therefore attempting to limit IPR over cleantech. In contrast, Approach B—the TRIPS-plus approach—emphasizes the incentive function of IPR, and thus attempts to strengthen IPR in order to motivate more investments in R&D activities. These two approaches reflect the afore-mentioned debate on IPR. Approach C—creative IPR management—attempts to balance the social benefit and the social cost of cleantech IPR by creatively paying for the public access, to keep the incentive function of IPR intact by respecting IPR as it should be and satisfying the public need to access the cleantech. Approach D—collaborative IPR management—respects IPR and attempts to manage IPR issues involved in technology cooperation collaboratively, thereby enhancing public access to IP-protected technologies. Notably, Approaches C and D seek to identify ways to utilize IPR creatively or collaboratively, so to encourage the development and deployment of cleantech globally, without tackling the conflict between IP protection of cleantech and public access to the IP-protected cleantech.

A. DISCARDING OR WEAKENING IPR FOR CLEANTECH

One approach, suggested by some developing countries, is to remove or weaken IPR for cleantech. These countries regard IPR as an inherent barrier to rapid and affordable access to cleantech.[130] Proposals proffered by these countries have included excluding cleantech from patent protection, revoking existing IP rights on cleantech in developing countries, leveraging the full flexibilities offered by the TRIPS Agreement (including compulsory licensing to access cleantech protected by IP laws), limited or reduced life terms for patents on cleantech, and non-exclusive royalty-free licensing of existing global IP-protected cleantech and associated know-how.[131] For example, in the 2013 TRIPS Council[132] discussion on IP, climate change, and development, Ecuador proposed to exclude clean technologies from patentable subject matter, to include in the TRIPS Agreement a new provision on the transfer of expertise, to implement compulsory licensing, and to reduce the life term of patents on clean

130. CARLOS M. CORREA, RESEARCH HANDBOOK ON INTELLECTUAL PROPERTY AND CLIMATE CHANGE 74 (Joshua D. Sarnoff ed., 2016) (He described the situation around year 2010, though).

131. *No Patents on Climate-Friendly Technologies, Say South*, THIRD WORLD NETWORK (June 12, 2009), https://perma.cc/496G-C6NZ.

132. *Council for TRIPS*, WORLD TRADE ORG. (Dec. 12, 2018), https://perma.cc/ER6V-FLKX ("The Council for TRIPS is the body, open to all members of the WTO, that is responsible for administering the TRIPS Agreement.").

technologies.[133] A number of developing countries such as Cuba, Bangladesh, Bolivia, Brazil, India, Indonesia, Nepal, Rwanda, and the Dominican Republic supported Ecuador's proposal.[134] The discussion below examines the feasibility of such proposals.

1. Excluding Cleantech from Patentable Subject Matter

Eliminating cleantech from patentable subject matter[135] would make cleantech patent- illegible, and thus will enable the public to access cleantech without the encumbrance of patent protection. However, doing so would undermine the TRIPS Agreement's mandate that patents be available for inventions in all fields of technology. As 164 out of the 195 countries are WTO members, the thirty-one non-WTO countries may adopt this approach without violating the TRIPS Agreement. However, a country opting this approach will potentially scare away foreign investors, who may be concerned about losing control over their clean technologies if they bring the technologies into the country.

For the 164 WTO member countries, removing cleantech from patentable subject matter may be costly. It is true that certain subject matters such as business method inventions and software inventions have been controversial as patentable subject matter.[136] However, as illustrated by the definition of "cleantech" in the Introduction, clean technologies go beyond these controversial areas and cover a wide range of subject matters that fall within the conventional concept of technology. Therefore, removing clean technologies from patentable subject matter would greatly disturb the patentable subject matter standard that the TRIPS Agreement has established; the implication of this is vast, and it is unlikely to gain approval from the WTO community. Administratively, it also likely would be a costly process for a patent office to administer the exclusion. As we have yet to have an internationally agreed classification scheme for cleantech, each patent office would need to design its own classification system for cleantech, and assess whether the invention claimed in a patent application is cleantech.

The same arguments apply to the proposal of shortening the life term of cleantech patents. Such a proposal differs from the TRIPS Agreement's requirement of a minimum 20-year life term for patents, which applies uniformly to all regular

133. *Contribution of Intellectual Property to Facilitating the Transfer of Environmentally Rational Technology – Communication from Equator*, WORLD TRADE ORG. (Feb. 27, 2013), https://perma.cc/HY5Y-FXUC [hereinafter "Ecuador 2013 proposal"].

134. *Contribution of Intellectual Property to Facilitate Transfer of Environmentally Rational Technology*, WORLD TRADE ORG. 28 (Oct. 11, 2013), https://perma.cc/A9Q6-TMWC.

135. Patentable subject matter points to what subject matter is eligible for patent protection. For example, in the U.S., process, machine, manufacture, composition of matter, or their improvement thereof is patentable subject matter. *See* 35 U.S.C. § 101. An invention satisfying the patentable subject matter inquiry still needs to meet other substantive inquiries such as utility, novelty, and inventive step before obtaining patent protection.

136. Joy Y. Xiang, *How Wide Should the Gate of 'Technology' be? Patentability of Business Methods in China*, 11 PAC. RIM L. & POL'Y J. 2 (2002).

patents.[137] It also would take considerable administrative resources to decide what patented subject matter is cleantech, to then determine how much life term these patents should have, and to administer such patents with different life-term standards.

Therefore, removing cleantech from patentable subject matter and shortening the life term of cleantech patents would be impractical to implement.

2. Liberal Compulsory Licensing of Cleantech

Compulsory licensing allows a government to use or to permit a third party to use a patented invention without the authorization of the patent owner.[138] The TRIPS Agreement limits such an overwriting of patent rights with a number of qualifications.[139] For example, the TRIPS Agreement requires that before the compulsory use, the proposed user needs to have sought permission from the IPR owner on reasonable commercial terms and needs to have failed to obtain such permission.[140] The requirements also include that the IPR owner receives adequate remuneration for the compulsory use and that such a compulsory use is "predominately" for supplying the domestic market of the country issuing the compulsory license.[141] In addressing access to essential medicine, the TRIPS Agreement adopted[142] the 2001 Doha Declaration on the TRIPS Agreement and Public Health.[143] The 2001 Doha Declaration waived the "domestic market" use requirement for issuing compulsory licenses on patented pharmaceuticals.[144] This means that countries issuing compulsory licenses on pharmaceutical patents can supply the products to other countries, such as the LDCs, that do not have the capacities to manufacture the products locally.[145]

Proponents of removing or weakening cleantech patent rights also have proposed liberal compulsory licensing of these rights.[146] Liberal compulsory licensing of cleantech patents would permit a developing country to authorize the use of patent-protected cleantech freely without patentees' consent, even though the country has provided patent rights to such cleantech. In particular, proponents of

137. TRIPS Agreement, *supra* note 41, art. 33.

138. *Id*. at art. 31.

139. *Id*. at art. 31(a)–(f).

140. *Id*. at art. 31(b).

141. *Id*. at art. 31(f).

142. *Id*. at art. 31 bis.

143. *The Doha Declaration on the TRIPS Agreement and Public Health*, WORLD TRADE ORG. (Nov. 20, 2001), https://perma.cc/NF2U-ABNQ.

144. *Id*.

145. However, there has been only one use of the Doha Declaration waiver – between Canada and Rwanda. *See Canada is First to Notify Compulsory License to Export Generic Drug*, WORLD TRADE ORG. (Oct. 4, 2007), https://perma.cc/2HKX-9X7N. It would be interesting to understand why the use has been so limited.

146. Charles R. McManis & Jorge L. Contreras, *Compulsory licensing of IP: A Viable Policy Lever for Promoting Access to Critical Technologies?*, *in* TRIPS AND DEVELOPING COUNTRIES – TOWARDS A NEW IP WORLD ORDER? 109, 127-31 (Gustavo Ghidini et al. ed., 2014).

removing or weakening cleantech patent rights have proposed the UNFCCC adopt a compulsory licensing approach of clean technologies similar to that of the 2001 Doha Declaration on TRIPS and Public Health.[147]

Several concerns arise regarding such a proposal of liberal compulsory licensing of cleantech patents. First, cleantech tends to consist of capital-intensive infrastructure projects such as wind farms, nuclear reactors, and transmission grids.[148] While compulsory licensing for an essential medicine may involve one or a few patents, compulsory licensing to build a cleantech product or service will likely involve hundreds or more patents. Therefore, the intrusion on private property rights is much broader and much more complicated to manage fairly.

Second, as Barton pointed out, most clean technologies are already in the public domain. What is under patent protection are incremental improvements or differentiating features.[149] For patented cleantech, multiple substitutes are likely available in the market.[150] Hence, compulsory licensing on the patented cleantech will neither broaden much of its dissemination scope nor reduce much of its price for access.[151]

Third, compulsory licensing on a cleantech patent cannot force the disclosure of the know-how and technical skills necessary for implementing the patented technology, as a patent does not normally provide such information. Since there are potentially multiple alternatives and substitutes for the patented cleantech in the market, the access needed by developing countries often is not only the patented technology itself, but more importantly, the associated know-how and technical skills for actually implementing the technologies. Such information often comes with interactions and collaborations with the cleantech owners. The threat of compulsory licensing may scare away cleantech owners from even getting involved with developing countries. If the country issuing the compulsory license does not have the capacity to implement the patented technology without its associated know-how and technical skills, then liberal use of compulsory licenses likely prevents the country from accessing these necessary skills.

Most developing countries do not have the patents from which to issue compulsory licenses. Data have shown that except for emerging economies, developing countries own few cleantech patents, regardless of whether the patents are

147. *The Doha Deadlock: Intellectual Property and Climate Change*, THE CONVERSATION (Dec. 11, 2012), https://perma.cc/4KYY-33L3.

148. McManis & Contreras, *supra* note 146, at 127.

149. JOHN H. BARTON, INTELLECTUAL PROPERTY AND ACCESS TO CLEAN ENERGY TECHNOLOGIES IN DEVELOPING COUNTRIES: AN ANALYSIS OF SOLAR PHOTOVOLTAIC, BIOFUEL AND WIND TECHNOLOGIES 13 (Dec. 2007), https://perma.cc/8XVE-WJRY.

150. *Id*. *See also* Jerome Reichman et al., *Intellectual Property and Alternatives: Strategies for Green Innovation*, CHATHAM HOUSE ENERGY, ENV'T AND DEV. PROGRAMME, Paper No. 08/03, 19 (Dec. 2008), https://perma.cc/3G8C-RVZ8, 19, at 19 (innovations in hybrid cars and fuel cells, wind energy represent incremental improvements.)

151. McManis & Contreras, *supra* note 146, at 128.

owned by domestic or foreign entities.[152] For example, data reveal that emerging economies such as China and India own 19.88% of the patents on key cleantech, while the rest of developing countries own about 0.12%.[153] This means that except for the emerging economies, most developing countries do not have a set of cleantech patents from which to issue compulsory licenses. Furthermore, if a developing country can access patent-protected cleantech via a compulsory license, the developing country may also want to ensure it has the needed technical skills or know-how to adapt or implement the cleantech locally without the input from the cleantech owner.

Meanwhile, the handful of emerging economies may not be enthusiastic about liberal compulsory licensing of cleantech patents. It is true that emerging economies may have obtained a set of cleantech patents and can issue compulsory licenses against these patents. These countries also likely have acquired good capacities in at least some scientific and technological areas.[154] However, emerging economies may hesitate to employ compulsory licensing, considering the negative impacts of compulsory licensing on the cleantech IP portfolios they have accumulated.[155] For example, compulsory licensing would scare away potential foreign investments and foreign cleantech owners from getting involved with these countries. Emerging economies also may consider their own growing domestic cleantech industries. Liberal use of compulsory licensing would deter these industries from further investment, innovation, and patent filings in cleantech.

Meanwhile, developed countries have granted few compulsory licenses in their jurisdictions,[156] though developed countries own the majority of the patents.[157] For example, the United States has no compulsory license regime per se. Despite the few exceptions where specific laws allow the issuance of a compulsory license,[158] the United States has never issued a compulsory license. To date, Japan and Australia have granted no compulsory licenses. Germany recently granted the sole compulsory license it has ever had in the "Raltegravir" case. Raltegravir is an active compound used in AIDS treatment.[159] However, the European Patent Office Board of Appeal revoked the patent that the compulsory

152. Various Cleantech Patent Studies, *supra* note 20, at 45.

153. *Id*.

154. *See generally* COMM'N ON INTELL. PROP. RIGHTS, INTEGRATING INTELLECTUAL PROPERTY RIGHTS AND DEVELOPMENT POLICY (Sept. 2002), https://perma.cc/5DPP-NNFQ.

155. Neel Maitra, *Access to Environmentally Sound Technology in the Developing World: A Proposal Alternative to Compulsory Licensing*, 35 COLUM. J. ENVTL. L. 407, 433-38 (2010).

156. JAMES LOVE, COMPULSORY LICENSING: MODELS FOR STATE PRACTICES IN DEVELOPING COUNTRIES, ACCESS TO MEDICINE AND COMPLIANCE WITH THE WTO TRIPS ACCORD 2–3 (2004), https://perma.cc/8NBT-MYB2.

157. COPENHAGEN ECONOMICS & THE IPR COMPANY, *supra* note 20.

158. For example, Federal Trade Commission Guidelines for Licensing of Intellectual Property, and Clean Air Act, 28 U.S.C. § 1498.

159. Tobias Wuttke & Meissner Bolte, *The First German Compulsory Patent License Ever – Start of a New Era?*, EUR. PAT. LAWS. ASS'N (Oct. 17, 2017), https://perma.cc/3DC2-VGS9.

license was based on.[160] Additionally, Canada had allowed compulsory licenses for pharmaceutical products, but it abolished the practice upon joining the 1994 North American Free Trade Agreement.[161]

Therefore, liberal compulsory licensing of cleantech patents does not seem to be a practical approach, given that most developing countries own few cleantech patents from which to issue a compulsory license, the emerging economies would not be enthusiastic about issuing compulsory license against their own growing cleantech patent portfolios, and developed countries rarely issue compulsory licenses.

To address the need to access the know-how and technical skills necessary for implementing complex cleantech, developing countries' proposal also asks to introduce in the TRIPS Agreement a new provision on the transfer of expertise or know-how.[162] There is no illustration on what such a new provision may contain. One possible implementation of this provision is to mandate such a transfer by cleantech owners, and to specify that the failure to provide such a transfer would subject the country of the cleantech owners to a WTO complaint and the potential consequences from its adjudication. One concern for such an implementation is that the effort required to amend the TRIPS Agreement with new provisions would be time-consuming, to say the least. A further concern may be that such a forced transfer of know-how and technical skills may not help developing countries that are yet to build the human capital or technical infrastructure to absorb, implement, or adapt the transferred technologies.

3. Revoking or Ignoring Existing IP Protection on Current Cleantech

A third main proposal from some developing countries to improve their access to cleantech is to revoke or disregard existing IP protection on current cleantech.[163] This means a national government revokes or ignores patent rights it has provided on existing cleantech. This approach seems efficient, as removing IP protection altogether on existing cleantech would preemptively void any barriers potentially caused by the existence of IP on current cleantech. However, this approach may not be feasible or necessary.

Such revocation may not be feasible because it violates the TRIPS Agreement, where 164 of the 195 countries in the global community are WTO members and

160. Rudolf Teschemacher, *European Patent for Raltergravir Revoked*, EUR. PAT. LAWS. ASS'N (Oct. 12, 2017), https://perma.cc/PFN6-46LU.

161. Canada established the Jean Chretien Pledge to Africa Act in 2004 so it can issue compulsory license for manufacturing essential medicines or medical devices for exporting to less developed countries per the 2001 Doha Declaration on the TRIPS Agreement and Public Health. *See* LOVE, *supra* note 156, at 2–3.

162. ZHONGFA MA, CLEAN ENERGY AND TECHNOLOGY TRANSFER (Naigeng Zhang & ZhongFa Ma eds., 2017) (in Chinese).

163. *Developing Countries Call for No Patents on Climate-Friendly Technologies*, THIRD WORLD NETWORK (June 11, 2009), https://perma.cc/R4RG-83KP.

have obligations to comply with the TRIPS Agreement. Revoking and disregarding existing patent protection on cleantech would also disrupt the normal expectation that a national government would honor the private property rights issued based on its own laws. The disruption would likely deter foreign investment and even domestic investment in innovations.

Such revocation may not be necessary either, because the existence of cleantech patents may not block access to cleantech. As previously mentioned, unlike pharmaceutical technologies, where one single patent can cover a technology that has no or inferior alternatives, most fundamental cleantech tends to already be in the public domain. Patent-protected cleantech usually consists of improvements over the fundamental technologies. Such improvement features likely would have good substitutes or alternatives available.[164]

B. TRIPS-PLUS APPROACH

An approach opposite to weakening or removing cleantech IPR is to provide stronger IP protection for cleantech than what is required by the TRIPS Agreement. As of 2002, the United States officially requires the trade agreements it enters to reflect a U.S.-like IP protection standard.[165] Because the TRIPS Agreement establishes the minimum IP standards, and the U.S. IP standards often are higher than those in the TRIPS Agreement are, the IP standards included in U.S. trade agreements (and later as promoted by the EU and Japan in their trade agreements) are labeled as TRIPS-plus standards.

TRIPS-plus standards tend to lean toward the expansion of IP protections instead of abridging them. For example, TRIPS-plus standards related to patent protection include more limitations on prior art references that would invalidate a patent or patent application. TRIPS-plus standards tend to expand subject matters that may come under patent protection—for example, by allowing patents for new uses or new methods of using known products. Such standards may limit challenges to the validity of patents by removing or limiting opportunities for a third party to challenge patent validity. TRIPS-plus standards may also include extending patent terms to compensate for unreasonable delays at the patent office, limiting exceptions to patent rights—for example, via prohibiting parallel imports while acknowledging national patent exhaustion, or negating the parties' ability to impose a compulsory license.[166] TRIPS-plus provisions may also include

164. *Cf*. John H. Barton, *supra* note 149, at 4.

165. Trade Act of 2002, Pub. L. No. 107-210, 116 Stat. 933. The U.S. had been using bilateral trade agreements to enforce its IP standards even before TRIPS Agreement. The multilateralism embodied by TRIPS Agreement may have just been a significant pause in the U.S.' historical use of bilateral agreements. *See* Ruth L. Okediji, *Back to Bilateralism? Pendulum swings in International Intellectual Property Protection*, 1 UNIV. OF OTTAWA L. & TECH. J. 125 (2003–2004).

166. McManis & Contreras, *supra* note 146, at 130; *see also* Horacio Rangel-Ortiz, *Patent and Trademark Rights in Commercial Agreements Entered by the United States with Latin American Nations in the First Decade of the Twenty-First Century: Divide et vinces*, *in* TRIPS AND DEVELOPING

provisions that are specific to pharmaceutical industries, such as permitting data exclusivity and patent linkage. Otherwise, they are industry or technology neutral.

TRIPS-plus standards can be detrimental to the interests of some developing countries, especially the poorer countries. Such countries have yet to build up their domestic innovation capabilities. Overly strong IPR protection would shrink their domestic industries' ability to learn from advanced practices via copying and imitation.

However, some scholars consider TRIPS-plus provisions to neutralize provisions in the TRIPS Agreement that are beneficial to developing countries.[167] This Article agrees with that view. This Article also perceives that TRIPS-plus provisions often are "necessary compromises" accepted by developing countries willingly in exchange for gains (such as continued access to developed countries' markets) in other aspects of the trade agreements they form with the United States, the EU, or Japan. Therefore, though developing countries normally accept TRIPS-plus provisions through willingly bargained compromises (albeit often between unequal parties), developing countries should not easily give in to TRIPS-plus provisions, such as an extension of patent terms, an expansion of patentable subject matter coverages, and the removal of the ability to issue compulsory licenses when needed. Developing countries should carefully review such provisions' impact on domestic economic development before accepting them.

C. CREATIVE IPR MANAGEMENT

The third main approach worthy of exploring for IPR management in international cleantech cooperation is to address IPR issues *creatively* based on existing IP legal regimes. The section below highlights a few examples of creative IPR management, such as a tiered approach that allows entities other than the IPR users to pay for the access, a cleantech procurement pooling approach that allows cleantech seekers to pool their cleantech needs together so to increase the seekers' bargaining power against the cleantech owners, and optimizations of exsisting patenting procedures for a faster or cheaper process for granting cleantech patents. Creative IPR management focuses on accepting existing IP regimes as they are and formulating *unconventional* IPR arrangements for effective international cleantech cooperation.

1. Tiered Approach

To address IPR issues encountered in international cleantech cooperation, scholars have suggested tiered approaches. IPR mainly serves two functions—to

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Countries: Towards a New IP World Order? 72, 86 (Gustavo Ghidini et al. eds., 2014); CYNTHIA M. HO, AN OVERVIEW OF "TRIPS-PLUS" STANDARDS (2011).

167. McManis & Contreras, *supra* note 146, at 130.

incentivize investments in innovative or creative works and to provide the public access to the innovative or creative work upon obtaining permission from the IPR owner, usually via a payment.[168] The tiered approaches separate the incentive function of IPR from the access function of IPR by allowing entities other than the users of the intellectual property (IP) to pay for at least part of the fee for accessing the assets protected by the IPR.[169] For example, in the U.S.'s Medicaid program, the U.S. government purchases patented drugs at their full commercial prices and distributes these drugs to the Medicaid patients for free; that is, the U.S. government absorbs the costs for the Medicaid patients' access of the patented drugs.[170] In doing so, this tiered approach sidesteps the contested dilemma of balancing IPR's social benefit of providing an incentive for investment in innovative or creative work with the social cost of limiting access to the IP-protected information by users who are unable to obtain permission for the access.

For example, Maitra has suggested setting up a fund that provides global subsidies for developing countries that purchase cleantech from developed countries.[171] The source of the fund comes from developed countries whose companies profit from these purchases.[172] The design is for private firms in developed countries to sell or license cleantech at a full commercial price to developing countries. Developing countries then present the proof of payments to the fund manager to receive specific subsidies.[173] The ideal contributors of the fund are developed countries whose private firms sell the cleantech to developing countries.[174] However, leading developing countries such as China and India probably should join as contributors as well, as they now own sizable portfolios of clean technologies, and their firms actively engage in international cleantech transactions. One of the benefits for a country contributing to the fund is that developing countries likely would choose to buy cleantech from private firms of the fund contributors, as such purchases would be subsidized by the fund and hence would be cheaper than unsubsidized cleantech commercial transactions.[175]

Additionally, Richman and Rai et al. have suggested establishing a global fund—for example, within the the World Intellectual Property Organization ("WIPO")—to buy out the IPR associated with select cleantech, and then make such cleantech available to interested parties such as developing countries.[176] As discussed at the beginning of Part II, IPR is territorial. The proposed mechanism

168. Daniel J. Hemel & Lisa Larrimore Ouellette, *Innovation Policy Pluralism*, 128 YALE L.J. 544 (2019).

169. *Id.*; *see also*, Maitra, *supra* note 155, at 436.

170. MEDICAID.GOV, https://perma.cc/G965-A8RR (last visited Dec. 12, 2018).

171. Maitra, *supra* note 155, at 434–439.

172. *Id.*

173. *Id.*

174. *Id.* at 21.

175. *Id.* at 23.

176. Reichman et al., *supra* note 150, at 24; *see also* RICHARD G. NEWELL, POST-KYOTO INTERNATIONAL CLIMATE POLICY 432 (Joseph E. Aldy & Robert N. Stavins eds., 2009) (suggesting that

applies only if a cleantech owner has applied and obtained IPR for the technology in developing countries. As discussed previously, data show that currently, few inventors are applying for IP protection for their cleantech in developing countries (except in a handful of emerging economies).[177] Also, implementing this proposal would involve cumbersome operational details. For example, before making a purchase, the fund administrator needs to figure out which developing countries may be interested in a particular clean technology, and whether the technology has IP rights in these countries. Further, such a program needs to install measures to prevent the resultant products in developing countries—which are likely to be cheaper, because the technology given to developing countries is free—from coming back to the cleantech owner's markets in developed countries through parallel import mechanisms.[178]

A further suggestion is to pool such purchased technologies, for example, via either of the global funds proposed by Maitra or Richman and Rai et al., and make them available as "a package" to potential users, especially those in developing countries.[179]

This Article considers the tiered approach a plausible way of addressing IPR issues in international cleantech cooperation, and hence worthy of experimentation. Developing countries have complained that IPR on cleantech raised the access price for cleantech.[180] Although there are still arguments regarding the accuracy of such complaints,[181] subsidizing developing countries' access to cleantech may help address such complaints. This approach becomes more feasible given the current effort at the UNFCCC to link its financial mechanisms with its Technology Mechanism, so that the GEF and the GCF can help finance developed and developing countries' collaborative effort in developing and deploying cleantech.

2. Pooled Cleantech Procurements

To enhance developing countries' ability to bargain for better pricing for cleantech, one proposal suggested pooling together multiple developing countries' procurement needs for cleantech.[182] In doing so, developing countries may thus obtain economies of scale; hence, they may attract suppliers of cleantech, thereby

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the World Bank establishes a "Strategic Technology Fund" that, among other things, would purchase climate-related intellectual property rights and place them in the public domain).

177. Various Cleantech Patent Studies, *supra* note 20, at 12.

178. Reichman et al., *supra* note 150, at 24.

179. *Id.*

180. Council for Trade-Related Aspects of Intellectual Prop. Rights, *Item 11 Contribution of Intellectual Property to Facilitate the Transfer of Environmentally Rational Technology*, WTO Doc. IP/C/M/76/Add.1 (June 11, 2014), https://perma.cc/L6RM-6K22.

181. *Id.* (Switzerland argues that it was manufacturing cost, not IPR, that determines most of the access price for cleantech.). *See also Joy Y. Xiang*, Addressing Climate Change*: Domestic Innovation, International Aid and Collaboration*, 5 N.Y.U. J. INTELL. PROP. & ENT. L. 196 (2015).

182. Reichman et al., *supra* note 150, at 24.

enabling them to bargain for more favorable terms.[183] This approach, also called collective bargaining,[184] may therefore address developing countries' ongoing complaint that IPR drives up the price of needed technologies, although the author's research has yet to find evidence supporting such a complaint in the area of cleantech generally.[185]

The scholars who propose the pooling approach also suggest combining this strategy with the threat of compulsory licensing.[186] This may further enhance developing countries' bargaining power. However, as indicated in the discussion above concerning the liberal use of compulsory licensing, this Article advises developing countries to use compulsory licensing judiciously to avoid scaring away potential foreign investors or discouraging domestic investments in cleantech innovation.

3. Optimizing the Procedures in the Existing Patent Systems

While the effectiveness of existing patent systems in addressing cleantech development and deployment may be debatable,[187] ways to leverage the existing patent systems to enhance international cleantech development and deployment remain.

A major suggestion for leveraging the existing patent system for international cleantech cooperation is to compile information on cleantech patents and patent applications, thereby making access to such information easier and more productive.[188] The compilation includes patent mapping or landscaping that identifies the specific technology sector to which a patented cleantech innovation belongs. In general, patent landscaping furthers innovation by helping researchers avoid duplicative R&D and making it easier for technological leapfrogging and other forms of cumulative development to occur. Patent landscaping can also help fuel, organize, and structure cleantech transfer transactions.[189] Such patent landscaping may help identify emerging technologies in key areas of interest.[190] Patent

183. *Id.*

184. Robert Bird & Daniel R. Cahoy, *the Impact of Compulsory Licensing on Foreign Direct Investment: A Collective Bargaining Approach*, 45 AM. BUS. L.J. 283 (2008).

185. *Joy Y. Xiang*, Addressing Climate Change: *Domestic Innovation, International Aid and Collaboration*, 5 N.Y.U. J. INTELL. PROP. & ENT. L. 196 (2016) (Concluding that the existence of IPR on cleantech has not been a major barrier for international cleantech transfer as most developing countries own no or few cleantech patents.).

186. Reichman et al., *supra* note 150, at 32.

187. *See*, *e.g.*, Claude Henry & Joseph E. Stiglitz, *Intellectual Property, Dissemination of Innovation and Sustainable Development*, 1 GLOBAL POL'Y 237 (2010); CARL SHAPIRO, NAVIGATING THE PATENT THICKET: CROSS LICENSES, PATENT POOLS, AND STANDARD SETTING, INNOVATION POLICY AND THE ECONOMY (Adam B. Jaffe et al. eds., 2001), https://perma.cc/KDA3-9TE2.

188. WORLD INTELLECTUAL PROPERTY ORGANIZATION, CLIMATE CHANGE AND THE INTELLECTUAL PROPERTY SYSTEM: WHAT CHALLENGES, WHAT OPTIONS, WHAT SOLUTIONS? 4 (n.d.), https://perma.cc/RV9G-VMTP.

189. *Id.* at 7.

190. *Id.*

landscaping can also reveal the changing temporal and geographical profile of innovation, highlight the most active or newest players to a technical field, and illustrate the significant role of the public and private sectors, developed and developing countries, and multinationals and small firms in the development of strategic cleantech.[191]

Currently, patent information is published by patent offices of different patent jurisdictions and is free for the public to access even without patent information compilation or patent landscaping. However, the proposed compilation or landscaping of such free patent information will need to utilize advanced information technology. Thus, one criticism for patent information compilation or landscaping is that compilation of public materials, to which developing countries already have access, would require the diversion of precious financial resources to fund expensive IT contracts.[192] Such financial resources could be used to address more critical tasks, such as helping developing countries procure needed cleantech, or improving their local capacities in adapting and implementing cleantech.

Meanwhile, different national patent jurisdictions have installed programs to accelerate the examinations of cleantech patents.[193] Through such fast-track processing, cleantech innovations can be publicly disclosed (for example, via published patent applications or granted patents), become commercialized, and become public domain information (as patents expire more quickly) in a faster cycle. This way, entities in developing countries may learn about and access the cleantech sooner. A recent international survey of the fast-tracking programs indicates that these programs have accelerated the diffusion of cleantech knowledge, at least in the short term.[194]

Another suggestion for leveraging the existing patent systems is to reduce the patenting fees associated with cleantech patent applications.[195] This approach will help reduce the private sector's financial burdens, especially those of solo or small-business inventors, in applying for patent protection for their cleantech inventions.

Thus far, the implemented optimizations are of procedural matters in cleantech patent procurement. Substantive matters, such as the ones discussed above in Part II.A, have yet to be implemented.

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191. *Id.*

192. Cynthia Cannady, ACCESS TO CLIMATE CHANGE TECHNOLOGY BY DEVELOPING COUNTRIES 13 (2009), https://perma.cc/VQ3W-K8P6.

193. For example, Australia, Canada, Israel, Japan, Korea, the United Kingdom, and the United States.

194. Antoine Dechezleprêtre, FAST-TRACKING GREEN PATENT APPLICATIONS 12 (2013), https://perma.cc/PG3S-78WX.

195. Keith Maskus, DIFFERENTIATED INTELLECTUAL PROPERTY REGIMES FOR ENVIRONMENTAL AND CLIMATE TECHNOLOGIES 22-23 (2010).

D. COLLABORATIVE IPR MANAGEMENT

Collaborative IPR management occurs when the parties involved in a technology transaction address IPR issues in a collaborative manner so that IPR acts not as a barrier, and may even facilitate the technology transaction at hand.

The range of tools for realizing collaborative IPR management include, though are not limited to, cooperative R&D agreements, win-win voluntary technology licenses, cross-licenses, technology standards agreements, and patent pooling. Evidence shows that collaborative IPR management tools have helped rapid improvement and broader diffusion of involved technologies.[196] They may also help technology users cut through patent thickets and avoid patent hold-ups in innovation.[197]

1. Cooperative R&D Agreements and the U.S.-China Clean Energy Research Center

For instance, joint R&D agreements between developed and developing countries provide a pathway for transferring technologies, R&D skills, and information to developing countries. International joint R&D can improve the efficiency of global R&D spending, increase synergy among countries, and reduce duplicative efforts.

Currently, international cooperative R&D has been limited in scope. Data show that at least 90% of cleantech R&D occurs within the same country.[198] As such, there are limited examples of international cooperative cleantech R&D efforts. For example, the International Energy Association ("IEA") has a Framework for international energy technology collaboration.[199] IEA member countries may establish contractual relationships according to this Framework to cooperate on energy technology research, development, and deployment.[200] Currently, IEA hosts 38 such agreements.[201] Participants of these agreements manage their own funding through domestic R&D programs and budgets[202] and establish their own IPR arrangements, per the Framework's requirements.[203] Another example is the Consultative Group on International Agricultural Research ("CGIAR"), a global research partnership aiming for a food-secure future. CGIAR is a major funder and performer of international agriculture R&D that focuses on helping developing countries meet their agricultural needs. CGIAR's budgets provide approximately 3% of global agriculture R&D

196. Iliev & Neuhoff, *supra* note 51, at 5.

197. *Id*. at 4.

198. Jason Els, et al., Galvanizing Low-Carbon Innovation 7 (2016) (unpublished working paper), *available at* https://perma.cc/4W3Q-Z7MG.

199. Int'l Energy Agency ["IEA"], *IEA Framework for International Energy Technology Cooperation* (2003), https://perma.cc/4BX6-J9QG.

200. *Id*. at art 1.1-2.

201. *Technology Collaboration Programmes*, IEA, https://perma.cc/6NCV-FVS5 (Dec. 12, 2018).

202. Reichman et al., *supra* note 150, at 26.

203. IEA, *supra* note 201, art. 4.4.3.

spending; viewing climate mitigation and adaptation as its key goals, CGIAR has committed to devote at least 60% of its budget towards these goals by 2030.[204] Also, as mentioned in Part I.C, bilateral joint R&D efforts have formed, for example, between the United States, Canada, and China, between the United States and India, and between China and African countries.

Joint R&D can occur through joint development, public-private partnerships, or joint ventures.[205] In either venue, the cooperation involves delineating intellectual property rights, for example, how different parties' IPR input to the cooperation should be managed, and how IPR created from the cooperation should be owned or used. The U.S.-China Cleantech Collaboration program is a good example of cooperative joint R&D efforts between a developed country and a developing country, as it has been ongoing since 2009 and has produced a unique IP management framework.

In 2009, the United States and China signed seven agreements to pursue cooperation in addressing climate change, energy, and environmental issues.[206] This cooperation has been regarded as the most ambitious model of bilateral cleantech cooperation to date.[207] The cooperation includes multiple cleantech areas such as energy conservation and efficiency, renewable energy, cleaner uses of coal, carbon capture and storage, sustainable transportation, smart grids, natural resource conservation, and low-carbon economic growth.[208] So far, the cooperation has established the U.S.-China Clean Energy Research Center ("CERC"),[209] the U.S.-China Electric Vehicle Initiative, the U.S.-China Renewable Energy Partnership, the U.S.-China Energy Efficiency Action Plan, the U.S.-China Shale Gas Partnership, and the U.S-China Energy Cooperation Program.[210] Among these establishments, the CERC has been the central focus and is particularly relevant for this Article because of the CERC's way of addressing IPR issues arising during cooperation.

The CERC claims that it created a unique IP framework for managing IPR issues arising from this bilateral cleantech cooperation.[211] The IP framework aims to effectively protect IPR via a system of shared or joint ownership of IP

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204. *Strategy*, CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH (last visited Sept. 24, 2019), https://perma.cc/3WVF-KRX5.

205. STANDING COMMITTEE ON THE LAW OF PATENTS, *supra* note 57, at 16.

206. *U.S.-China Memorandum of Understanding to Enhance Cooperation on Climate Change, Energy and the Environment*, U.S. DEP'T OF STATE (July 28, 2009), https://perma.cc/7YZM-Z637.

207. JOANNA I. LEWIS, PAULSON INST., A BETTER APPROACH TO INTELLECTUAL PROPERTY? LESSONS FROM THE US-CHINA CLEAN ENERGY RESEARCH CENTER 7 (June 2015), https://perma.cc/4ZMJ-B9W2.

208. U.S. DEP'T OF STATE, *supra* note 206.

209. CERC researchers in the United States and China are to focus energy solutions in five key research areas: Advanced Coal Technology, Building Energy Efficiency, Clean Vehicles, Water and Energy Technologies, Medium-and Heavy-Duty Trucks. *See U.S.-China Energy Collaboration*, U.S. DEP'T OF ENERGY OFF. OF INT'L AFF., https://perma.cc/9LEH-M7FF (last visited Sept. 24, 2019).

210. MATTHEW RIMMER, IP AND CLIMATE CHANGE–INVENTING CLEAN TECHNOLOGIES 267 (2011).

211. *Intellectual Property*, U.S.-CHINA CLEAN ENERGY RES. CTR., https://perma.cc/Z27K-7YZT (last visited Sept. 25, 2019).

emerging from the collaboration.[212] The framework aims to make researchers feel comfortable to share information and to enable them to retain appropriate rights for new technologies they create.[213] A review of the CERC's IP framework reveals a detailed and concrete delineation of key IPR issues that may arise from international cleantech cooperation.

For example, the IP framework defines "Background IP"—IP created or invented outside the scope of the cooperation and used during the cooperation—and states that the owners of such IP retain all rights to the IP, and that the cooperation may be required to obtain a license to use such IP.[214] This way, the framework identifies the owners of the original IP that makes the cooperation possible and how the participants may use such IP.

The IP framework also defines "Project IP," which is IP created or invented within the scope of the collaboration. A Project IP resulting from the CERC cooperation is jointly owned by the U.S. and Chinese participants. That is, if the Project IP comes out from the defined scope of jointed funded cooperative activities, Chinese participants own its IP rights in China, and U.S. participants own the corresponding IP rights in the United States.[215] This arrangement implies that China would own Chinese patents on the improvement of U.S.-owned background IP, while the United States would own U.S. patents on the improvement of Chinese-owned background IP. Meanwhile, the non-IP-owning party has the right to access and a free right to use any Project IP when executing the jointly funded cooperative activities.[216] If the non-IP-owning party needs to use the Project IP outside the scope of jointly funded cooperative activities, the IP-owning party must negotiate in good faith a non-exclusive right for the non-IP-owning party to use the IP.[217] A party separately owns a Project IP if the Project IP originates from the party's activities *outside* the defined scope of jointly funded cooperative activities.[218]

The CERC aims to support the wide sharing of scientific information generated during the cooperation. Accordingly, the IP framework grants each collaborating party a worldwide royalty-free license to use scientific and technical journal articles, reports, and books directly arising from the cooperation.[219] The IP

212. *Id.*

213. *Id.*

214. *CERC Annotated Technology Management Plan, Article III–Ownership of Intellectual Property*, U.S.-CHINA CLEAN ENERGY RES. CTR. (Dec. 12, 2018) (on file with author).

215. This implies that China will own the Chinese IP on improvements coming out from a background IP owned by the U.S., if the improvements are results of the jointed funded cooperative activities; and vice versa.

216. U.S.-CHINA CLEAN ENERGY RESEARCH CTR., *supra* note 214, Article III–Ownership of Intellectual Property, Provision 4.

217. *Id.*, Article V–Sharing and Protection of Interests in Intellectual Property Rights, Provision 4.1.

218. *Id.*

219. *CERC Protocol, Article II–Allocation of Rights*, U.S.-CHINA CLEAN ENERGY RES. CTR. (Dec. 12, 2018) (on file with author).

framework also defines what constitutes business confidential information, which shall be excluded from public dissemination, protected according to law, and includes the execution of confidentiality agreements to protect this information.[220]

Lastly, the IP framework outlines a dispute resolution process for IP disputes arising from CERC activities.[221] The parties are to resolve a dispute first through discussions. Failing that, the dispute is to be submitted to an agreed-upon arbitration tribunal for binding arbitration according to applicable international law. The process sets the arbitration rules of the United Nations Commission on International Trade Law ("UNCITRAL") as the binding rules.

Specific and concrete as the CERC's IP framework is, it nonetheless took the United States and China lengthy discussions to overcome disagreements and reach a consensus about it. According to people who participated in the discussions, the countries discussed and compromised on different positions for multiple IPR arrangements.[222] For example, the United States prefers non-exclusive licensing to extend automatically to a licensee's subsidiaries or branches. China prefers that there be no such automatic extension and that the licensor should grant such a sub-license independently. The consensus reached is that there is no automatic extension of a non-exclusive license to the subsidiaries or branches of a licensee.[223] Furthermore, the United States prefers that an IP co-owner be free to license to a third party without being accountable to the other IP co-owner. China prefers a non-exclusive license to a third party and wants as a precondition that such a license be beneficial and acceptable to all IP owners. The consensus reached allows an IP co-owner to issue a nonexclusive license to a third party and not be accountable to other IP co-owners or the respective government.[224]

Thus far, the results manifested from using the CERC IP framework have been a mix of positives and ambivalences. On the positive side, during 2011-2015, CERC participants produced more than 400 research papers, forty-four significant research outcomes, and thirty-nine patent applications.[225] Interestingly, there has been no co-ownership of Project IP.[226] Co-ownership means both Chinese and U.S. participants together own the Chinese patent or the U.S. patent on a project IP. This lack of co-ownership may reflect both the Chinese and U.S.

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220. *Id*., Article III–Business-Confidential Information.

221. U.S.-CHINA CLEAN ENERGY RESEARCH CTR, *supra* note 214, at 9.

222. Liu Shen & Yu Xiang, *Managing IP In Sino-US Clean Energy Collabaration–The Case of the US-China Clean Energy Research Center*, WIPO-WTO COLLOQUIUM PAPERS 32, 37 (Asian ed. 2017), https://perma.cc/U3PY-CM7G.

223. *Id*., at 38.

224. *Id*.

225. Abdel-Latif, *supra* note 113, at 238.

226. In 2017, CERC announced a draft U.S.-China joint IP agreement for the development of an open source, online, building-energy efficiency audit tool. U.S.-CHINA CLEAN ENERGY RES. CTR. (last visited Sept. 25, 2019), https://perma.cc/7BQJ-9PED (the effect of such an agreement has yet to be seen).

participants' concerns about restrictions on exploitations on co-owned patents.[227] Additionally, while Chinese participants have filed patents in both China and the United States, U.S. participants have only filed patents in the U.S.[228] This phenomenon may reflect the U.S. participants' perspective about IPR protection in China.

The CERC IP framework is credited with having encouraged participants to join CERC activities, though it does not solve all the IP challenges.[229] The United States and China have agreed to extend the CERC for the years 2016–2020. In comparison, the U.S.-India clean energy partnership, with a similar mission as the CERC, has produced fewer positive results; lacking an IP framework like the CERC has is viewed as one of the possible reasons.[230]

Scholars view the CERC IP framework as a potential model, or at least a good starting point, for managing IPR issues arising during international cleantech cooperation.[231] Yet, as shown by the lack of co-owned patent filing and the lack of patent filings in China by the U.S. participants, the distance in IP sophistication between developed countries and emerging economies or other developing countries remains a reality for IPR management in international cleantech cooperation.

2. Win-Win Voluntary Technology License

In today's knowledge and innovation economy, licensing—granting permission to use a tangible or intangible asset—is the predominant model for technology transactions.[232] Voluntary technology licenses make up most technology transactions, international or domestic. A win-win license agreement in a voluntary technology licensing transaction comes about when both parties "contribute relatively equal value to the technology transaction and stand to gain relatively equal benefit."[233] Such a contract is sustainable because both parties win in relatively equal amounts; hence, both are willing to abide by the terms of the contract.[234] Therefore, creating a win-win voluntary technology license will help promote sustainable international cleantech cooperation.

The actualization of win-win technology licensing needs parties from both developed and developing countries to respect and offer to fulfill the essential needs of parties on the other side. Let's assume a city in a developing country solicits globally for a bid to build an environmentally-friendly public transportation system.

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227. Shen & Xiang, *supra* note 222, at 39.
228. Lewis, *supra* note 9, at 552.
229. LEWIS, *supra* note 207.
230. *Id.*
231. *Id. See also*, Ahmed Abdel-Latif, *supra* note 113, at 239.
232. ROBERT W. GOMULKIEWTCZ ET AL., LICENSING INTELLECTUAL PROPERTY–LAW AND APPLICATION 20 (3d Edition, 2014).
233. Cannady, *supra* note 192, at 17.
234. *Id.* (see examples).

A scenario of a win-win technology license for international cleantech cooperation would be the following: when a company in a developed country bids for the opportunity, the company offers not only an IP license to its patents for building such a transportation system, but also documentation of its know-how, as well as the training of engineers from the developing country.[235] Meanwhile, the city in the developing country accepts the IP license and provides an environment to uphold the IP license, allowing other parties to use or copy the patented technology only with proper permission from the IP owner. A one-sided technology license would be that the company from the developed country only offers the license to the patents, but no access to the associated know-how or the training of engineers from the developing country, and the city in the developing country fails to properly supervise the use of the IP assets and protect the developed country's legal rights.

International institutions and national governments can encourage win-win voluntary licensing between entities in developed and developing countries by offering tax incentives, guarantees, subsidies, and other encouragements.[236] They can also help create enabling environments that respect and enforce IPRs, and cultivate human capitals that can quickly learn and adapt new technologies.

3. Cross-Licensing

Cross-licensing is the formation of a contractual agreement among two or more parties to grant each other mutual rights to the parties' IP assets.[237] The terms in such agreements typically are based on royalty-free licensing terms; hence, parties have no monetary obligations toward each other. The IP assets involved usually are patents, such as a portion or the entirety of a party's patent portfolio.

Cross-licensing usually occurs between parties who have IP covering different aspects of one or more products. Parties normally use cross-licensing to clear potential IP infringement, in order to avoid lawsuits and share risks of mutual infringement.[238] For example, Google and Samsung entered a broad cross-license agreement so they can "reduce the potential for litigation and instead focus on innovation."[239] Cross-licensing may also save parties from developing technologies that the other parties have already developed, which accelerates technology development and diffusion.[240] However, a cross-licensing arrangement may cause antitrust concerns when the arrangement could stifle competition; this may

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235. *Id*. at 18 (see examples).
236. *Id*. at 22.
237. SHAPIRO, *supra* note 187, at 127.
238. *Id.; see also* Iliev & Neuhoff, *supra* note 51, at 7.
239. Eric Pfanner, *Google and Samsung Sign Broad Cross-Licensing Agreement*, N.Y. TIMES (Jan. 14, 2014), https://perma.cc/4JQF-GA6U.
240. Iliev & Neuhoff, *supra* note 51, at 25.

happen when an arrangement involves collusion for price fixing or market divisions.[241]

Cross-licensing may not be a good option for entities in developing countries other than the handful of emerging economies. As mentioned before, emerging economies such as China and India have built their own cleantech IP portfolios, and thus are likely to be in a position to cross-license their cleantech IP assets with other countries. However, for the rest of developing countries, cross-licensing may not be a viable IPR management approach, as these countries have yet to build up their own cleantech IP portfolios for cross-licensing to occur. For entities in developing countries to utilize the cross-licensing tool necessary to access cleantech owned by entities in developed countries, developing countries need to be clear about their own IP assets and intentional about building their IP portfolios, in order to have bargaining power during international cleantech cooperation.

4. Technology Standards Agreements

Technology standards agreements form when key players for a particular shared or complementary technology agree to provide access to each other's IPRs to stimulate the adoption and diffusion of the technology in return for a modest royalty, or even nothing.[242] Such an arrangement can accelerate the development and deployment of technology.[243] Technology standards can be proprietary if the participants do not allow parties outside the group to use the standards. Open technology standards form when third-parties can join the agreement and adopt and implement the standardized technologies. The adoption of open technology standards can save duplicated R&D efforts, decrease barriers to entry for newcomers, and produce unexpected and novel uses of technology.[244]

For international cleantech cooperation, when entities in developed countries opt not to enter the markets of developing countries, these entities may opt to form open technology standards surrounding particular clean technologies. Of course, such standard formations need to observe developing countries' policies and practices for standards. This way, developing countries will have access to the technologies, and adapt and diffuse the technologies into the local markets, while the entities in developed countries may receive some revenues through royalty payments.[245]

241. *Id*. at 7–8.
242. *Id*. at 5.
243. *Id*.
244. *Id*. at 23.
245. *Id*. at 24.

5. Patent Pooling

Patent pooling gathers complementary patents owned by different parties; these parties and outsiders can then access these patents via a non-exclusive license.[246] For example, makers of hybrid cars can pool their patents together. This allows these carmakers to access each other's patents via a non-exclusive license, and allows a third-party to license these patents as a package. Patent pooling can accelerate the development and diffusion of technology, as they may integrate complementary technologies, reduce transaction costs, clear blocking positions, and avoid costly infringement litigations.[247]

However, patent pooling may also cause antitrust concerns.[248] For example, when the contributors to a patent pool collectively possess dominating market powers, not allowing a would-be participant to join the patent pool can be anticompetitive, if they consequently cannot effectively compete in the market for the good or service incorporating the licensed technologies.[249]

A further concern for patent pooling is that developing countries may need to pay for technologies that are not patented in their jurisdictions when accessing technologies through patent pools.[250] On the other hand, when a technology has no patent protection in a developing country, though the country can access and use the technology for free, the country often cannot access the associated know-how and technical expertise necessary for implementing the technology. Such information often comes from having a healthy relationship with the technology owner. Patent pooling may provide a venue for building such a relationship.

Royalty-free patent pooling for cleantech has been suggested as a means through which developing countries can use IP-protected cleantech without paying royalties or license fees. For example, in 2009 a group of developing countries proposed establishing a Global Technology Pool for Climate Change.[251] The Pool's purpose is to promote and ensure access to IP-protected cleantech and associated know-how. The proposal asked for nonexclusive royalty-free licensing terms for developing countries.[252] There is also a suggestion to have the GCF—one of the UNFCCC financial mechanisms—manage a cleantech patent pool.[253]

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246. Reichman et al., *supra* note 150, at 24. Another form of patent pooling is called package licensing, where two or more patent holders jointly license their complimentary patents and divide up the proceeds; s*ee* SHAPIRO, *supra* note 187, at 127.

247. U.S. DEP'T OF JUSTICE & U.S. FED. TRADE COMM'N, ANTITRUST GUIDELINES FOR THE LICENSING OF OF INTELLECTUAL PROPERTY 30 (2017), https://perma.cc/Z59G-SVMJ.

248. Iliev & Neuhoff, *supra* note 51, at 7–8.

249. U.S. DOJ & FTC, *supra* note 247, at 33.

250. Cannady, *supra* note 192, at 11.

251. THIRD WORLD NETWORK, *supra* note 131.

252. *Id*. at 2.

253. Fabrice Mattei, *Green Climate Fund as a Patent Pool for Climate Change Technologies*, ROUSE (Jan. 29, 2018), https://perma.cc/NWJ9-Y5DE.

The idea is for the GCF to invest in, acquire, and own cleantech inventions and patents in order to diffuse them to developing countries.[254]

While the above two proposals have yet to be put into practice, a few patent pools have used the idea of nonexclusive royalty-free licensing of cleantech patents. The most acclaimed cleantech patent pools include the Eco-Patent Commons project and the GreenXchange project; both are industry-initiated voluntary cleantech patent pools. The discussion below gives an overview of their formation and examines what we can learn from them.

a. Eco-Patent Commons

Established by several multinational companies,[255] Eco-Patent Commons ("EPC") pooled environmentally-beneficial patents pledged by member companies.[256] The EPC then licensed the patents to its members and non-members on royalty-free terms, while the patent owners retained ownership. The pledging companies promised not to enforce the patent rights on the EPC licensees as long as the licensees' use of the pledged patents achieved an environmentally-beneficial result.[257]

The EPC offered a low threshold for membership: any entity could join the EPC by pledging at least one patent and the EPC charged no membership fee. The pledging companies had the freedom to decide what patents they would like to donate; they were not obligated to provide support to the EPC users of the patents, and they had discretion on whether to keep on paying the maintenance fee at the patent offices to keep the donated patents alive.[258]

Started in 2008, the EPC wound down starting in 2011, when no new patents came in, and ceased operation in 2016 due to lack of activities.[259] During the EPC's existence, companies pledged 248 patents covering ninty-four cleantech innovations.[260]

Scholars had questioned whether EPC member companies would have the incentive to contribute large numbers of environmentally beneficial patents and whether the patents pledged to the EPC would be ultimately useful for addressing environmental issues.[261] A post-mortem study of the patents pledged to the EPC

254. *Id.*

255. E.g., IBM, Nokia, Pitney Bowes, and Sony. *See generally* Bassem Awad, *Global Patent Pledges: a Collaborative Mechanism for Climate Change Technology*, 81 CTR. FOR INT'L GOVERNANCE INNOVATION CIGI PAPERS 1, 5 (Nov. 27, 2015), https://perma.cc/8CUL-SX9E.

256. Wayne Balta, *Welcome to the Eco Patent Commons*, CEF (Sept. 7, 2015), https://perma.cc/T2MS-WWTT.

257. *Id.*

258. *Id.*

259. Jorge L. Contreras et al., *Assessing the Effectiveness of the Eco-Patent Commons–A Post-mortem Analysis*, 161 CTR. FOR INT'L GOVERNANCE INNOVATION CIGI PAPERS 1, 3–5 (Feb. 2018), https://perma.cc/5E9X-QYKN.

260. *Id.* at 9.

261. Reichman et al., *supra* note 150, at 21.

indicates that companies did not pledge valuable patents. Forward citations of a patent is a way of indicating how valuable a patent is. The post-mortem study shows that the EPC patents are half as likely to be cited as the patents in the control group.[262] The same study shows that pledging companies did pledge potentially useful cleantech patents, though those patents had only moderate values and most of them were never used by and were not essential to the pledging companies.[263] The study also found that the technologies covered in the pledged patents were not disruptive technologies, but instead were mostly derived from old technologies.[264] As a result, licensing the pledged patents on a royalty-free term likely had no discernable impact on the diffusion of the patented knowledge.[265]

The post-mortem study of the EPC also revealed that the EPC project lacked demonstrable results: the companies pledged cleantech patents on their own initiative without knowing what was actually needed.[266] As a result, the utilization of the pledged patents was not high. The study recommended future similar patent commons projects to create independent and sufficient funding in order for the commons to be sustainable, gather patents that have great inherent values, require contributors to identify potential applications of the patents, and track patent utilization to demonstrate results.[267] The study also suggested that patent commons such as the EPC may become more effective in technology diffusion if there were more promotion on the use of the technologies in the pledged patents, for example, via providing concrete guidance on how subsequent innovations may leverage the technologies protected by pledged patents.[268]

b. GreenXchange

A similar yet more restrictive patent pool project was the GreenXchange (GX).[269] The GX was a web-based marketplace where companies could post their patented technologies and license the technologies to others. The GX aimed to stimulate IP sharing to fast-track green innovation for sustainable development.[270]

A review of patents posted on the GX indicates that most of them could not be used for commercial exploitation. The GX differs from the EPC in that the

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262. Bronwyn H. Hall & Christian Helmers, *Innovation and Diffusion of Clean/Green Technology: Can Patent Commons Help?* 13 (Nat'l Bureau for Econ. Res., Working Paper No. 16,920, June 2011), https://perma.cc/M2GH-UWYE.

263. *Id*. at 37.

264. *Id*.

265. *Id*.

266. Contreras et al., *supra* note 259, at 16.

267. *Id*. at 17.

268. *Id*.

269. GREENXCHANGE, ABOUT THE GREENXCHANGE, https://perma.cc/55UW-95XT (last visited Sept. 25, 2019).

270. GREENXCHANGE, ABOUT THE PROJECT, https://perma.cc/Y3NH-LQJT (last visited Sept. 25, 2019).

companies posting their IP assets on the GX had three licensing options. The Standard Option is similar to that of the EPC: GX users obtained a royalty-free license to use the patented technology commercially.[271] Unlike the EPC, the GX did not restrict the commercial use to environmentally-beneficial use. The second option, Standard Plus, allowed a patent owner to charge users a licensing fee and to restrict who could accept the license by defining the field of use or geography of use.[272] This option allowed the patent owner to limit the licensees to non-competitors or users from developing countries. The third option, the Research Non-exempt Option, allowed non-profit institutions, such as universities, to conduct research on the patented technology, and to patent the subsequent improvements for non-commercial use.[273] Of the 463 patents posted on the GX, two were set up with the Standard Licensing Option, five were set up with the Standard Plus Option, and 456 were set up with the Research Non-exempt Licensing option. Hence, most of the GX patents could not be used for commercial exploitation.

In 2010, ten leading organization launched the GX.[274] It became inactive in 2011. Most of the members did not pledge any patents. The patents posted online came from only three members.[275]

In reviewing the experience, GX personnel attributed the failure of the GX to three reasons. First, the GX's IP sharing concept ran contrary to the conventional approach of using IP as a defensive weapon to block competitors and mitigate infringement risk.[276] The author questions this observation. Starting in the late 1990s, companies, especially those in developed countries, realized that their IP portfolios were business assets they could monetize and stopped regarding defensive use of IP assets as the main function of IP portfolios. For example, multinational companies such as IBM, Microsoft, Ericsson, and Nokia have reaped billions of U.S. dollars in annual revenues from IP licensing.[277]

The other two reasons offered by the GX personnel sound more reasonable. For one, users were more interested in the knowledge that created the posted patents than in gaining access to the patents. Here, the GX learned to use the online platform to build relationships between the patent owners and potential users so to improve the potential users' exploration of the patents and access to knowledge and technical skills associated with the patented technology, rather than focusing

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271. *Id.*

272. *Id.*

273. *Id.*

274. Nike, Yahoo!, Best Buy, Creative Commons, IDEO, Mountain Equipment Co-op, nGenera, Outdoor Industry Association, salesforce.com, and 2degrees. *See*, GREEN XCHANGE, *supra* note 270.

275. Wherein Nike contributed 444 patents, Best Buy fifteen, and the Univ. of Berkeley four. *Id.*

276. Roya Ghafele & Robert O'Brien, *Open Innovation for Sustainability: Lessons from the GreenXchange Experience*, INT'L CTR. FOR TRADE AND SUSTAINABLE DEV. (June 1, 2012), https://perma.cc/UBR8-H7YE.

277. *See, e.g.*, *IBM Patents Add 1.2B to Revenue*, INTELL. PROP. CTR. (Aug. 3, 2018), https://perma.cc/XZ6W-MQ4A. *See also Top Licensors Ericsson, Microsoft and Nokia All See Drop in Year-on-Year Patent Revenues*, IAM MKT. (June 30, 2019), https://perma.cc/4XR6-DYC7.

the online platform on accruing patent assets.[278] The last reason cited for the GX's failure is that the resources allocated for building the GX platform were limited. For example, the GX consisted of only two staff members, which became further insufficient after the GX shifted its focus to relationship building surrounding the posted patent assets.[279]

The failures of both the EPC and GX projects offer valuable insights into voluntary cleantech transfer. For example, these experiences indicate that cleantech transactions based on goodwill or moral obligation may result in second-rate cleantech being transferred and the participants in the transactions being less motivated to keep the momentum going.

However, cleantech patent pooling is a good mechanism to identify available clean technologies and establish connections between cleantech solution suppliers and cleantech solution seekers. The experience of the EPC and the GX helps to clarify that cleantech patent pooling needs to have a sustainable infrastructure. For example, participants in a pool need to pay a membership fee, or the pool needs to charge a user fee, and participants of the pool need to be motivated to collaborate in using the technologies in the pledged patents. The patents pledged to the pool need to be examined to ensure they are truly valuable or needed by the markets. All this points to the necessity of a governing body for a patent pool. The governing body should have sustainable funding and the capacity to evaluate or engage competent parties to evaluate the quality of the pledged cleantech patents.

c. WIPO Green

In 2013, WIPO established the WIPO Green platform. WIPO Green is more than a patent pool; it is a technology pool, as the platform includes an open-access online database that collects clean technologies (including not only intellectual property, but also technical information such as know-how)[280] that are available for licensing, collaboration, and sale.[281] WIPO Green also provides an internet portal that connects cleantech experts and those who seek cleantech solutions. The portal allows those seeking cleantech solutions to post need requests.[282] WIPO Green charges no fees for using the online database and the internet portal. Unlike the services offered by the CTCN of the UNFCCC Technology Mechanism, which connects cleantech solution suppliers with governments of developing countries, WIPO Green connects cleantech solution suppliers with entities in developing countries that have cleantech needs.

278. Ghafele & O'Brien, *supra* note 276.

279. *Id.*

280. *Terms and Conditions for the Use of the WIPO Green Database, art. 1.1.*, WIPO GREEN (Oct. 20, 2019), https://perma.cc/59GS-P2XA.

281. *WIPO GREEN–the MarketPlace for Sustainable Technology*, WIPO (Dec. 12, 2018), https://perma.cc/LX3W-MAPC.

282. *WIPO GREEN Database*, WIPO (Dec. 12, 2018), https://perma.cc/VE5F-ZUH7.

WIPO Green itself does not participate in the transaction between a cleantech solution seeker and a cleantech solution provider; the parties work out a mutually-agreeable contract on their own.[283] WIPO Green has a Charter that provides the operating principles for the program, with IPR being one of the principles. The Charter states that IPRs "are an important policy tool to encourage innovation," "provide economic incentives to develop new technology and help diffuse innovation," and "structure relationships that underpin commercial transactions."[284]

WIPO Green currently provides limited services for supporting user transactions, though noting services supporting the transactions between cleantech solution seekers and providers are important. The services WIPO Green currently provides its users include access to normal WIPO services (such as capacity building in areas related to IPR management), WIPO's multi-jurisdictional patent filing system (the PCT System), and WIPO's Arbitration and Mediation services at a reduced rate.[285]

WIPO Green has an advisory board comprising of industry partners and the WIPO Secretariat. The advisory board guides the activities for the program, e.g., advising the program on strategies, amendments to the program Charter, and classification of the cleantech in the WIPO Green database, and building relationships with external institutions.[286] Thus far, WIPO Green has about eighty-six industry partners[287] and over 5,000 members (partners and users of the program).[288] The membership is diverse, including multinational companies, financing institutions, intergovernmental organizations, small to medium-size businesses, consultants, industry associations, NGOs, and academics.[289]

WIPO's regular budgets fund the daily operations of WIPO Green. WIPO Green itself does not provide financial support to its users. However, it does provide its users a list of external financial resources where the users may seek financial support for the development and deployment of cleantech.[290]

Even with the limited funding and supporting services, WIPO Green has sustained itself and has been growing steadily. From 2013 to early 2019, WIPO Green has posted more than 3,000 cleantech in its online database, has posted more than 150 need requests from cleantech solution seekers, mostly from developing countries, and has made more than 300 connections between cleantech

283. *WIPO GREEN–the Marketplace for Sustainable Technology, Charter*, WIPO (Feb. 2013), https://perma.cc/EUL4-Z4NQ. However, WIPO GREEN does provide a detailed IP license checklist guiding the parties on issues to cover in an IP licensing transaction. *See WIPO Green Licensing Checklist*, WIPO GREEN (Dec. 12, 2018), https://perma.cc/K7XC-8HBW.

284. *WIPO Green Licensing Checklist*, *supra* note 283.

285. *Frequently Asked Questions*, WIPO GREEN (Jan. 25, 2019), https://perma.cc/MB4F-77CK.

286. *Id.*

287. *Partners*, WIPO GREEN (Jan. 25, 2019), https://perma.cc/KB6B-9EW6.

288. *WIPO GREEN Network*, WIPO GREEN (Jan. 25, 2019), https://perma.cc/UR45-NTNV.

289. *Id.*

290. *Finding Sources of Funding*, WIPO GREEN (Jan. 25, 2019), https://perma.cc/6ETJ-FPTE.

solution seekers and cleantech solution providers.[291] Into its seventh year, the WIPO Green program is still growing and gaining international attention.[292] WIPO Green seems to be a promising program for enabling cleantech owners and cleantech seekers to form cleantech transactions based on mutually-agreed terms.

III. PROPOSAL: MUTUALLY BENEFICIAL INTERNATIONAL CLEANTECH COOPERATION

Based on the discussion above concerning international cleantech cooperation and available IPR management models for it, this Article now proposes how we may go forth with international cleantech cooperation and the associated IPR management.

This Article proposes the construction of mutually beneficial international cleantech cooperation to enhance the needed global development and deployment of cleantech. Mutually beneficial international cleantech cooperation means the terms of the cooperation address the major interests of participating parties and are agreeable to all participating parties. Such cooperation includes proper management of IPR issues involved in the cooperation.

For proper IPR management in international cleantech cooperation, this Article proposes that besides trying to reform the existing IPR regimes for cleantech specifically, we should in the meantime take existing IP regimes as they are and manage IPR issues in international cleantech cooperation creatively and collaboratively. In particular, this Article proposes to enhance the existing WIPO Green program so to make it an effective global platform for mutually beneficial international cleantech deployment.

A. PROPOSAL PART A: TAKE EXISTING IP REGIMES AS THEY ARE

To achieve proper management of IPR issues arising during international cleantech cooperation, this Article proposes that we should also use the current international and domestic IP regimes as is.

In proposing this, this Article presumes that the global community can still explore approaches to reform the existing IP regimes concerning cleantech. For example, the discussion and exploration on approaches such as removing, weakening, or revoking IP protection on clean technologies, or liberal use of compulsory licensing on cleantech patents, may continue. Nonetheless, these substantive changes require much consensus building, and thus would be time-consuming. This Article proposes we meanwhile take the existing IP regimes as they are and proceed with managing IPR issues arising during international cleantech cooperation accordingly. This way, we will not waste time making much-needed progress in global cleantech development and deployment.

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291. *WIPO Green Database, supra* note 282; *see also* Abdel-Latif, *supra* note 113, at 233.
292. Abdel-Latif, *supra* note 113, at 236.

In proposing so, this Article suggests that developing countries also act judiciously toward TRIPS-plus standards that may expand IPR on cleantech, taking them on only after carefully balancing the short-term and long-term implications of implementing such standards.

Specifically, the proposal on taking the current IP regimes as they are means keeping intact the substantive issues of IPR concerning cleantech, such as the patentability of cleantech and compulsory licensing of cleantech patents. This, however, allows for optimizing IPR procedural issues concerning cleantech. As discussed in Part II.C, optimizing IPR procedural issues concerning cleantech includes, for example, accelerating the cleantech patent examination process and reducing cleantech patent procurement fees for small businesses or individual inventors. Optimizing these procedures is relatively easy and less time- or resource-consuming; a few countries have already done so.[293]

B. PROPOSAL PART B: MANAGE IPR ISSUES IN INTERNATIONAL CLEANTECH COPERATION CREATIVELY AND COLLABORATIVELY

Managing IPR issues arising during international cleantech cooperation creatively and collaboratively includes two components. The first component is to address IPR management in international cooperation for developing cleantech. This Article suggests that each such cooperation incorporate a concrete and detailed IP management framework so that participants are clear of the ownership and sharing of IP involved or created during the cooperation. The U.S.-China CERC IP management framework (discussed in Part II.D) sets an example for managing IPR issues in specific international cleantech development cooperation.[294] It can be adapted for each specific international cleantech development cooperation.

The second component is to address international cooperation for deploying cleantech. For this component, this Article envisions a global platform where cleantech solution providers and cleantech solution seekers are able to interact and cooperate on well-informed and mutually agreed-upon terms. Specifically, this Article proposes we expand and optimize the afore-mentioned WIPO Green program into such a global platform.

1. A Global Platform for Mutually Beneficial International Cleantech Deployment

This Article envisions a global platform for mutually beneficial international cleantech deployment. The platform is a global marketplace where cleantech solution providers can exhibit their cleantech products and services, where

293. *See supra* Part II.C.3.

294. Other scholars have suggested so as well. *See*, LEWIS, *supra* note 207, at 7–10; Abdel-Latif, *supra* note 113, at 239.

cleantech solution seekers can post their needs, and where a solution provider and a solution seeker are free to work out their cleantech transaction on mutually agreed-upon terms independently. In addition, the global platform offers features that would enpower entities from developing countries to obtain the cleantech they need. The global platform also integrates the advantageous features of creative and collaborative IPR management approaches discussed in Part II and avoids their shortcomings.

The global platform should have the following features. First, a neutral and independent entity should administer the global platform. The entity itself will not invest in, acquire, or exploit cleantech; it will function merely as a good matchmaker between cleantech solution seekers and cleantech solution suppliers. Nor will the entity itself engage in a transaction between a cleantech solution seeker and a cleantech solution provider. The cleantech solution seeker and the cleantech solution provider will complete a cleantech transaction on their own, in terms mutually agreeable to them. As discussed in Part II.D, prior proposals have suggested that, for example, the GCF invest in, acquire, and exploit cleantech inventions and patents so to diffuse them to developing countries.[295] This Article suggests that cleantech owners should remain in charge of how to exploit cleantech inventions and patents. Cleantech solution seekers benefit the most from having a direct relationship with cleantech owners (i.e., cleantech solution providers), as they know best the operations of clean technology and hence are in the best position to advise cleantech solution seekers how to adapt and implement the cleantech in different environments.

Second, the global platform should allow cleantech solution providers and seekers to set up mutually agreeable terms for a transaction. This will likely enable cleantech solution providers to obtain fair and just compensation as well as the proper treatment of their IP assets, and therefore motivate them to share valuable cleantech solutions readily and willingly. This also means that the global platform will not mandate a cleantech transaction to be royalty-free, which is what the failed Eco-Patent Commons did or the proposed Global Technology Pool for Climate Change would do.[296] The global platform will also provide cleantech solution providers with opportunities to display their cleantech solutions to a global audience and access to a wide base of potential users of the cleantech solutions; this will further promote the global deployment of the cleantech solutions.

Third, the global platform should have sufficient funding, sufficient staffing, and an independent and empowered governing body. These features are necessary for the platform to provide good support to the international cleantech deployment transactions occurring via the platform. For example, the global platform can use the funding to subsidize cleantech seekers from developing

295. Mattei, *supra* note 253.

296. *Developing Countries Call for No Patents on Climate-Friendly Technologies*, *supra* note 163.

countries in purchasing or licensing cleantech via the global platform. Sufficient funding will also ensure the global platform sufficient staffing to provide needed functions for the platform and helpful services to the users of the platform. An independent and empowered governing body will be able to manage and grow the global platform and provide meaningful services to its users.

2. Optimizing WIPO Green toward the Envisioned Global Platform

The WIPO Green program as-is has some of the essential features of the envisioned global platform; hence it can be enhanced to enable mutually beneficial international cleantech deployment.[297] This Article proposes we enhance and expand the existing WIPO Green program. The proposal integrates lessons from Part II's analysis of the creative and collaborative IPR management models, especially those from the experiences of the cleantech patent pools such as the Eco-Patent Commons and the GreenXchange project.

As described in Part II.D, WIPO Green is an online market place where cleantech solution seekers can post their needs, cleantech solution providers can post their technologies or services, and where a cleantech solution seeker and provider can form a cleantech deployment transaction on their own. WIPO Green aims to accelerate the adaptation, adoption, and deployment of cleantech and has an advisory board that functions essentially as a governing body for the program.[298] Currently, the advisory board is already providing guidance and strategies for the platform.[299]

This Article suggests WIPO Green retain its current design. This includes WIPO Green remaining as an independent and neutral middle agent, a matchmaker between cleantech solution seekers and cleantech solution suppliers. This also includes WIPO Green keeping its current infrastructure as an online marketplace for cleantech solution providers and seekers to be informed of each other's services and needs.

Additionaly, this Article suggests that WIPO Green should expand or add certain features to enable its users to create well-informed and mutually beneficial international cleantech deployment transactions and to give cleantech seekers from developing countries easier procurement of the clean technologies they need.

First, WIPO Green should obtain sufficient funding. The funding can come from, for example, WIPO Green charging fees for using the program, the cleantech solution providers paying a percentage of the revenue generated from

297. We could have looked into the CTCN platform provided by the UNFCCC Technology Mechanism. However, the CTCN is more about providing advice and policy support for governments of developing countries in adopting cleantech solutions. Hence, the CTCN services do not seem to cover or focus on concrete international cleantech cooperation transactions among subnational entities such as specific cleantech seekers and owners, which is what this Article seeks to address.

298. *About WIPO Green*, WIPO GREEN (Dec. 12, 2018), https://perma.cc/YX7Z-GMR5.

299. Abdel-Latif, *supra* note 113, at 233.

successful cleantech transactions made via the program, or financial support from one of the international funding mechanisms, such as the UNFCCC financial mechanisms. In addition, as suggested by Maitra in his proposal for a global fund, one additional source of the funding for the program can be contributions from developed countries whose companies profit from using WIPO Green.[300]

Sufficient funding will enable WIPO Green to subsidize entities from developing countries conducting cleantech transactions via this program. For example, adopting the model suggested by Maitra,[301] after purchasing or licensing from a cleantech solution provider via the program, cleantech seekers from developing countries may present the proof of payments to WIPO Green to receive corresponding subsidies. The subsidies, for example, can be a certain percentage of the payments.

Sufficient funding will also ensure WIPO Green adequate staffing to support its users. WIPO Green should enhance the services it provides to the users of the platform. Such services, for example, can include educating cleantech solution seekers, especially those from developing countries, on how to negotiate a technology license and how to manage IPR issues arising during cooperation. Such services can also include matching potential cooperators and helping cleantech solution providers to introduce their cleantech products or services to the cleantech solution seekers. Such services can further include, as we learned from the GX experience (discussed in Part II.D.5), helping cleantech solution seekers and cleantech solution providers build relationships with each other so to ensure the cleantech solution seekers have accurate understanding of the cleantech solutions, as well as the know-how and technical skills necessary for implementing a cleantech solution.

Second, WIPO Green should support entities from developing countries in obtaining the cleantech they need. Such support includes providing the financial subsidies mentioned above and the services for enhancing these entities' abilities to negotiate and build constructive relationships with cleantech solution providers. Such support can also include allowing cleantech solution seekers to pool their procurement needs together if the conditions of the cleantech transactions permit such a pooled cleantech procurement. This way, the cleantech solution seekers, especially those from developing countries, may have better bargaining power in interacting with cleantech solution providers. Correspondingly, the cleantech solution providers should have the liberty to reject such a pooling approach.

Third, WIPO Green should expand the functions of the advisory board as the governing body of the program.[302] For example, learning from the experience of

300. Maitra, *supra* note 155, at 436.

301. *Id.*

302. Abdel-Latif, *supra* note 113, at 232 (The Board currently advises on the program strategy, amendments to the Charter, and the classification of green technologies on the online database, as well as networking with external networks and institutions.).

the EPC (discussed in Part II.D.5), the advisory board should have the ability to evaluate cleantech posted on the WIPO Green online marketplace or to engage an outside expert group to do the evaluation. The advisory board may also require cleantech solution providers when applying to display their cleantech solutions through the WIPO Green online marketplace to provide concrete guidance on the implementation and potential applications of a cleantech solution. The advisory board may also keep track of the utilization of a cleantech solution to see if it has the desired results in solving the needs stated by the cleantech solution seekers or as claimed by the cleantech solution provider.

C. EVALUATING THE PROPOSAL

In summary, this Article proposes that, while the global community continues to enhance one-way voluntary international cleantech transfer, the global community should also emphasize mutually-beneficial internatonal cleantech cooperation. Mutually-beneficial international cleantech cooperation aims to address the major interests of both cleantech seekers and cleantech owners. Such cooperation includes proper management of IPR issues involved. This Article suggests taking the existing IPR regimes as they are and manage IPR issues arising in international cleantech cooperation creatively and collaboratively. Specifically, this Article suggests the U.S.-China CERC IP management framework as a starting point for addressing IPR issues arising during international cooperation for cleantech development, and proposes the WIPO Green program be optimized to provide a global platform for international cleantech deployment.

One advantage of this proposal is that it may immediately speed up the needed increase of cleantech transfer from developed countries to developing countries. First, in suggesting taking the existing domestic and international IP regimes as they are, less time will be lost in waiting for the existing IP regimes to be reformed for cleantech development and deployment. Second, the proposal does not require the creation of new agencies or new frameworks for IPR management. For example, at the operational level, the proposal suggests to adapt an existing IP management framework, such as the U.S.-China CERC IP Framework, for international cooperation in cleantech development, and to optimize an existing international program, such as WIPO Green, for international cooperation in cleantech deployment. Both characteristics of the proposal will allow a speedy increase in the needed cleantech transfer to developing countries.

Further, by suggesting a global platform such as an enhanced WIPO Green program, the proposal enables cleantech solution providers and seekers to reach for mutually beneficial cleantech cooperation. The proposed platform allows both sides to express and address their interests, and thus will increase cleantech owners' willingness in transferring cleantech to developing countries, as well as

developing countries' access to cleantech. The proposal addresses cleantech owners' motivation in having fair dealings and just compensation from the use of their technologies, in addition to their motivation to act with goodwill, moral obligation, or a sense of social responsibility. Meanwhile, the proposal provides cleantech solution seekers from developing countries financial subsidies for the cleantech transactions they form with entities from developed countries. This way, cleantech solution seekers from developing countries are compensated for prices of accessing cleantech, which developing countries have complained about being set too high.

A concern for the proposal may be that it suggests providing financial subsidies to entities of developing countries that purchase or license cleantech solutions from entities of developed countries. The concern may be about the necessity of the financial subsidies and the source of the funding. This Article considers providing financial subsidies a small price to pay, compared with the consequences brought about by the failure to mitigate or timely adapt to climate change, or the potential damaging impact on current and future cleantech innovation that would be caused by removing or weakening IP protection on cleantech. In addition, the proposal allows entities of developed countries to profit from international cleantech deployment on agreed terms, including compensation at market rate and proper IPR treatment. Given this, and that developed countries do have obligations to transfer technologies to developing countries under international treaties such as the UNFCCC and the TRIPS Agreement, it would be reasonable for developed countries to provide financial subsidies for entities of developing countries who purchase or license cleantech from entities of developed countries.

Another concern of the proposal may be the antitrust concern that usually comes with patent pooling, as the WIPO Green platform may grow to contain a large collection of cleantech patents. This should not be a concern. The potentially large collection of cleantech patents in WIPO Green would be an incidental pooling of cleantech patents contributed by cleantech solution providers from different industry sectors and geographical locations, not an intentional gathering of patents by key players from a particular market, which is a criterion for the formation of a patent pool. However, to address this concern and potential abusive use of cleantech IPR or the WIPO Green platform, the WIPO Green advisory board should consider seting up a monitor service for receiving and addressing complaints from the platform users.

Overall, the proposal, if implemented, will likely enhance international cooperation in developing and deploying cleantech, especially by attracting the willing participation of more cleantech owners. It provides a viable alternative or addition to the one-way voluntary cleantech transfer model that passively relies on governments of developed countries to stimulate their cleantech owners to transfer cleantech to developing countries.

CONCLUSION

The focus on developed countries voluntarily transferring clean technologies to developing countries has not worked well. This Article explores an alternative approach—mutually beneficial cooperation between cleantech owners and seekers—to increase cleantech owners' active participation in international cleantech development and deployment. This approach takes existing IP regimes as they are, instead of waiting for them to be reformed specifically for cleantech. It also employs creative and collaborative IPR management models for international cleantech development and deployment. Specifically, this Article suggests the U.S.-China CERC IP management framework be used as a starting point for addressing foreseeable IPR issues arising during international cooperation for cleantech development, and proposes the optimization of the WIPO Green program for international cooperation for cleantech deployment. Such international cleantech cooperation hence may be sustainable and scalable, and therefore effective in combatting climate change via global development and deployment of clean technologies.