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ADDRESSING CLIMATE CHANGE: DOMESTIC INNOVATION, INTERNATIONAL AID AND COLLABORATION

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Climate change is a pressing issue confronting the global community. The rapid development and diffusion of clean technologies (i.e., technologies necessary for adapting to or mitigating climate change) must be a central part of the solution. However, a stalemate has persisted in global climate change negotiations at the United Nations, caused by diverging views regarding the role of intellectual property rights ("IPR") in the international transfer of clean technologies. Developed nations insist on strong IPR for clean technologies, while developing nations claim that IPR is a major barrier to the international transfer of clean technologies and demand to remove or reduce IPR for clean technologies.

This article explores two questions: (1) Is the existence of IPR a major barrier to the international transfer of clean technologies, and (2) why has the international transfer of clean technologies to developing nations been limited? Analyzing evidential data available, this article concludes that IPR probably has not been a major barrier to the international transfer of clean technologies. However,

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sustainable international transfer of clean technologies requires the joint efforts of developing and developed nations. To prepare for sustainable international transfer of clean technologies and to advance the effort for addressing climate change, this article proposes a new paradigm based on domestic innovation, international aid and international technology collaboration.

INTRODUCTION

> "[T]he question before us is no longer the nature of the challenge – the question is our capacity to meet it."
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> - Barack Obama[1]

In December 2009, at the 15th global climate change conference in Copenhagen, leaders from 115 nations gathered to negotiate an international agreement for addressing climate change.[2] The agreement was expected to include provisions to enhance the international transfer of technologies capable of adapting

[1] Barack Obama, Speech to the Copenhagen Summit, (Dec. 18, 2009), *in* GUARDIAN, http://www.theguardian.com/environment/2009/dec/18/obama-speech-copenhagen-climate-summit. There may still be skeptics of climate change, of its causes, or of the optimal timing for addressing climate change. For the purpose of discussion, this article adopts the international consensus, manifested at the United Nations, which presumes that climate change is unequivocal and that the time to address climate change is now, rather than in the future.

[2] *Copenhagen Climate Change Conference - December 2009,* U.N. FRAMEWORK CONVENTION ON CLIMATE CHANGE, http://unfccc.int/meetings/copenhagen_dec_2009/meeting/6295.php (last visited July 15, 2015).

to or mitigating climate change.[3] Unfortunately, the talks stalled. Developed and developing nations disagreed on a host of issues, especially the treatment of intellectual property rights ("IPR") protecting clean technologies.[4] Even before the Copenhagen conference, developing nations proposed to exclude clean technologies held by developed nations from patent protection.[5] Developed nations, meanwhile, considered that IPR should not be part of the global climate change negotiations and proposed to remove provisions dealing with IPR from the negotiations.[6]

The Copenhagen conference resulted in a non-binding agreement[7] that did not reference IPR issues.[8] Nevertheless, the debate regarding IPR persisted through the subsequent global climate change negotiations. The global climate change conference, held in Lima in December 2014, presented both developed nations' and developing nations' positions regarding IPR as equal options to be negotiated at the next global climate change conference in Paris in December 2015.[9] The agreement resulting from the 2015 Paris conference, however, did not mention IPR issues; just as in the Copenhagen conference, the preference of developing nations was not reflected.[10]

The debate regarding the treatment of IPR in the climate change context breaks down as follows: developed nations[11] insist on strong IPR for clean

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[3] Tove Iren S. Gerhardsen, *Technology Transfer Will Be Part of Copenhagen Climate Deal*, INTELL. PROP. WATCH (Sept. 16, 2009), http://www.ip-watch.org/2009/09/16/technology-transfer-will-be-part-of-copenhagen-climate-deal/.

[4] *See id.*

[5] United Nations Framework Convention on Climate Change, Bangkok, Thai. / Barcelona, Spain, Sept. 28-Oct. 9, 2009 / Nov. 2-6, 2009, *Report of the Ad Hoc Working Group on Long-Term Cooperative Action Under the Convention on its Seventh Session*, at 156, U.N. Doc. FCCC/AWGLCA/2009/14 (Nov. 20, 2009).

[6] Hira Jhamtani, *US Proposal to Remove IPRs from the Table Arouses Developing Countries' Objections*, TEBTEBBA (Aug. 11, 2009), http://www.tebtebba.org/index.php/content/137-technology-us-proposal-to-remove-IPR-from-the-table-arouses-developing-countries-objections.

[7] *Copenhagen Climate Change Conference - December 2009*, *supra* note 2.

[8] Gerhardsen, *supra* note 3.

[9] *See* United Nations Framework on Climate Change, Conference of the Parties, Twentieth Session, Lima, Peru, Dec. 1-14, 2014, *Lima Call for Climate Action*, U.N. Doc. FCCC/CP/2014/10/Add.1 (Feb. 2, 2015).

[10] United Nations Framework Convention on Climate Change, Twenty-First Session, Paris, Fr., Nov. 30-Dec. 11, 2015, *Adoption of the Paris Agreement*, U.N. Doc. FCCC/CP/2015/L.9 (Dec. 12, 2015).

[11] Developed nations are nations which rank highly in the United Nations developed indicators such as GDP, industrialization, life expectancy, and education level. The U.S., Canada, Europe, and Japan are typical examples. International groups, like the WTO, do not

technologies, viewing IPR as indispensable for incentivizing the development of such technologies and facilitating their deployment. Conversely, developing nations[12] have sought to weaken or even remove IPR for clean technologies, viewing the existence of IPR as a major barrier to the international transfer of clean technologies.

Hence, an ongoing divide exists between developing and developed nations regarding the role of IPR in the international transfer of clean technologies for addressing climate change. International agencies such as the World Trade Organization ("WTO"), the World Intellectual Property Organization ('WIPO"), the United Nations Environmental Programme ("UNEP"), the World Meteorological Organization, and the World Bank have all initiated discussions to resolve the divide.[13] The stakeholders in this discussion include governments, public entities, and commercial entities from developed and developing nations, and those with interests in combatting climate change. To date, these shareholders are still searching for effective solutions.

This article joins the search by exploring whether the existence of IPR is a major barrier to the international transfer of clean technologies, and the possible reasons behind the currently limited transfer of clean technologies to developing nations. After analyzing evidential data available on clean technologies and reviewing current scholarship on international technology transfer, this article concludes that IPR has been a major barrier to the international transfer of clean technologies, and that successful and sustainable international transfer of clean technologies needs certain conditions, which require efforts from both developing and developed nations.

To create such conditions, and continue advancing the effort of leveraging clean technologies to address climate change, this article proposes a solution based

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have an official definition. *See, e.g.*, *Who Are Developing Countries in the WTO?*, WORLD TRADE ORG., https://www.wto.org/english/tratop_e/devel_e/d1who_e.htm (last visited July 2, 2015).

[12] Developing nations are countries other than developed nations. *Id.* This article groups developing nations into three categories: the emerging economies, the least developed countries ("LDC"s), and the rest of developing nations, which this article will call mid-tier developing countries ("MDC"s). *See Emerging Markets*, WIKIPEDIA, https://en.wikipedia.org/wiki/Emerging_markets (last visited Oct. 23, 2015); *List of Least Developed Countries*, UNITED NATIONS (Dec. 4, 2013), http://www.un.org/en/development/desa/policy/cdp/ldc/ldc_list.pdf.

[13] *E.g.*, *Climate Change and the WTO Intellectual Property (TRIPS) Agreement*, WORLD TRADE ORG., https://www.wto.org/english/tratop_e/trips_e/cchange_e.htm (last visited Aug. 20, 2015); *Climate Change and IP*, WORLD INTELL. PROP. ORG., http://www.wipo.int/policy/en/climate_change/ (last visited July 23, 2015).

on domestic innovation, international aid, and international technology collaboration, instead of the international transfer of clean technologies.

This article proceeds as follows. Part I reviews climate change, the role of clean technologies in addressing climate change, the reality of international transfer of clean technologies, and the disagreement between developed and developing nations over how to improve international transfer of clean technologies to developing nations. Part II explores whether the existence of IPR is a major barrier to the international transfer of clean technologies to developing nations and what may be the reasons for the currently limited international transfer of clean technologies to developing nations. Based on Part II's analysis and findings, Part III proposes the solution summarized above. Part IV discusses the advantages and concerns regarding the solution.

I
GROUNDWORK: CLIMATE CHANGE, CLEAN TECHNOLOGIES, AND INTERNATIONAL TRANSFER OF CLEAN TECHNOLOGIES

The development and deployment[14] of clean technologies are a central part of the response to climate change. Because of developing nations' need for clean technologies, and because developed nations own the majority of the existing clean technologies, transfer of clean technologies from developed nations to developing nations has been the focus of the global effort in leveraging clean technologies to address climate change. However, despite this focus, such transfers have been limited in the past two decades, with the majority going to the emerging economies,[15] and little being transferred to the other developing nations. Meanwhile, developed and developing nations continue to disagree on how to improve the situation.

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[14] For the purpose of this Article, deployment of clean technologies includes both the implementation and distribution of clean technologies, as well as cross-border transfer of technologies.

[15] Emerging economies are developing nations that have experienced rapid economic growth. These countries have the potential to continue this growth, but also pose substantial political, financial, or social risk. As of 2015, typical nations that are considered emerging economies include Brazil, Russia, India, China, Mexico, Indonesia, Turkey, Saudi Arabia, Iran. Similar terms used include emerging markets and emerging market economies. *See, e.g.*, *Definition of Emerging Markets*, FIN. TIMES, http://lexicon.ft.com/Term?term=emerging-markets (last visited Oct. 23, 2015)*; Emerging Economies*, BUSINESSDICTIONARY.COM, http://www.businessdictionary.com/definition/emerging-economies.html (last visited Oct. 23, 2015); *Definition of Emerging Market*, FIN. TIMES, http://lexicon.ft.com/Term?term=emerging-markets (last visited Oct. 23, 2015); *Emerging Markets*, WIKIPEDIA, https://en.wikipedia.org/wiki/Emerging_markets (last visited Oct. 23, 2015).

A. Climate Change

Climate change is occurring, and its impact is global. Human activities using high-carbon technologies have been deemed the main cause of climate change.

In the context of this article, the term "climate change" refers to change in global or regional climate patterns, such as increasing global temperature and the rising sea level, which have become particularly apparent from the mid to late 20th century onwards.[16] The Intergovernmental Panel on Climate Change ("IPCC"),[17] the leading international scientific organization for assessing climate change, concluded that the period spanning from 1983-2012 was likely the warmest period of the past 1,400 years.[18] The IPCC also concluded that greenhouse gases ("GHG") present in the atmosphere are at levels unprecedented in at least the past 800,000 years.[19]

The effect of climate change on human and natural environments is global. The IPCC found that changes in climate have impacted natural and human systems on all continents and across the oceans.[20] These impacts include alteration of ecosystems, disruption of water supply, reduction of crop yields that result in increased food price and food insecurity, excess heat-related human mortalities, and infectious disease patterns.[21] According to a 2009 report by the Global Humanitarian Forum, climate change costs 300,000 human lives each year, and

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[16] *Climate Change*, OXFORD DICTIONARIES, http://www.oxforddictionaries.com/us/definition/american_english/climate-change (last visited July 2, 2015).

[17] *Organization*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, http://www.ipcc.ch/organization/organization.shtml (last visited July 30, 2015) [hereinafter *IPCC Organization*].

[18] Lisa V. Alexander et al., *IPCC 2013: Summary for Policymakers*, *in* CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS. CONTRIBUTION OF WORKING GROUP I TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 5 (Stocker et al. eds., 2013), http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_SPM_FINAL.pdf [hereinafter *IPCC Fifth Synthesis Report*].

[19] *Id.*, at 11.

[20] Christopher B. Field et al., *IPCC, 2014: Summary for Policymakers in* CLIMATE CHANGE 2014: IMPACTS, ADAPTATIONS, AND VULNERABILITY. PART A: GLOBAL AND SECTORAL ASPECTS. CONTRIBUTION OF WORKING GROUP II TO THE FIFTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 4 (Christopher B. Field et al. eds., 2014), http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/ar5_wgII_spm_en.pdf.

[21] *Id.* at 4-7.

leaves 300 million people vulnerable to its effects, a number set to double by 2030.[22]

The United Nations Framework Convention for Climate Change ("UNFCCC"),[23] the main global agreement designed for addressing climate change, attributes climate change "directly or indirectly to human activity that alters the composition of the global atmosphere."[24] In its latest assessment report, the IPCC once again confirmed that, using statistical qualification methods on the scientific data collected, "it is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century."[25] The human influence or activities referred to involve the use of fossil fuel,[26] e.g., by developed nations' coal-fired industries since the Industrial Revolution and today's hydro-carbon fueled transportation industries. These human activities account for the 70% increase in GHG emissions from 1970 to 2004.[27] Technologies relying heavily on fossil fuel – such as steam-engine locomotives, ships, airplanes, and power grids – were the backbone of these human activities. These high-carbon technologies attributed to the increased GHG emissions, leading to climate change.

B. Clean Technologies

Going forward, clean technologies[28] play a critical role in the solution for climate change. These technologies produce low GHG emissions and enable us to

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[22] Hilary Whiteman, *Report: Climate Change Crisis 'Catastrophic*,' CNN (May 29, 2009, 1:17 PM), http://www.cnn.com/2009/WORLD/europe/05/29/annan.climate.change.human/index.html?eref=rss_world.

[23] The goal of UNFCCC is to stabilize "greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." 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, http://unfccc.int/essential_background/items/6031.php (last visited July 2, 2015).

[24] United Nations Framework Convention on Climate Change, art 1.2, May 9, 1992, S. Treaty Doc No. 102-38, 1771 U.N.T.S. 107 [hereinafter UNFCCC Treaty].

[25] *IPCC Fifth Synthesis Report*, *supra* note 18, at 17.

[26] INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: SYNTHESIS REPORT 5 (2007), http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf [hereinafter IPCC FOURTH SYNTHESIS REPORT].

[27] *Id.* Others have cited higher numbers. For example, WIPO Director Francis Curry stated that developed countries were responsible for 77% total GHG emissions in the past. *See* Francis Gurry, Dir. Gen., World Intell. Prop. Org., WIPO's Role in Green Technology, Presentation at Conference on IP and Public Policy Issues (July 13-14, 2009), http://www.wipo.int/export/sites/www/meetings/en/2009/ip_gc_ge/presentations/gurry.pdf.

[28] Similar terms include climate friendly technology, environmentally sound technology,

mitigate or adapt to climate change. Rapid development and deployment of clean technologies is needed to address climate change and to make clean technologies viable market alternatives to traditional high-carbon technologies.

Stakeholders in climate change have agreed that the ability for humans to survive climate change largely depends on the rapid development and global deployment of a wide variety of clean technologies.[29] The UNFCCC recognized clean technologies as an important route for addressing climate change.[30] The United Nations General Assembly also adopted resolutions recognizing the fundamental role played by innovative clean technologies in addressing climate change.[31]

Discussions about addressing climate change have generally focused on mitigation and adaption. The UNFCCC defines mitigation as human intervention to reduce the production or enhance the removal of GHGs, and adaptation as adjustment in natural or human systems in response to actual or expected climatic change, which moderates harm or exploits beneficial opportunities brought by climate change.[32]

Mitigating climate change is crucial. Assessments have suggested that to avoid the catastrophic effects of climate change, global average temperature should rise no more than 2°C above pre-industrial level ("the 2°C goal").[33] In order to

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green technology, low-carbon technology, etc.

[29] Ahmed Abdel Latif et al., *Overcoming the Impasse on Intellectual Property and Climate Change at the UNFCCC: A Way Forward*, INT'L CTR. TRADE & SUSTAINABLE DEV. POLICY BRIEF NO.11, 1 (Nov. 11, 2011), http://www.ictsd.org/sites/default/files/research/2012/03/overcoming-the-impasse-on-intellectual-property-and-climate-change-at-the-unfccc-a-way-forward.pdf ("the rapid development and diffusion of these technologies is a key component of the global response to climate change"); Catherine Saez, *Human Survival Depends on Shared Technology, Says New UN Climate Chief*, INTELL. PROP. WATCH (Mar. 9, 2010), http://www.ip-watch.org/2010/09/03/human-survival-depends-on-technology-says-new-un-climate-chief/ ("survival depends on our improvement of technology").

[30] *See Background on the UNFCCC*, *supra* note 23.

[31] *E.g.*, U.N. Secretary-General, *Promotion of New and Renewable Sources of Energy*, U.N. Doc. A/66/100 (Aug. 15, 2011); Protection of Global Climate for Present and Future Generations of Mankind, G.A. Res. 43/53, U.N. Doc. A/RES/43/53 (Dec. 6, 1988).

[32] *Glossary of Climate Change Acronyms*, U.N. FRAMEWORK CONVENTION ON CLIMATE CHANGE, http://unfccc.int/essential_background/glossary/items/3666.php (last visited July 24, 2015).

[33] IPCCC FOURTH SYNTHESIS REPORT, *supra* note 26; *see also* Michael E. Mann, *Earth Will Cross the Climate Danger Threshold by 2036*, SCIENTIFIC AMERICAN (Mar. 18, 2014), http://www.scientificamerican.com/article/earth-will-cross-the-climate-danger-threshold-by-2036/; Jeff Tollefson, *Global-Warming Limit of* 2°C *Hangs in the Balance*, NATURE (Mar. 27,

limit temperature increase, GHG concentrations in the atmosphere need to be stabilized so that they will not continue to cause further atmospheric warming. Nations that are parties to the UNFCCC have committed to limit GHG emissions in a way to achieve the 2°C goal.[34] However, achieving this goal would require the development and deployment of a wide range of clean technologies.[35] For example, the IPCC determined that the necessary mitigation technologies include technologies that utilize renewable energy sources -- e.g., 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.[36]

While mitigation is crucial, adapting to the impact of climate change is also an important, long-term effort. Many GHGs stay in the atmosphere for a hundred years or more.[37] Even if we were to completely stop GHG emissions now, the existing GHG concentration in the atmosphere would still cause a certain amount of future rise in global average temperature. Like mitigation, adaption will also require the development and deployment of certain technologies, such as seeds that can survive flooding caused by rising sea levels, irrigation technologies for resisting droughts, and early-warning or defense systems for extreme weather.[38]

2015), http://www.nature.com/news/global-warming-limit-of-2-c-hangs-in-the-balance-1.17202; William D. Nordhaus, *Strategies for the Control of Carbon Dioxide*, 39-40 (Cowles Found. for Research in Econ., Discussion Paper No. 443, 1977), http://cowles.yale.edu/sites/default/files/files/pub/d04/d0443.pdf. Some scientists have argued that the current 1°C rise has had effects similar to the predicted effects of the 2°C rise, and that a 4°C rise is likely by 2050-2070. Kevin Anderson, *Climate Change: Going Beyond Dangerous… Brutal Numbers & Tenuous Hope or Cognitive Dissonance?* SLIDESHARE (July 5, 2011), http://www.slideshare.net/DFID/professor-kevin-anderson-climate-change-going-beyond-dangerous.

[34] United Nations Framework Convention on Climate Change, Conference of the Parties, Fifteenth Session, Copenhagen, Den., Dec. 7-18, 2009, *Copenhagen Accord*, U.N. Doc. FCCC/CP/2009/L.7 (Dec. 18, 2009); *see also The Cancun Agreements*, U.N. FRAMEWORK CONVENTION ON CLIMATE CHANGE, http://cancun.unfccc.int/ (last visited July 23, 2015).

[35] Hans Joachim Schellnhuber et al., *Technological Options*, *in* AVOIDING DANGEROUS CLIMATE CHANGE 333, 335 (Hans Joachim Schellnhuber et al. eds., 2006).

[36] Frank Ackerman, et al., *Technological and Economic Potential of Greenhouse Gas Emissions Reduction*, *in* CLIMATE CHANGE 2001: MITIGATION: CONTRIBUTION OF WORKING GROUP III TO THE THIRD ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (2001), http://www.ipcc.ch/ipccreports/tar/wg3/index.php?idp=90.

[37] *Overview of Greenhouse Gases*, U.S. ENVTL. PROT. AGENCY, http://www3.epa.gov/climatechange/ghgemissions/gases.html (last visited Aug. 1, 2015).

[38] CLIMATE CHANGE SECRETARIAT [U.N. FRAMEWORK CONVENTION ON CLIMATE CHANGE], TECHNOLOGIES FOR ADAPTATION TO CLIMATE CHANGE 9 (2006), http://unfccc.int/resource/docs/publications/tech_for_adaptation_06.pdf.

Clean technologies have developed significantly in the past decades. For example, technological advancements have reduced the production cost of wind energy by 80% over the last twenty years and solar power by 90% since the 1970s.[39] However, even with these achievements, there remains a considerable gap between current efforts to develop clean technologies and the level of investment required.

First, multiple sectors of clean technologies will require breakthroughs in development. The UNFCCC indicates that further breakthroughs are needed 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.[40] For example, waves of retiring fossil-fuel-based power plants are ready to adopt clean coal technologies, such as carbon capture and sequestration.[41] However, carbon capture and sequestration technologies have advanced slowly.[42] In order to meet the 2°C goal, carbon capture and sequestration technologies must double their capture and storage rates by 2025.[43]

Second, further technical advancements are needed to reduce the price of clean technologies and make them viable alternatives to traditional high-carbon technologies. Currently, clean technologies are often more expensive than existing fossil-fuel-based technologies.[44] For example, renewable energy technologies still need significant innovation to compete with traditional hydrocarbon-based technologies at similar price level.[45] The World Bank indicated that energy storage would need further cost reduction and performance improvement for large-scale

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[39] Diana Propper de Callejon et al., *Clean Technology: A Compelling Investment Opportunity*, LIFESTYLES OF HEALTH AND SUSTAINABILITY, http://www.lohas.com/clean-technology (last visited Aug. 1, 2015).

[40] U.N. FRAMEWORK CONVENTION ON CLIMATE CHANGE, FACT SHEET: WHY TECHNOLOGY IS SO IMPORTANT 2 (2009), https://unfccc.int/files/press/backgrounders/application/pdf/fact_sheet_on_technology.pdf.

[41] *'Clean Coal' Technologies, Carbon Capture & Sequestration,* WORLD NUCLEAR ASS'N (Aug. 2015), http://www.world-nuclear.org/info/Energy-and-Environment/-Clean-Coal--Technologies/.

[42] *See Energy Technology Perspectives 2014: Harnessing Electricity's Potential,* INT'L ENERGY AGENCY 5 (May 12, 2014), http://www.iea.org/media/140512_ETP_slides.pdf.

[43] *Id.*, at 8.

[44] FACT SHEET, *supra* note 40.

[45] PARSONS BRINCKERHOFF, POWER THE NATION UPDATE REPORT 2010 (2010), http://www.pbworld.com/pdfs/regional/uk_europe/pb_ptn_update2010.pdf.

deployment of solar and wind power and electric vehicles.[46] In 2012, the global energy demand for fossil fuels was 82% while the demand for renewable energies was a mere 13%.[47] The consumption of modern renewable energies has risen at an annual growth rate of 4%, while an annual growth rate of 7.5% is needed.[48]

Third, the deployment of clean technologies needs to accelerate. To meet the 2°C goal, the net volume of global anthropogenic GHG emissions will need to be reduced 60% by 2050, using the 2000 global anthropogenic GHG emissions as a base line.[49] However, the traditional model of technology deployment may be too slow to achieve a 60% reduction in global GHG emissions by 2050. Studies show that inventions in the energy sector generally take 20-30 years to reach mass markets, which normally start first in the nations where the inventions are developed.[50] Under the traditional model of deployment, developed nations develop new technologies, which reach developing nations via commercial roll-outs.[51] To accelerate the development and deployment of clean technologies, one possible approach is for both developing and developed nations to develop and deploy clean technologies independently and collaboratively, instead of relying on the traditional model of deployment. The recent rapid R&D efforts for clean technologies in Brazil, China, India, and a few other developing nations illustrate the independent effort by developing nations, and the Mediterranean Solar Plan illustrates the collaboration between developed and developing nations on a large scale.[52] However, these exemplary practices are yet to become common practice.

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[46] WORLD BANK, WORLD DEVELOPMENT REPORT 2010: DEVELOPMENT AND CLIMATE CHANGE 218 (2010), https://openknowledge.worldbank.org/handle/10986/4387.

[47] INT'L ENERGY AGENCY, TRACKING CLEAN ENERGY PROGRESS 2015 10 (2015), http://www.iea.org/publications/freepublications/publication/Tracking_Clean_Energy_Progress_2015.pdf.

[48] SUSTAINABLE ENERGY FOR ALL, PROGRESS TOWARDS SUSTAINABLE ENERGY - GLOBAL TRACKING FRAMEWORK 2015 KEY FINDINGS 5 (2015), http://www.se4all.org/wp-content/uploads/2013/09/GTF_2015-Key_Findings.pdf.

[49] *IPCC Fourth Assessment Report: Climate Change 2007 - Emission Trajectories for Stabilisation,* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, https://www.ipcc.ch/publications_and_data/ar4/syr/en/mains5-4.html (last visited Aug. 20, 2015).

[50] BERNICE LEE ET AL., WHO OWNS OUR LOW CARBON FUTURE? INTELLECTUAL PROPERTY AND ENERGY TECHNOLOGIES vii (Chatham House 2009), https://www.chathamhouse.org/sites/files/chathamhouse/public/Research/Energy, Environment and Development/r0909_lowcarbonfuture.pdf.

[51] WORLD BANK, WORLD DEVELOPMENT REPORT 2010, *supra* note 46, at 220.

[52] *Mediterranean Solar Plan Links North Africa to Europe,* THE AFRICA-EU PARTNERSHIP, http://www.africa-eu-partnership.org/en/success-stories/mediterranean-solar-plan-links-north-africa-europe (last visited Dec. 12, 2015).

C. International Transfer of Clean Technologies to Developing Nations

While rapid development and deployment of clean technologies is important, widespread transfer of clean technologies to developing nations has been deemed as much so, if not more, important. Developing nations are increasingly in need of clean technologies due to rising energy consumption and the corresponding environmental impact. Since developed nations currently own the majority of the existing clean technologies, transfer of clean technologies from developed nations to developing nations has become a focus of the global climate change efforts. However, during the past two decades, actual transfer of clean technologies to developing nations has been limited.

1. Transferring Clean Technologies to Developing Nations Has Been an Important Focus of International Climate Change Efforts

International instruments such as the IPCC and the UNFCCC have emphasized the transfer of clean technologies from developed to developing nations. This emphasis seems appropriate, given developed nations' ownership of most existing clean technologies under IPR protection and the growing need of developing nations to employ clean technologies to address climate change and to develop their economies.[53]

In developing their economies, developing nations have increased their demand for energy resources, and have thus increased their impact on the environment. For example, in 2014, China became the world's largest overall energy consumer, followed by the U.S., the EU, and India.[54] Historically, developed nations dominated in GHG emissions.[55] However, starting in 2004, developing nations' GHG emissions from energy use surpassed those of developed nations;[56] by 2010, the GHG emissions from developing nations exceeded those of

[53] This emphasis on the transfer of clean technologies from developed nations to developing nations seems to assume that these clean technologies are useful to developing nations, as well as easily transferred and adopted. Such assumptions are yet to be verified.

[54] *Total Energy Consumption*, ENERDATA, https://yearbook.enerdata.net/ (last visited July 20, 2015).

[55] Johannes Friedrich & Thomas Damassa, *The History of Carbon Dioxide Emissions*, WORLD RES. INST. (May 21, 2014), http://www.wri.org/blog/2014/05/history-carbon-dioxide-emissions.

[56] Wanna Tanunchaiwatana, Manager, Technology, UNFCCC Secretariat, Role of Patents in Green Technology Transfer in the Context of Climate Change, WIPO Conference on Intellectual Property and Public Policy Issues (July 13, 2009) (on file with the author.)

developed nations by about 40%.[57] Much of this increase may be traced to the rapid growth of China, India and other emerging economies. This figure is expected to increase to 130% by 2040.[58] Therefore, to prevent further aggregation on the climate, it is important that developing nations fully utilize clean technologies in the pursuit of economic development.

On the other hand, developed nations currently own most of the existing clean technologies that are protected by IPR.[59] For example, according to a 2008 international survey, developed nations owned 80% of patents covering relevant clean technologies (though the percentage was a significant reduction from ten years ago, where developed nations owned 95% of the patents on clean technologies.)[60]

Consequently, global climate change technology efforts have focused on the transfer of clean technologies from developed nations to developing nations. As early as 1992, the IPCC pointed out that "as the GHG emissions in developing nations are increasing with their population and economic growth, rapid transfer, on a preferential basis to developing nations, of technologies which help to monitor, limit or adapt to climate change, without hindering their economic development, is an urgent requirement."[61] The UNFCCC, signed in 1992, subsequently listed technology transfer as a main method for addressing climate change. The UNFCCC requires developed nations 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 nations.[62] The WTO's Agreement on Trade-Related Aspects of Intellectual Property Rights ("TRIPS Agreement"), signed in 1994, also asks developed nations to promote and encourage technology transfer to the least

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[57] *Developing Countries' Carbon Emissions Will Vastly Outpace Developed Nations, U.S. EIA Says*, HUFFINGTON POST (July 25, 2013, 7:25 PM), http://www.huffingtonpost.com/2013/07/25/carbon-emissions-developing-countries_n_3651513.html.

[58] *Id.*

[59] The ownerships of IPR-protected clean technologies are identifiable because of the registration data in national IPR offices. Data on clean technologies not protected by IPR needs to be gathered and made available for the public to access.

[60] COPENHAGEN ECONOMICS & THE IPR COMPANY, IS IPR A BARRIER TO THE TRANSFER OF CLIMATE CHANGE TECHNOLOGY? 18 (2009), http://trade.ec.europa.eu/doclib/docs/2009/february/tradoc_142371.pdf [hereinafter STUDY F].

[61] Intergovernmental Panel on Climate Change, *Overview*, *in* FIRST ASSESSMENT REPORT, https://www.ipcc.ch/ipccreports/1992 IPCC Supplement/IPCC_1990_and_1992_Assessments/English/ipcc_90_92_assessments_far_overview.pdf.

[62] UNFCCC Treaty, *supra* note 24, at art. 4.5; *see also id.* at art. 4.1, 4.3, and 4.7.

developed countries ("LDCs") members.[63] Specifically, the TRIPS Agreement asks developed nations 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."[64]

To facilitate the transfer of clean technologies, the UNFCCC has set up several mechanisms. The first mechanism is a technology transfer framework established in 1992, when the UNFCCC was signed. The framework has several components,[65] including a Technology Needs Assessment component wherein parties of the UNFCCC identify and prioritize the clean technologies needed, as well as determine the major barriers for the inbound transfer of clean technologies.[66] The second is the Clean Development Mechanism (CDM) and Joint Implementation (JI) mechanism established by the UNFCCC Kyoto Protocol[67] in 1997. The CDM and JI mechanisms allow a nation with an emission-reduction or emission-limitation commitment under the Kyoto Protocol to implement an emission-reduction or emission-removal project in developing nations. Such projects can earn scalable emission reduction credits that are counted toward the Kyoto commitment of the providing nation.[68] The third is the Technology Mechanism established by the 2010 Cancun climate change conference, to help nations develop and transfer clean technologies.[69] The Technology Mechanism aims to support and accelerate clean technology diffusion via a nation-driven approach, based on national circumstance and priorities of developing nations.[70]

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[63] Agreement on of Aspects of Intellectual Property Rights, art. 66.2, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 183, 33 I.L.M. 1197 [hereinafter TRIPS Agreement].

[64] *Id.*

[65] *Technology Transfer Framework*, U.N. FRAMEWORK CONVENTION ON CLIMATE CHANGE, http://unfccc.int/ttclear/templates/render_cms_page?TTF_home (last visited Aug. 1, 2015).

[66] *Id.*

[67] *Kyoto Protocol*, U.N. FRAMEWORK CONVENTION ON CLIMATE CHANGE, http://unfccc.int/kyoto_protocol/items/2830.php (last visited July 24, 2015).

[68] Kyoto Protocol to the United Nations Framework Convention on Climate Change, art. 5-6, Dec. 10, 1997, U.N. Doc. FCCC/CP/1997/7/Add.1, 37 I.L.M. 22 (1998) [hereinafter Kyoto Protocol].

[69] *The Technology Mechanism of the Convention*, U.N. FRAMEWORK CONVENTION ON CLIMATE CHANGE, http://unfccc.int/ttclear/templates/render_cms_page?TEM_home (last visited on July 15, 2015).

[70] United Nations Framework Convention on Climate Change, Copenhagen, Denmark, Dec. 7-15, 2009, *Report of the Ad Hoc Working Group on Long-Term Cooperative Action Under the Convention on its Eighth Session*, at 24-27, U.N. Doc. FCCC/AWGLCA/2009/17 (Feb. 5, 2010).

2. Technology Transfer Defined

The IPCC defines technology transfer as "a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change" among and between all nations.[71] The IPCC considers technology transfer to include the adaptation of the transferred technology, "the process of learning to understand, utilize, and replicate the technology, including the capacity to choose and adapt to local conditions and integrate it with indigenous technologies."[72] The Kyoto Protocol of the UNFCCC also has a broad definition of technology transfer, which includes providing developing nations the know-how and best practices associated with a transferred technology.[73]

Channels for technology transfer can be market-based, such as trade, foreign direct investment and technology licensing.[74] Transfer can also be informal. Organizations or individuals may engage in unsanctioned imitation and technical and managerial personnel may bring "know-how" with them as they change employment.[75]

Technology transfer can be initiated by the commercial sector or the public sector. In practice, most technology transfer occurs in the commercial sector.[76] Nevertheless, the role of the public sector is important. Technology transfer

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[71] INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, METHODOLOGICAL AND TECHNOLOGICAL ISSUES IN TECHNOLOGY TRANSFER 3 (Bert Metz et al. eds, 2000).

[72] *Id.*

[73] Kyoto Protocol, *supra* note 70.

[74] KEITH MASKUS, PRIVATE RIGHTS AND PUBLIC PROBLEMS: THE GLOBAL ECONOMICS OF INTELLECTUAL PROPERTY IN THE 21ST CENTURY 66-69 (2012); *see also* Bernard M. Hoekman et al., *Transfer of Technology to Developing Countries: Unilateral and Multilateral Policy Option,* 33(10) WORLD DEV. 1587, 1588-1590 (2005) (channels of technology transfer include trade in goods, FDI and licensing, labor turnover and movement of people); Bronwyn H. Hall & Christian Helmers, *The Role of Patent Protection in (Clean/Green) Technology Transfer* (Nat'l Bureau Econ. Research, Working Paper No. 16323, 2010), http://www.nber.org/papers /w16323.pdf; Matthew Littleton, *The TRIPS Agreement and Transfer of Climate-Change-Related Technologies to Developing Countries* 2 (United Nations Dep't Econ. & Soc. Affairs, Working Paper No. 71, 2008), U.N. Doc. ST/ESA/2008/DWP/7, http://www.un.org/esa/desa/ papers/2008/wp71_2008.pdf (Technology transfer includes intra-firm, inter-firm, FDI, and unsanctioned technology transfer through imitation).

[75] *See generally*, MASKUS, PRIVATE RIGHTS AND PUBLIC PROBLEMS, *supra* note 74; Hoekman et al., *supra* note 74.

[76] Commercial investments made up at least 70% of total global investments in clean energy technologies. *See* General Electric, *Innovation, Protection and Transfer of Green Technologies,* WORLD INTELL. PROP. ORG. 3, (July 13, 2011), http://www.wipo.int/edocs/mdocs/mdocs/en/wipo _inn_ge_11/wipo_inn_ge_11_ref_t.pdf.

normally is neither an automatic nor a costless process, and it can become subject to market failures; in such cases, public interventions such as legal and policy incentives are necessary.[77]

3. International Transfer of Clean Technologies to Developing Nations Has Been Limited

In spite of the support mechanisms provided by the UNFCCC system and TRIPS Agreement, the international transfer of clean technologies to developing nations has been limited. In particular, extensive surveys conducted in the past two decades reveal that foreign clean technologies are not reaching developing nations adequately, especially the LDCs.[78]

In 2011, researchers from the London School of Economics and Political Science and the Organization for Economic Cooperation and Development ("OECD") published a global survey on the invention and transfer of climate change mitigation technologies ("Study A").[79] Study A analyzed the geographic distribution of thirteen classes of climate mitigation technologies during 1978-2005, and was based on patent data from over eighty national and international patent offices.[80] As the figure below shows, Study A found that international transfer of clean technologies mostly occurred between developed nations (73% of the overall exported inventions).[81] It also noted that exports of clean technology inventions from developed nations to emerging economies – such as China, Brazil, and India – were growing rapidly (22% of the overall exported inventions).[82] The study further found that the flow of clean technology inventions from developing nations to developed nations made up 4%, while the flow between developing

[77] INT'L CTR. FOR TRADE & SUSTAINABLE DEV., CLIMATE CHANGE, TECHNOLOGY TRANSFER AND INTELLECTUAL PROPERTY RIGHTS 2 (2008), https://www.iisd.org/pdf/2008/cph_trade_climate_tech_transfer_ipr.pdf.

[78] Most of the surveys are based on patent data on clean technologies. Evidential studies on unpatented clean technologies are difficult to accomplish and find.

[79] 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 (2011), http://reep.oxfordjournals.org/content/5/1/109.full.pdf+html [hereinafter *Study A*].

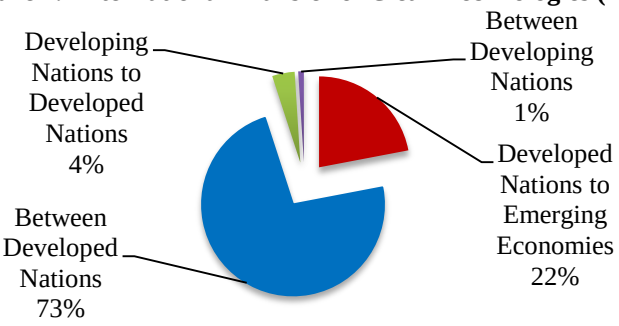
[80] *Id.* (These technologies include six renewable energy technologies (wind, solar, geothermal, ocean energy, biomass, and hydropower), waste-to-energy, methane destruction, energy conservation in buildings, climate-friendly cement, motor vehicle fuel injection, and energy-efficient lighting. They involve very diverse sectors such as electricity and heat production, the manufacturing industry, and the residential sector.)

[81] *Id*. at 122.

[82] *Id.*

nations was much less, a mere 1% of the overall flow.[83] This implies that the transfer of clean technologies from developed nations to developing nations that are not emerging economies was almost nonexistent.

Figure 1. International Transfer of Clean Technologies (2011)



A different global patent survey confirms the findings of Study A. In 2010, the UNEP, the European Patent Office and the International Centre for Trade and Sustainable Development conducted a study[84] of the patenting landscape and licensing practices of key clean energy technologies[85] ("Study B"). This study discovered that 58% of its respondents (entities based in developed nations) reported they had not entered into licensing agreements with entities based in a developing nation during the three years before 2010, the time when Study B was conducted.[86]

Conversely, Study B found that the owners of clean technologies were willing to transfer the technologies. Of the respondents in Study B, 73% believed it was important to seek opportunities to license out their technologies, and 82% viewed IPR as vital to licensing transactions.[87] This data indicates that clean technology owners do want to transfer the technologies, and the existence of IPR is critical to facilitating such transfers. Study B also found that clean technology owners, especially academic and public organizations, were generally open to

[83] *Id.*

[84] U.N. ENVTL. PROGRAMME, EUR. PATENT OFFICE & INT'L CTR. FOR TRADE & SUSTAINABLE DEV., PATENT AND CLEAN ENERGY: BRIDGING THE GAP BETWEEN POLICY AND EVIDENCE, FINAL REPORT 9 (2010), http://documents.epo.org/projects/babylon/eponet.nsf/0/cc5da4b168363477c12577ad00547289/$FILE/patents_clean_energy_study_en.pdf [hereinafter STUDY B].

[85] Clean energy technologies are technologies that reduce energy consumption and/or enable the transition to a renewable-based energy economy. *See, Categories*, MIT CLEAN ENERGY PRIZE, http://cep.mit.edu/structure/categories (last visited Dec. 10, 2015).

[86] STUDY B, *supra* note 84, at 58.

[87] *Id.*

providing flexible licensing terms to entities based in developing nations with limited financial resources.[88]

Similar to Study A, Study B also found that emerging economies such as China, Brazil, India and Russia were the main beneficiaries of licensing flows from developed nations.[89] Study B indicated that companies from developing nations experienced some difficulties in obtaining clean technologies from entities based in developed nations, [90] resulting from the high cost of licensing the foreign clean technologies and/or having to resort to obtaining less-advanced substitutes.[91]

A third survey, a 2009 United Nations report, assessed the effect of the CDM – one of the technology transfer mechanisms mentioned in Part I.C.1 ("Study C"). [92] The study noted that only 36% of the 3,296 documented CDM projects involved the transfer of clean technologies.[93] Study C also noted that the CDM projects had been concentrated in only a few developing nations, e.g., Brazil, China, India, Mexico.[94] These, again, are emerging economies. The rest of developing nations had taken up only 25% share of the overall CDM projects.[95]

In summary, the available empirical evidence shows that the international transfer of clean technologies occurs mainly between developed nations. The more infrequent, but growing transfer of clean technologies from developed nations to developing nations flows mainly to emerging economies, such as China, Brazil, India, Mexico, Russia and South Africa. Little transfer occurs between developed nations and the rest of the developing nations, or among developing nations themselves.

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[88] *Id.* at 60.
[89] *Id.* at 58.
[90] *Id.* at 23.
[91] *Id.*
[92] U.N. DEP'T OF ECON & SOC. AFFAIRS, WORLD ECONOMIC AND SOCIAL SURVEY 2009: PROMOTING DEVELOPMENT, SAVING THE PLANET, at 138, U.N. Doc. ST/ESA/319, U.N. Sales No. E.09.II.C.1 (2009) [hereinafter STUDY C].
[93] *Id.*
[94] *Id.* (citing Antoine Dechezleprêtre et al., *The Clean Development Mechanism and the International Diffusion of Technologies: An Empirical Study.* 36(4) ENERGY POLICY 1273 (2008)).
[95] *Id.*

D. How to Increase Transfer of Clean Technologies to Developing Nations – An Ongoing Debate

Developing and developed nations have been discussing how to increase the international transfer of clean technologies to developing nations. However, they disagree over the means to achieve this goal. Developing nations claim that IPR is a major barrier to the international transfer of clean technologies and ask for the reduction or elimination of IPR protections on clean technologies. Developed nations, on the other hand, insist that IPR facilitates development and deployment of clean technologies and assert that the barrier to the international transfer of clean technologies is developing nations' lack of capacity to attract foreign clean technologies.

1. Developing Nations

Developing nations regard IPR as an inherent barrier to the international transfer of, and affordable access to, clean technologies in a rapid time frame.[96] According to this view, IPR of clean technologies keeps prices of clean technologies high and limits access. Developing nations have pointed to specific instances to support this view. For example, firms and R&D institutions in developing nations have indicated that commercial firms and public institutions in developed nations refused to license important technologies related to fuel-cells.[97] Local firms in India indicated that they were refused licenses for patented technologies on ozone reduction.[98] Several developing nations have also criticized a small group of multinational companies ("MNC"s) owning clean technologies needed by developing nations. These MNCs were criticized for using their ownership of clean technologies as a means to control production, therefore limiting their transfer to the developing nations who needed these clean technologies.[99]

During recent UNFCCC climate change conferences, developing nations suggested limiting or eliminating IPR for clean technologies. Specifically, Brazil, South Africa, China, India, and Russia have suggested rethinking the existing IPR

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[96] *Id.*

[97] METHODOLOGICAL AND TECHNOLOGICAL ISSUES IN TECHNOLOGY TRANSFER, *supra* note 71.

[98] Keith Maskus, *Encouraging International Technology Transfer*, INT'L CTR. TRADE & SUSTAINABLE DEV. ISSUE PAPER NO. 7 (2004), http://www.iprsonline.org/resources/docs/Maskus - Encouraging International ToT- Blue 7.pdf.

[99] THE ENERGY & RESOURCES INST., EMERGING ASIA CONTRIBUTION ON ISSUES OF TECHNOLOGY FOR COPENHAGEN 30 (2009), http://www.indiaenvironmentportal.org.in/files/Paper_AEI.pdf.

regime, excluding clean technologies from patent protections, introducing a compulsory licensing scheme for clean technologies, and pushing for technology transfer, flexible licensing mechanisms, and institutional mechanisms.[100] The president of Bolivia likewise commanded that "innovation and technology related to climate change must be within the public domain, not under any private monopolistic patent regime that obstructs and makes technology transfer more expensive to developing countries."[101]

In 2013, the WTO TRIPS Council[102] organized a discussion on IP, Climate Change, and Development. Ecuador submitted a proposal ("Ecuador 2013 proposal").[103] In the proposal, Ecuador argued that IPR could "create a monopolistic situation characterised by high prices and a restriction of the dissemination of knowledge" for adapting to climate change and use of clean technologies.[104] Ecuador proposed to exclude clean technologies from patentable subject matter, include in the TRIPS Agreement a new provision on the transfer of expertise or know-how, implement compulsory licensing, and reduce the life term of patents on clean technologies.[105]

A number of developing nations such as Cuba, Bangladesh, Bolivia, Brazil, India, Indonesia, Nepal, Rwanda and the Dominican Republic supported Ecuador's proposal.[106] India especially supported the proposal's stance regarding compulsory licensing and reduction of patent life term.[107] India stated:

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[100] MATTHEW RIMMER, INTELLECTUAL PROPERTY AND CLIMATE CHANGE – INVENTING CLEAN TECHNOLOGIES 48 (2011) (hereinafter RIMMER, INVENTING CLEAN TECHNOLOGIES).

[101] Open Letter, President Evo Morales Ayma, Save the Planet from Capitalism (Nov. 28, 2008), http://links.org.au/node/769.

[102] *Work of the TRIPS Council*, WORLD TRADE ORG., https://www.wto.org/english/tratop_e/trips_e/intel6_e.htm (last visited on July 25, 2015) ("the Council for TRIPS is the body, open to all members of the WTO, that is responsible for administering the TRIPS Agreement").

[103] WORLD TRADE ORG., CONTRIBUTION OF INTELLECTUAL PROPERTY TO FACILITATING THE TRANSFER OF ENVIRONMENTALLY RATIONAL TECHNOLOGY – COMMUNICATION FROM EQUATOR (2013), https://docs.wto.org/dol2fe/Pages/FE_Search/FE_S_S009-DP.aspx?language=E&CatalogueIdList=115118&CurrentCatalogueIdIndex=0&FullTextSearch= (hereinafter "Ecuador 2013 Proposal").

[104] *Id.*

[105] *Id.*

[106] WORLD TRADE ORG., EXTRACT FROM MINUTES OF MEETING HELD ON OCT. 10-11, 2013 OF THE COUNCIL FOR TRADE-RELATED ASPECTS OF INTELLECTUAL PROPERTY RIGHTS 28 (2013), https://www.wto.org/english/tratop_e/trips_e/october2013_on_climate_e.pdf.

[107] WORLD TRADE ORG., EXTRACT FROM MINUTES OF MEETING HELD ON JUNE 11-12, 2013 OF THE COUNCIL FOR TRADE-RELATED ASPECTS OF INTELLECTUAL PROPERTY RIGHTS 32 (2013), https://www.wto.org/english/tratop_e/trips_e/june2013_on_climate_e.pdf [hereinafter TRIPS

> On any principle of equity, industrialized countries have to bear a large share of the burden. They are historically responsible for the bulk of the accumulated greenhouse gas emissions and this alone suggests a greater responsibility. They also have high per capita incomes, which give them the highest capacity to bear the burden. They are technically the most advanced, and to that extent best placed to provide environmentally sound technology to developing countries at fair and favourable terms and conditions.[108]

India's statement captured the essential position of developing nations toward the proposal.

2. Developed Nations

Meanwhile, entities in developed nations have insisted that IPR is not a barrier, but a facilitator for development and deployment (e.g., international transfer) of clean technologies. Their arguments focus on the incentives and legal certainty that IPR provides. For example, General Electric, a large producer of clean technologies, argues that IPR helps incentivize R&D investments in clean technologies, especially by the commercial sectors, which account for 70% of the overall R&D investments.[109] Industry associations, such as Alliance for Clean Technology Innovation, assert that strong IPR protection provides "legal certainty" for technology owners to engage in "voluntary, market-based technology transfer in all its possible forms."[110] Researchers for the International Centre for Trade and Sustainable Development ("ICTSD") stated that IPR provides incentives for clean technology innovations, especially in sectors such as wind, solar, carbon capture and storage, and biofuels that need major R&D investments.[111]

Consequently, governments of developed nations – such as the U.S., Australia, Japan, and the EU – have insisted on strong IPR protection for clean technologies.[112] Todd Stern, the U.S. Special Envoy for Climate Change, stated:

MEETING MINUTES JUNE 11-12, 2013]; *see also* Matthew Rimmer, *WTO Debate on IP, Climate Change, and Development in the TRIPS Council*, STORIFY, https://storify.com/DrRimmer/wto-debate-on-ip-climate-change-and-development-in (last visited July 25, 2015).

[108] TRIPS MEETING MINUTES JUNE 11-12, 2013, *supra* note 107.

[109] General Electric, *Innovation, Protection and Transfer of Green Technologies*, *supra* note 76.

[110] Alliance for Clean Technology Innovation, et al., *IPR-Related Demands in UN Climate Change Negotiations*, U.S. COUNCIL FOR INT'L BUS. (Nov. 26, 2014), http://www.uscib.org/docs/2014_11_26_UNFCCC_Association_Letter.pdf.

[111] Latif et al., *supra* note 29.

[112] RIMMER, INVENTING CLEAN TECHNOLOGIES, *supra* note 100, at 62.

"we must make the development and dissemination of technology a top priority in order to help bring sustainable, low-carbon energy services to people around the world, AND we must do so in a way that recognizes the importance of protecting and enforcing intellectual property rights."[113] The EU, Japan, Canada, New Zealand have expressed similar views.[114] Australia denied that IPR could be a significant barrier to technology cooperation or use. Instead, Australia argued, greater incentives should be provided so that the commercial sectors—responsible for 86% of overall global investment and financial flows—can engage in technology transfer.[115]

Responding to Ecuador's 2013 proposal, which gained support from quite a few developing nations, several developed nations countered with the position that IPR encourages the development of clean technologies and allows their transfer at accessible prices.[116] The EU's response noted that a large quantity of key clean technologies are already in the public domain, the LDCs offer market values insufficient to attract commercial businesses in developed nations, and the LDCs do not provide IPR; therefore the LDCs can use foreign clean technologies for free.[117] Further, the EU argued that without patent protection for products and processes, companies owning the clean technologies in developed nations may be reluctant to engage in technology transfer and associated investments.[118] The EU stated: "IPR, particularly patents, will be a catalyst, not a barrier, to creating and deploying low-carbon technologies….Threat[s] to strong IPR, such as easily-obtained compulsory licensing, are likely to be a strong disincentive to invest."[119] The EU's position likely represents the essential view of developed nations on IPR's role in the international transfer of clean technologies to developing nations.

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[113] Todd Stern, Special Envoy for Climate Change, U.S. Dept't of State, The Current State of Our Negotiations on a New International Climate Agreement, (Sept.10, 2009), http://www.state.gov/e/oes/rls/remarks/2009/129204.htm (emphasis added).

[114] RIMMER, INVENTING CLEAN TECHNOLOGIES, *supra* note 100, at 64.

[115] AUSTL., TECHNOLOGY COOPERATION: SUBMISSION TO THE AD-HOC WORKING GROUP FOR LONG TERM COOPERATIVE ACTION UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (2008), http://unfccc.int/files/kyoto_protocol/application/pdf/australia_lca_technology.pdf.

[116] TRIPS MEETING MINUTES JUNE 11-12, 2013, *supra* note 107.

[117] *Id.* at 40 (EU comments on Ecuador's 2013 proposal).

[118] *Id.*

[119] *Id.* (quoting IAN HARVEY, INTELLECTUAL PROPERTY RIGHTS: THE CATALYST TO DELIVER LOW CARBON TECHNOLOGIES (The Climate Group 2008), http://www.theclimategroup.org/_assets/files/intellectual-property-rights.pdf).

II
ANALYSIS: POSSIBLE REASONS FOR THE LIMITED INTERNATIONAL TRANSFER OF CLEAN TECHNOLOGIES TO DEVELOPING NATIONS

One may ask: why has transfer of clean technologies to developing nations been limited? Is the existence of IPR in fact a major barrier to the international transfer of clean technologies? After reviewing and analyzing currently available data on clean technologies and scholarship regarding international technology transfer, this article finds that the existence of IPR has not been a major barrier to the international transfer of clean technologies. This article also finds that for a nation to attract inbound transfer of foreign technologies, it needs to offer: sufficient IPR protection, the capacity to absorb and adopt foreign technologies, sufficient market size, policy certainty, and transparency.[120]

A. Is the Existence of IPR a Major Barrier for Transfer of Clean Technologies to Developing Nations?

Examining IPR's role in the development and deployment of clean technologies, and assessing IPR's impact on developing nations in attracting international transfer of clean technologies, this section concludes that the existence of IPR has not been a major barrier to the international transfer of clean technologies.

1. IPR and Its Role

IPR has been viewed as an important tool to incentivize investments in innovation; it has also been viewed as increasing the cost of accessing IPR innovation. Though both climate and public health are public goods, IPR has different impacts in corresponding technology industries. Due to the specific nature of the clean technology industries, IPR plays less of a defining role in clean technology industries than in pharmaceutical industries. Therefore, solutions for IPR issues in pharmaceutical industries may not apply directly to IPR issues in clean technology industries.

The term "intellectual property" refers broadly to creations of the human mind.[121] Intellectual property rights ("IPR") protect the interests of the creators by

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[120] The evidential data and scholarship cited herein are utilized to answer the above questions; the inherent limitations in the evidential data and scholarship will be identified, compensated by rational analysis, (e.g., using the author's own experience in global IPR practice,) or left open for further research and/or to be addressed in future articles.

[121] *What is Intellectual Property?*, WORLD INTELL. PROP. ORG., http://www.wipo.int/about-ip/en/ (last visited July 25, 2015).

giving them property rights over their creations.[122] The major forms of IPR include patents, trade secrets, copyrights and trademarks. Patents generally protect innovative technical improvements, trade secrets generally protect confidential information which can include innovative business or technical know-how, trademarks generally protect the distinctive symbols identifying a product or service, and copyrights generally protect the artistic expressions of ideas.

When discussing the development and deployment of technologies, patent rights are the most relevant form of IPR, followed by trade secrets, which come into play when transfer of the know-how associated with a technology or business practice is involved. From this point forward, unless indicated otherwise, the article will use the term "IPR" to refer to patent protection. 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 specifically identified and discussed as needed.

Patent rights are territorial, granted by individual national governments and are effective only within the particular geographic regions covered by the national governments.[123] In order to gain patent protection on an innovation in a particular nation, the owner must file for a patent right on the innovation from the government of the particular nation.[124] Therefore, when this article mentions that a technology owner has a patent on a technology, it means the technology owner has applied for patent protection from a specific nation, the nation has granted patent protection on the technology, and the technology owner can enforce the patent within the territory of the nation.

As exemplified by the debate discussed in Part I.D, IPR's role in the development and deployment of technologies has been controversial. Traditionally, IPR has been a policy tool for incentivizing investments – especially commercial investments – in innovation.[125] Once an innovation is granted patent protection by the government of a nation, the owner of the invention can exclude a third party from practicing the innovation in the nation, or grant the permission with a fee, generating license revenue. The prospect of a monopoly or profit-making on a patented invention is presumed to incentivize investments in R&D to create the invention.

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[122] *Id.*

[123] *Patents*, WORLD INTELL. PROP. ORG., http://www.wipo.int/patents/en/ (last visited Nov. 2, 2015).

[124] *Id.*

[125] Latif et al., *supra* note 29, at 1.

Meanwhile, IPR has been viewed to increase the cost for accessing the IPR-protected technologies or to increase the cost of learning them via imitation.[126] For example, when technology is protected by a patent or a trade secret in a nation, access to the technology in the nation is barred unless the owner of the technology gives permission, which may come attached with restrictive conditions and/or a higher price due to its IPR. IPR may also have the effect of diminishing the speed of innovation, as IPR is alleged to demotivate owners of -protected technologies for continuous innovation, since it grants the owners a monopoly power (albeit temporary) over the protected technologies.[127]

Because both climate and public health are public goods and have global impact, there is a potential parallel between IPR issues regarding clean technologies with IPR issues regarding pharmaceutical technologies.[128] However, this parallelism may not be warranted.

First, IPR may be less significant to clean technologies than to pharmaceutical technologies. Patents on many of the technologies that are fundamental to modern clean technologies have long been expired and these fundamental technologies are in the public domain.[129] Existing patents mostly protect only specific features or incremental improvements over the fundamental technologies in the public domain.[130] These specific features and incremental improvements likely would be easy to design around, and therefore would have multiple alternatives and substitutes on the market. The availability of these alternatives and substitutes will likely bring down the price that might be charged under a monopoly afforded by IPR protection.[131] Meanwhile, patents on clean technologies tend to be diffused and owned by a large number of firms.[132] Hence, the power of patent owners in clean technologies tends to be limited.

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[126] Hall & Helmers, *supra* note 74, at 6.

[127] KEITH MASKUS, GLOBALIZING INFORMATION: THE ECONOMIC OF INTERNATIONAL TECHNOLOGY TRADE 5 (2014).

[128] STUDY F, *supra* note 60, at 7.

[129] John Barton, *Patenting and Access to Clean Energy Technologies in Developing Countries*, WIPO MAG., (Mar. 2009), http://www.wipo.int/wipo_magazine/en/2009/02/article_0005.html; *see also* John Barton, *Intellectual Property and Access to Clean Energy Technologies in Developing Countries: An Analysis of Solar Photovoltaic, Biofuel, and Wind Technologies*, INT'L CTR. TRADE & SUSTAINABLE DEV. ISSUE PAPER NO. 2 (2007).

[130] Barton, *Patenting and Access to Clean Energy Technologies in Developing Countries*, *supra* note 129.

[131] *Id.*

[132] *See generally id.*

In the pharmaceutical industry, IPR plays a significant role. The general assumption is that the originator pharmaceutical sector is highly dependent on strong patent protection, mainly because of the high cost involved in developing novel medicines and the low cost of reverse engineering these new medicines.[133] The owner of a new medicine needs to rely on the monopoly secured by a patent to recuperate the R&D investments and generate significant economic returns. Also, in the pharmaceutical industry, one firm usually owns the patent of a key pharmaceutical technology, which normally has no alternative or substitute technologies, granting the firm dominant market power.[134]

Furthermore, unlike pharmaceutical technologies, clean technologies involve a variety of different industries, and IPR is less important in some industries than others.[135] For example, clean technologies include sophisticated bio-tech engineering, such as genetically modified seeds for drought resistance, and low-tech mechanical innovations, such as farming techniques.[136] Patent rights are likely more relevant to the drought-resistant seeds, which may require more R&D investments than the mechanical farming techniques.

2. Evidential Data

This article will now examine IPR's influence on the development and deployment of clean technologies for developing and developed nations, through analyzing available evidential data on global investments and patenting of clean technologies. Investments such as commercial investments and R&D expenditures are a measure of the input to innovation, while patenting data is a measure of the output to innovation.[137] Meanwhile, patenting data can be one indication of international transfer of technology, as patenting data identifies the location of an invention – e.g., where the patent was filed originally, and also where the invention is transferred – by where else the patent was filed besides the location of the invention.[138] Patenting of foreign technologies likely occurs in nations that have

[133] FREDERICK M. ABBOTT, INNOVATION AND TECHNOLOGY TRANSFER TO ADDRESS CLIMATE CHANGE: LESSONS FROM THE GLOBAL DEBATE ON INTELLECTUAL PROPERTY AND PUBLIC HEALTH (Int'l Ctr. For Trade note & Sustainable Dev. 2009), http://ictsd.org/i/publicatons/50454.

[134] STUDY F, *supra* note 60, at 7.

[135] Hall & Helmers, *supra* note 74, at 19.

[136] *Id.*

[137] *Study A*, *supra* note 79, at 111.

[138] *Id*.

well-enforced IPR and have a high capacity to absorb and implement the foreign technologies.[139]

Going forward, this article will group developing nations into three sets according to their stages of economic development. One group is the emerging economies, such as Brazil, Russia, India, China, and South Africa. Another group is the LDCs, such as Cambodia, Nepal, Haiti, and Uganda.[140] The remaining group encompasses the rest of developing nations, whose economic developments are between those of the emerging economies and the LDCs. This article calls them the mid-tier developing nations ("MDCs"); Georgia, Egypt, Cuba, and Argentina may be considered MDCs.

i. Investments for Clean Technologies

The examination of evidential data on global investments in clean technologies provides two revelations. First, commercial investments in developing nations have increased rapidly and even surpassed those in developed nations in 2012. This implies that IPR may become increasingly important to developing nations as they can leverage IPR to harvest and protect innovations that result from the increased commercial investments in clean technologies. IPR can also help sustain momentum in commercial investments in clean technologies.

Second, at least in developed nations, commercial investments in clean technologies overshadow government investments. Therefore, governments in developed nations may have a difficult time relaying the developing nations' requests for the removal or weakening of IPR protection on clean technologies to their domestic commercial sectors. This is due to the significant roles these sectors play in the investments in clean technologies and these sectors' preference for strong IPR for clean technologies.

In recent decades, investments in clean technologies have increased rapidly, especially in developing nations. The 2014 Science and Engineering Indicators[141] published by U.S. National Science Foundation ("Study E") illustrates the

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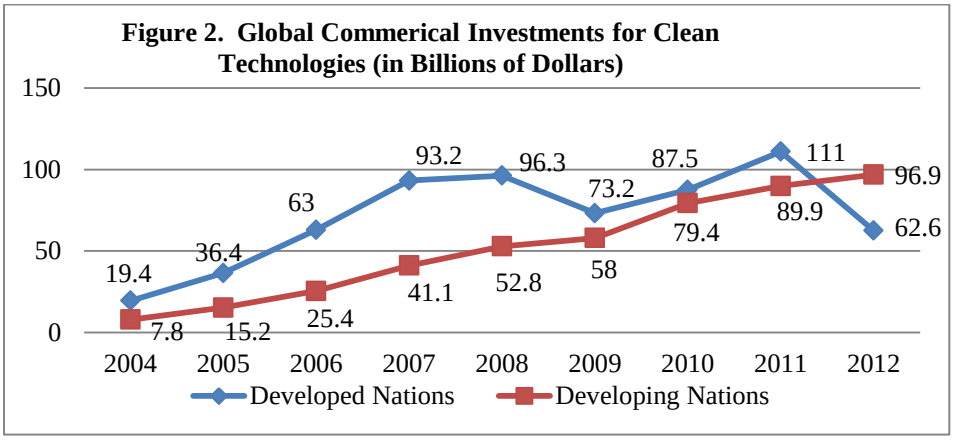
[139] Antoine Dechezleprêtre et al., *What Drives the International Transfer of Climate Change Mitigation Technologies? Empirical Evidence from Patent Data*, 54(2) ENVTL. & RESOURCE ECON. 161, 165 (2013) [hereinafter *Study G*].

[140] *List of Least Developed Countries*, UNITED NATIONS (Dec. 4, 2013), http://www.un.org/en/development/desa/policy/cdp/ldc/ldc_list.pdf.

[141] NAT'L SCI. Foundation, *Industry Technology and the Global Marketplace*, *in* SCIENCE AND ENGINEERING INDICATORS 2014 6, 6-21 (2014), http://www.nsf.gov/statistics/seind14/content/chapter-6/chapter-6.pdf [hereinafter *Study E*].

phenomena well.[142] According to Study E, global commercial investments in clean energy technologies have risen from less than 30 billion USD to 160 billion USD from 2005-2012.[143] The figure below provides further details.

Figure 2. Global Commerical Investments for Clean Technologies (in Billions of Dollars)



As shown, developing nations' commercial investments in clean technologies rose rapidly from 2004-2012. The input rose from 8 billion USD in 2004 to nearly 100 billion USD in 2012, making up over 61% of the global total. In 2012, China's commercial investments in clean technology totaled about 61 billion USD. Other developing nations, led by emerging economies such as Brazil, India, Indonesia, and Mexico, made up about 36 billion USD.

The rapid increase in commercial investments in clean technologies by developing nations indicates that IPR may be utilized to harvest the inventions from these commercial investments. Currently, governments of developing nations may prefer no or weak IPR on clean technologies. However, increased domestic holdings in clean technologies and an increased desire on the part of domestic industries to apply IPR protection to their own technologies will likely change the current preference.

Meanwhile, during 2004-2012, developed nations' commercial investments in clean technologies rose from about 19 billion USD in 2004 to about 63 billion USD in 2012, comprising 39% of the global total.[144] In 2012, the U.S. and the EU, with 27 billion USD and 29 billion USD respectively, tied as the second-largest

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[142] *Id.* at 6-49, 6-50.

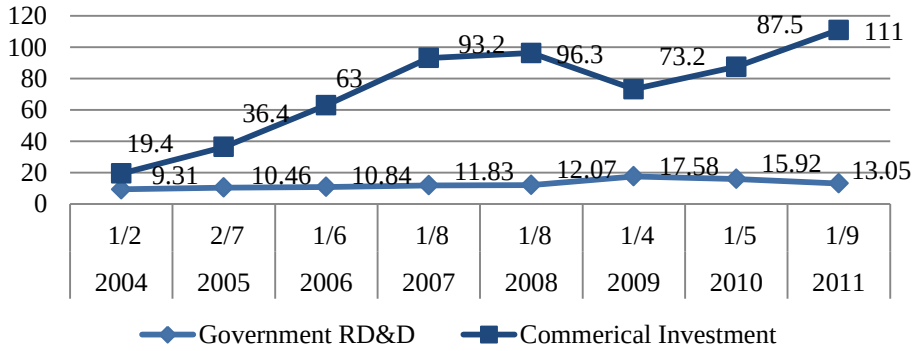
[143] *Id.*

[144] *Id.* at 6-51 ("Investment has been volatile in the aftermath of the global recession. Investment rebounded in 2010 and reached a new high of $110 billion in 2011 before plunging to $63 billion in 2012, its lowest level since 2006. After rising steadily prior to the global recession, U.S. investment fell sharply in 2008 before recovering to $32 billion in 2010, near its pre-recession level.").

sources of clean technology commercial investments. However, both investments were significantly less than the 61 billion USD from China, which led the commercial investments in clean technologies among developing nations. In 2012, commercial investments of the other developed nations were much lower than those of the U.S. and the EU, only amounting to a collective 7 billion USD.[145]

In the meantime, commercial investments in clean technologies in developed nations far exceed investments in clean technologies by governments of these nations. As shown in the figure below, in 2011, the governments of developed nations invested only 13 billion USD in research, development and demonstration ("RD&D") for clean technologies, compared to the total 110 billion USD spent by the commercial sectors in developed nations.[146] Specifically, the U.S. government and the Japanese government invested the most, with each spending 4 billion USD for RD&D in clean technologies in 2011; the EU was the next largest, with 2.6 billion USA. The governments of Canada, Australia, and South Korea each spent 1 billion USD, 600 million USD, and 500 million USD respectively.[147]

Figure 3. Developed Nations: Govern'mt RD&D v. Commerical Investments for Clean Tech (in Billions of Dollars)



As shown in the figure, the distance between government RD&D investments and commercial investments in clean technologies in developed nations has increased consistently over the past years; the ratio (as shown under the horizontal axis of the figure) changed from 1:2 in 2004 to 1:9 in 2011.

In general, there are two types of government support for the development and deployment of technologies. One is the enforcement of private rights, such as IPR, for incentivizing commercial investments.[148] Another is direct government

[145] *Id.*
[146] *Id.* at 6-51 to 6-52.
[147] *Id.* at 6-52.
[148] NICOLAS STERN, THE ECONOMICS OF CLIMATE CHANGE: THE STERN REVIEW 398 (2007).

funding of innovation.[149] The data above reveal the significant role commercial investments play in the development and deployment of clean technologies in developed nations. It thus implies that incentives such as IPR, which motivate commercial investments in clean technologies, probably should not be easily abridged. The governments of developed nations will have a difficult time supporting proposals to remove or weaken IPR on clean technologies, as such a proposals likely would not be accepted by the commercial sectors in developed nations.

ii. Patent Ownership for Clean Technologies

The examination of global patenting data on clean technologies identified three specific findings. First, developed nations own a majority of the patents on existing clean technologies. Second, the emerging economies are catching up rapidly in the number of clean technology patents, though patents on foreign clean technologies have taken up a significant share of these clean technology patents, Third, the rest of the developing nations have had few patents of clean technologies by domestic or foreign entities. The findings imply that IPR may be an issue for emerging economies' access to some foreign clean technologies due to the existence of local patents, but not an issue for the rest of the developing nations' access, since there are few local patents on foreign clean technologies.

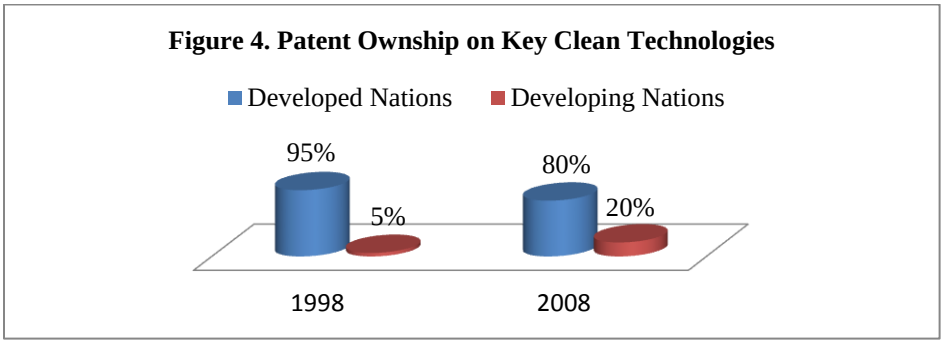
Study A, cited in Part I.C, examined the original filings of patents during 1978-2005 in thirteen climate change mitigation technologies.[150] Original filings of patents typically indicate where the patented inventions were developed. Study A found that 60% of the inventions patented worldwide in 1978-2005 originated from three developed nations: Japan, the U.S., and Germany.[151] Emerging economies represent 15% of the total inventions covered by Study A.[152]

A 2009 study on patent ownership of clean technologies by European economic consultancy Copenhagen Economics ("Study F")[153] confirms the pattern found by Study A. As shown in the figure below, Study F found that from 1998 to 2008, the ratio between developing and developed nations' patent holdings on

[149] *Id.*
[150] *Study A*, *supra* note 79.
[151] *Id.* at 124.
[152] *Id.* at 116 (demonstrating that inventions from these countries had a lower export rate, indicating lower values in these innovations).
[153] STUDY F, *supra* note 60.

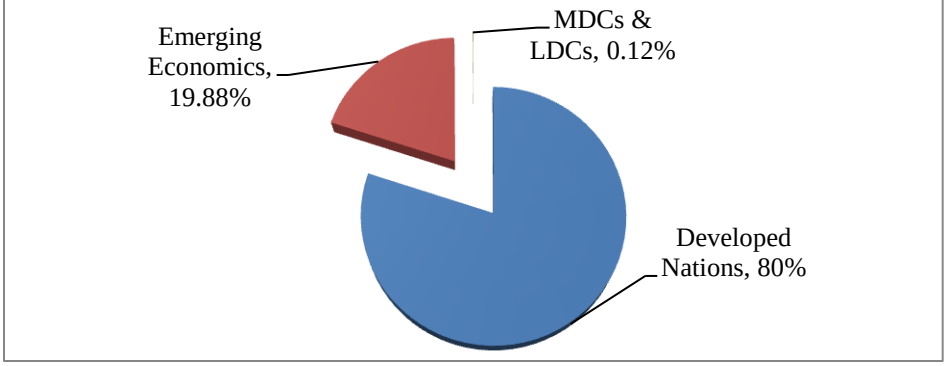
seven key clean technologies[154] grew from 1:20 to 1:5.[155] The improvement is significant, though the gap in patent ownership of clean technologies between developing nations and developed nations remains considerable.

Figure 4. Patent Ownship on Key Clean Technologies



A closer look at the data in Study F reveals a larger contrast of patent ownership between the emerging economies and the other developing nations – i.e., the MDCs and the LDCs. Study F found that in 2008, the emerging economies accounted for 99.4% of all protected patents filed by developing nations in the seven key clean technology areas reviewed, while the MDCs and the LDCs accounted for only the remaining 0.6%.[156] As shown in the figure below, this means that emerging economies owned 19.88% of the patents filed globally in the seven clean technology areas in 2008, while the MDCs and the LDCs owned a mere 0.12%. Furthermore, Study F found that two thirds of these patents owned by the emerging economies were filed by foreigners and one third by local residents.[157]

Figure 5. Patent Ownership on Key Clean Technologies (2008)



[154] *Id.* at 4 (reviewing patent ownerships in these clean technology areas: waste and biomass energy, solar, fuel cell, ocean, geothermal and wind power.)
[155] *Id.*
[156] *Id.* at 4-5.
[157] *Id.* at 22.

The above-identified findings of Study F are consistent with findings from Study B, which was discussed in Part I.C. Study B also found that patents on clean energy technologies in low-income nations – e.g., the LDCs and at least some MDCs – are relatively rare.[158] Study B further found that six developed nations – Japan, the U.S., Germany, South Korea, the United Kingdom, and France – accounted for almost 80% of patent filings in clean energy generation technologies.[159] Some of the emerging economies, such as Argentina, Brazil, China, India, Russia, the Philippines, and the Ukraine, have dramatically increased their patenting on clean technologies to such an extent that some of them filed 4,000 patent applications on clean technologies annually.[160] Meanwhile, current scholarship also indicates proprietary clean technologies do not enjoy protection in a number of jurisdictions, particularly in the most vulnerable economies.[161]

The fact that the MDCs and the LDCs held few patents in clean technologies indicates that owners of foreign clean technologies were not filing patents in these developing nations. This is consistent with the finding in Part I.C that the MDCs and the LDCs had little inbound transfer of foreign clean technologies. The fact that emerging economies have had the most share of the clean technology patents filed in developing nations and that two thirds of these patents were filed by foreigners has at least two implications. First, emerging economies have developed and owned certain clean technologies, and second, owners of foreign clean technologies value the emerging markets and thus applied for patent protections for clean technologies there.

3. Assessment

This article will now assess IPR's impact on the international transfer of clean technologies to developing nations, based on the evidence identified above, the author's professional experience in global IPR practice, and current scholarship on IPR and technology transfer. Multiple factors impact the international transfer of clean technologies. The existence of proper IPR protection in a receiving nation is a positive factor; other factors include the market and policy conditions in the receiving nation. As of now, the existence of IPR in the emerging economies has helped to attract foreign clean technologies to the emerging economies. The lack of IPR or weak IPR may have further deterred foreign clean technologies from dispersing to the remaining developing nations.

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[158] STUDY B, *supra* note 84, at 58.
[159] *Id.* at 4.
[160] Latif et al., *supra* note 29, at 4.
[161] *Id.*; *see also* ABBOTT, *supra* note 133.

IPR systems in developed and developing nations possess varying levels of maturity and sophistication. Developed nations have developed their IPR systems over a long time.[162] The emerging economies likely have established the formal structures of an IPR system within the past century, and can improve upon IPR enforcement.[163] The MDCs and especially the LDCs in general tend to have limited or non-existent IPR systems.[164]

Patents may, at best, be one of many factors encouraging investment in technology research and development.[165] Studies have found that in most circumstances, the promise of patent protection is not an important ex ante inducement to investments in technologies, though firms do register patents ex post to protect their inventions.[166] Evidence indicates that commercial investment in developing new clean technologies depends on more factors than just IPR, such as anticipated market demand, relative prices of alternative energy sources, regulatory demands, the costs of investment, and public research subsidies and tax inducements.[167]

However, patents play a stronger role in international technology transfer. Foreign technology owners want to be sure that the technologies will be protected from unwanted leaks caused by unsanctioned imitation or movements of personnel.[168] Empirical studies have shown that the volume and technology content of licensing contracts from U.S.-based firms to partners with developing nations

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[162] The first formal patent system came from the Western Hemisphere in 1474 in Venice. Patent laws in England and the U.S. were formally established in the 1620's and 1790's, respectively. *See* DANIEL C.K. CHOW & EDWARD LEE, INTERNATIONAL INTELLECTUAL PROPERTY 252-3 (2d ed. 2012).

[163] For example, the modern Indian patent law was established in 1970. *See* Jeffrey Colin, *Coming into Compliance with TRIPS: A Discussion of India's New Patent Laws,* 25 CARDOZO ARTS & ENT. L.J. 877, 880 (2013). Similarly, the modern Chinese patent law was established in 1984. *See* Joy Y. Xiang, *How Wide Should the Gate of Technology Be? Patentability of Business Methods in China,* 11 PAC. RIM L. & POL'Y J. 795, 801 (2002).

[164] *Understanding the WTO: Developing Countries*, WORLD TRADE ORG., http://www.wto.org/english/thewto_e/whatis_e/tif_e/dev1_e.htm (last visited July 25, 2015).

[165] Keith Maskus, *Differentiated Intellectual Property Regimes for Environmental and Climate Technologies* 16 (OECD Envir., Working Paper No. 17, 2010), http://dx.doi.org/10.1787/5kmfwjvc83vk-en [hereinafter Maskus, *Differentiated IP Regimes*].

[166] Levin, Richard C. et al., A*ppropriating the Returns from Industrial Research & Development,* BROOKINGS PAPERS ON ECON. ACTIVITY, SPECIAL ISSUE, 783, 812-818 (1987), http://www.brookings.edu/~/media/projects/bpea/1987%203/1987c_bpea_levin_klevorick_nelson_winter_gilbert_griliches.pdf.

[167] Maskus, *Differentiated IP Regimes*, *supra* note 165.

[168] KEITH E. MASKUS, INTELLECTUAL PROPERTY RIGHTS IN THE GLOBAL ECONOMY 136-141 (2000).

rises significantly when developing nations strengthen their patent rights.[169] Furthermore, strong patent reforms in developing nations have been demonstrated to bring more imports of capital goods and high-tech goods from developed nations.[170]

Meanwhile, studies further suggest that the ability of IPR to support international technology transfer may depend on other factors such as the market and policy conditions in the receiving nations.[171] This explains why positive impacts of IPR on international technology transfer have been found only in emerging economies, but not in the MDCs and especially not in the LDCs. Technology owners tend not to transfer technologies to the LDCs, because the LDCs tend to have small domestic markets along with relative low capacity for local absorption of technologies, skilled labor, weak governance, and infrastructure.[172]

i. The Emerging Economies

Though IPR may have increased the cost for the emerging economies to access foreign clean technologies, that does not justify why IPR has been a major barrier for emerging economies to access foreign clean technologies.

In contrast with the MDCs and the LDCs, the emerging economies have established more mature IPR systems. [173] Therefore, owners of clean technologies from developed nations may prefer to apply for patent protection for their clean technologies in the emerging economies than in the MDCs or the LDCs.[174] The cost of transferring such clean technologies from developed nations may include the cost of securing IPR on these technologies in the emerging economies.

However, IPR that protects foreign clean technologies in the emerging economies should not pose an overwhelming threat to the emerging economies'

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[169] Lee G. Branstetter et al., *Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from U.S. Firm-level Panel Data*, 121 Q.J. ECON. 321, 321 (2006).

[170] Olena Ivus, *Do Stronger Patent Rights Raise High-Tech Exports to the Developing World?* 81 J. INT'L ECON. 38, 45 (2010).

[171] Maskus, *Differentiated Intellectual Property Regimes for Environmental and Climate Technologies*, *supra* note 165.

[172] *Id.*

[173] *See* discussion *supra* notes 163-164.

[174] *See supra* Part II.A.2 (emerging economies have had most of the patent filings in developing nations, and patents on foreign clean technologies have taken about two thirds of the clean technologies patents owned by the emerging economies.)

access to clean technologies. As discussed in Part II.A.1, the basic technical solutions of climate change have long expired from patent protection; rather, incremental improvements or individual features are being patented.[175] Second, a clean technology tends to have different alternatives and substitutes in the market; weakening a single patent holder's control over the market.[176] Both facts imply that a singular IPR-protected clean technology may not have significant dominance in the relevant market.

Meanwhile, the emerging economies benefit from IPR for clean technologies. First, given the emerging economies' increasing commercial investments in clean technologies,[177] they need IPR for clean technologies to capture these investments and build up their own IP portfolios in the clean technologies. In addition, in order for the emerging economies to attract more inbound transfer of foreign clean technologies and to stimulate local innovations, they need to enhance their IPR systems rather than weaken them. International trade flows respond positively to increases in patent protections in the emerging economies, especially in industries that rely heavily on patent protection.[178]

ii. The LDCs

IPR should not be a major barrier for the LDCs to access foreign clean technologies. Few foreign clean technology owners have applied for patents in the LDCs.[179] Conversely, as the above review of data on global patenting of clean technologies shows, the LDCs administer few patents on clean technologies.[180] These consequences are likely multiplied by factors such as limited market sizes and potential profit returns that the LDCs offer to foreign firms, and/or their lack of confidence in the investment environment offered by the LDCs.[181]

On the contrary, the LDCs' lack of or limited IPR protection may be one of the reasons for the almost non-existent rate of inbound transfer of foreign clean technologies. Lack of or limited IPR protection in the LDCs enables users in the LDCs to imitate, reverse engineer, and use foreign clean technologies for free. Hence, foreign firms owning clean technologies may choose not to transfer the

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[175] Barton, *Intellectual Property and Access to Clean Energy Technologies in Developing Countries*, *supra* note 129, at 13.

[176] *Id*.

[177] *See* discussion *supra* Part II.A.2.i.

[178] Maskus, *Encouraging International Technology Transfer*, *supra* note 98, at 10.

[179] *See* discussion *supra* Part II.A.2.ii (on patent ownership for clean technologies).

[180] *See* discussion *supra* Part II.A.2.ii.

[181] *See* TRIPS MEETING MINUTES JUNE 11-12, 2013, *supra* note 107.

technologies to the LDCs voluntarily, fearing the loss of control over the technologies.[182]

iii. The Other Developing Nations – i.e., the Mid-tier Developing Nations

When an MDC is building up its economy to become more like an emerging economy, IPR will likely help the MDC attract owners of foreign clean technologies to apply for IPR protection of their technologies in the MDC. In such a situation, IPR may increase the price of the MDC's access to the IPR-protected foreign clean technologies.

On the other hand, IPR should not be part of the cost for an MDC's access to foreign clean technologies, especially if the MDC remains at status quo or recedes to become more like an LDC. As data on the global patenting of clean technologies have shown, the MDCs along with the LDCs owned few clean technology patents.[183] Lack of or limited IPR protection in the MDCs may be one reason for this phenomena.

B. What Are the Potential Underlying Reasons for the Limited Transfer of Clean Technologies to Developing Nations?

While the existence of IPR has not been a major barrier to the international transfer of clean technologies to developing nations, this begs the question: what is? To find the answer, this article analyzes available evidential data such as data supplied by developing nations themselves on what constitutes major barriers to the inbound transfer of clean technologies. This article then supplements the analysis with a review of current scholarship regarding international technology transfer.

1. Evidential Data

Data from developing nations collected by the United Nations identify a number of barriers to the inbound transfer of foreign clean technologies. Though IPR was initially listed as a barrier, it has not been considered one since 2009. Data from different surveys on international transfer of clean technologies suggest that IPR helps a developing nation to attract foreign clean technologies. Such data also indicates that IPR is not the sole determinant; other conditions include a developing nation's market size and its capacity to absorb and implement foreign clean technologies.

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[182] *Study G*, *supra* note 139, at 167.

[183] *See* discussion *supra* Part II.A.2.ii (on patent ownership for clean technologies).

i. Developing Nations' Own Assessments

As introduced earlier in Part I.C, one mechanism that the UNFCCC established via its international technology transfer framework is the Technology Needs Assessment ("TNA") reports. These reports are for developing nations that are parties to the UNFCCC, to identify both their needs for specific clean technologies and the barriers these nations perceive to the inbound transfer of clean technologies.[184] Thus far, these nations have submitted three sets of TNA reports: the first in 2006 with 23 participating developing nation parties, the second in 2009 with 70 participating developing nation parties, and the third in 2013 with 31 participating developing nation parties.[185] The TNA reports by developing nations from 2006 to 2013 identify a number of barriers for inbound transfer of foreign clean technologies. Whereas IPR is listed as a barrier in the 2006 TNA reports, it is not in later reports. The TNA reports do not seem to support the claim that the existence of IPR has been a major barrier to the transfer of clean technologies to developing nations.

The three sets of TNA reports identified very similar patterns on what constituted major barriers to the inbound transfer of clean technologies to developing nations. In all the three sets of TNA reports, developing nations highlighted economic and market barriers as one of the major barriers to the inbound transfer of clean technologies.[186] Specifically, 83%, 82%, and 90% of the

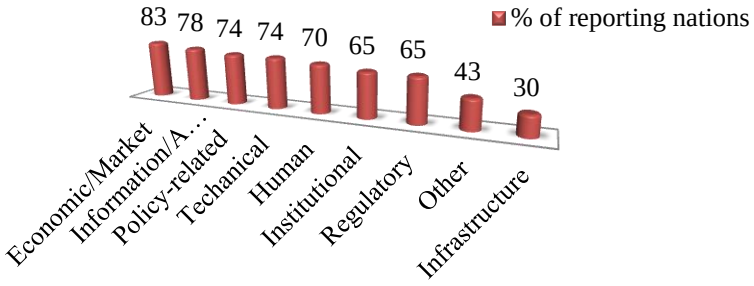
[184] *Synthesis of Technology Needs Assessments*, U.N. FRAMEWORK CONVENTION ON CLIMATE CHANGE, http://unfccc.int/ttclear/templates/render_cms_page?TNA_ida (last visited July 26, 2015).

[185] Data extracted from the 2006, 2009, and 2013 TNA synthesis reports. United Nations Framework Convention on Climate Change, Subsidiary Body for Scientific and Technological Advice, Twenty-Fourth Session, Bonn, Ger., May 18-26, 2006, *Synthesis Report on Technology Needs Identified by Parties not Included in Annex I to the Convention*, U.N. Doc. FCCC/SBSTA/2006/INF.1 (Apr. 21, 2006) [hereinafter 2006 TNA Reports]; United Nations Framework Convention on Climate Change, Subsidiary Body for Scientific and Technological Advice, Thirtieth Session, Bonn, Ger., June 1-10, 2009, *Second Synthesis Report on Technology Needs Identified by Parties not Included in Annex I to the Convention*, U.N. Doc. FCCC/SBSTA/2009/INF.1 (May 29, 2009) [hereinafter 2009 TNA Reports]; United Nations Framework Convention on Climate Change, Subsidiary Body for Scientific and Technological Advice, Thirty-Ninth Session, Warsaw, Pol., Nov. 11-16, 2013, *Third Synthesis Report on Technology Needs Identified by Parties not Included in Annex I to the Convention*, U.N. Doc. FCCC/SBSTA/2013/INF.7 (Oct. 21, 2013) [hereinafter 2013 TNA Reports].

[186] 2006 TNA Reports, *supra* note 185. 2009 TNA Reports, *supra* note 185; 2013 TNA Reports, *supra* note 185.

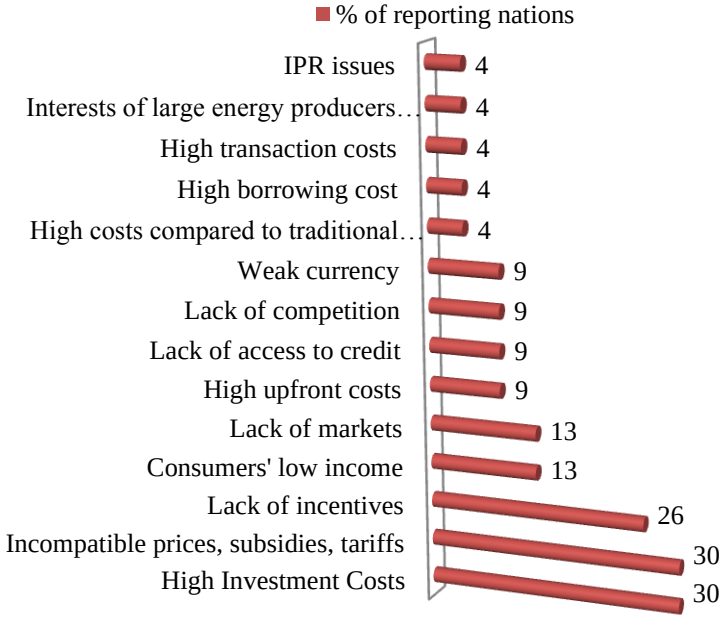
reporting nations in the 2006, 2009, and 2013 TNA reports did so, respectively.[187] The figure below ranks the major barriers reported in 2006, according to the percentage of reporting nations who cited these major barriers in their 2006 TNA reports.[188]

Figure 6. Major Barriers (2006)



In these three sets of TNA reports, the reporting nations also identified what constituted economic and market barriers. The figure below shows such data from the 2006 TNA reports.[189] As shown, here, IPR issues were identified as one of the barriers, though by the fewest reporting nations.

Figure 7. Economic and Market Barriers (2006)

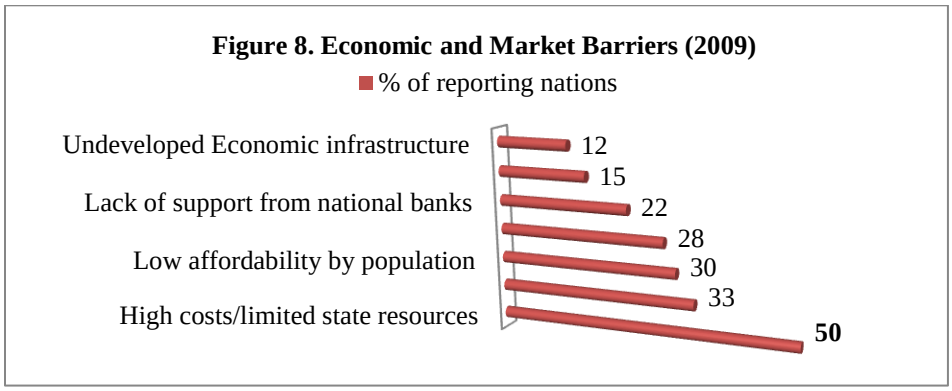


[187] 2006 TNA Reports, *supra* note 185. 2009 TNA Reports, *supra* note 185; 2013 TNA Reports, *supra* note 185.

[188] 2006 TNA Reports, *supra* note 185.

[189] *Id.*

However, the 2009 and 2013 TNA reports made no mention of IPR issues. The 2009 report, for instance, as shown below, identified "underdeveloped economic infrastructure," "lack of support from national banks, "low affordability by population," and "high costs/limited state resources" as economic and market barriers, and did not include IPR on the list.[190]



One possible reason for the disappearance of IPR issues from the TNA reports is that the reporting nations no longer considered IPR issues a barrier to the international transfer of clean technologies. Alternatively, the reporting nations may have merged IPR issues with another barrier, for instance the barriers relating to high costs or incompatible prices. Only high costs consistently appeared in all three sets of TNA reports. Developing nation parties of the UNFCCC have consistently cited high costs and/or lack of financial resources as an economic and market barrier to the inbound transfer of clean technologies and it has consistently ranked the highest in term of the number of reporting nations citing it as a barrier.[191]

These reports, however, did not identify what caused the high investment cost or high cost for transfer for clean technologies. They also did not mention IPR an element of these high costs. Could IPR price be a necessary part of the cited

[190] 2009 TNA Reports, *supra* note 185, at 29-30.

[191] For example, 30% of the reporting nations in the 2006 TNA reports cite high investment costs as an economic and market barrier, 50% of the reporting nations in the 2009 TNA reports cite high costs and limited state resources as an economic and market barrier; and 85% of the reporting nations in the 2013 TNA reports cite lack of or inadequate access to financial resources as an economic and market barrier to the development and transfer of mitigation technologies within the energy sector. *See* 2006 TNA Reports, *supra* note 185; 2009 TNA Reports, *supra* note 185; 2013 TNA Reports, *supra* note 185. The 2013 reports have separated reporting regarding developing nations' needs on mitigation technologies from those of adaptation technologies. The 2006 and 2009 TNA reports did not make such a distinction.

high costs or high investment cost for inbound transfer of clean technologies for developing nations?

The answer depends on a developing nation's ability to attract technologies with IPR. If a developing nation is able to attract foreign firms to apply for and obtain IPR locally on the firms' clean technologies, the high cost of technology transfer may include the price premium added by local IPR on the foreign clean technology. Otherwise, when foreign firms do not apply for IPR protection for their clean technologies in developing nation, the high cost of the transfer of clean technologies likely does not include IPR costs.

The high costs facing the MDCs and the LDCs for inbound transfer of foreign clean technologies are not likely the result of IPR protection. The MDCs and the LDCs have few patents on clean technologies.[192] These nations may not have provided sophisticated IPR systems that foreign technology owners can rely on. Furthermore, foreign technology owners may choose not to transfer their technologies to these nations due to their limited market sizes and low potentials for financial profits.[193]

On the other hand, IPR might have contributed to the high costs for inbound transfer of foreign clean technologies to emerging economies. As the analysis of the patent data in Part II.A shows, the emerging economies have held most of the clean technology patents in developing nations, and two-thirds of these patents were on foreign clean technologies. Because of the market size and potential profitability emerging economies can offer, foreign technology owners may be attracted to transfer their technologies to the emerging economies. Meanwhile, the emerging economies tend to have established IPR systems which allow the foreign technology owners to secure local IPR protection on their technologies.

ii. Other Evidential Data

Other evidential data[194] supplement the findings from the TNA reports, which suggest that IPR helps attract foreign clean technologies to developing nations. The data also indicates that IPR is not the sole determinant; other conditions that attract these technologies include adequate market size and the capacity to absorb and implement foreign clean technologies. The additional evidence correlates with developing nations' TNA reports, which identified multiple domestic barriers such as economic and market, public policy, human

[192] *See* discussion *supra* Part II.A.
[193] *See* TRIPS MEETING MINUTES JUNE 11-12, 2013, *supra* note 107.
[194] *See Study G*, *supra* note 139; STUDY B, *supra* note 84.

capital, institutional, infrastructure, etc., for attracting inbound transfer of clean technologies.

Surveys have found that IPR is good for the international transfer of clean technologies to developing nations. For example, a 2010 study examining factors driving international transfer of clean technologies ("Study G") using patent data from sixty-six nations during 1990-2003 found that strong IPR has a positive impact on in-bound transfer of clean technologies.[195] Further, Study B (cited in Part I.C) found that the patent system can support and enhance technology transfer, because without patents to protect the foreign companies' products and processes, the foreign companies may be reluctant to engage in technology transfer and associated investments.[196]

However, studies also discovered that IPR is not the only factor in attracting foreign clean technologies to developing nations. For example, Study G finds that a nation's capacity to absorb foreign clean technologies is determinative for local patent filing and thus the inbound transfer of foreign clean technologies.[197] For example, Study G found that patent filings on foreign technologies increase in nations that have active R&D in the same technology field,[198] and restrictions on international trade negatively affect international technology transfer.[199]

Furthermore, Study B found that the main factors that impede international transfer of clean technologies include access to trade secrets, developing nations' ability to provide suitable skilled staff, scientific infrastructure, and favorable market conditions.[200] These are collectively known as access to know-how from the foreign companies. Meanwhile, Study B enlisted necessary complementary factors such as infrastructure, effective government policies and regulations, knowledge institutions, and access to credit and venture capital, skilled human capital, and networks for research collaboration.[201] These factors correlate with the major barriers identified by developing nations in the TNA reports discussed above.

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[195] *Study G*, *supra* note 139, at 180.
[196] STUDY B, *supra* note 84, at 9.
[197] *Study G*, *supra* note 139.
[198] *Id*. at 180.
[199] *Id.* at 181 (However, Study G finds that restrictions to FDI promote technology transfer. Study G reasons that this may be because the restrictions ask for technology transfer, or force foreign technology owners rely more on patents as an alternative or to secure their FDI.)
[200] STUDY B, *supra* note 84, at 50.
[201] *Id.*

2. Assessment

The analysis below examines what impacts the transfer of clean technologies to developing nations via each of the three market-based venues i.e., international technology licensing, FDI, and international trade. The analysis leverages current scholarship on international technology transfer, finding that IPR protection, capacity to absorb and adopt foreign technologies, market size and policy certainty and transparency are likely conditions for a nation attracting inbound transfer of foreign technologies. Further, although IPR helps attract foreign technologies, strong IPR likely stifle the development of local industries for some developing nations – such as the LDCs – that are at the beginning stages of technology development and rely on learning via duplicative imitation.

i. International Technology Licensing

Technology licensing occurs when an owner of a proprietary technology consents to another party's use of the technology in exchange for value.[202] International technology licensing is a particularly important source for the transfer of standalone technologies, e.g., technical information or know-how that is not embodied in equipment or hardware.[203]The main criteria for a nation to attract foreign technologies via international technology licensing include market size, policy certainty and transparency, capacity to absorb and implement foreign technologies, and sufficient IPR protection. For example, studies shows that nations with substantial engineering skills and R&D programs for adaptation and learning attract more international technology licensing than other nations.[204]

IPR is another important factor for international technology transfer via technology licensing. When developing nations with the capacities to absorb and use foreign technologies strengthen their IPR protections, developed nations are more likely to license their technologies to these developing nations due to their low wage and production cost.[205] Study B, cited in Part I.B, also found that the state of IPR in the nation of the licensee was an important factor in a licensor's decision to enter into a licensing agreement; and that licensing-intensive respondents viewed IPR as a more important factor than others in the nation of the

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[202] WORLD INTELL. PROP. ORG., SUCCESSFUL TECHNOLOGY LICENSING 5 (2015), http://www.wipo.int/edocs/pubdocs/en/licensing/903/wipo_pub_903.pdf.

[203] *See* Hoekman et al., *supra* note 74, at 1589.

[204] Guifang Yang & Keith E. Maskus, *IPR, Licensing and Innovation in an Endogenous Product-Cycle Model* (World Bank, Working Paper No. 2973, 2003), https://openknowledge.worldbank.org/bitstream/handle/10986/19156/multi0page.pdf?sequence=1.

[205] MASKUS, GLOBALIZING INFORMATION, *supra* note 127.

licensee such as scientific infrastructure, human capital, favorable market conditions, and investment climates.[206]

ii. Foreign Direct Investment

Foreign direct investment ("FDI") refers to when one nation's commercial entity invests cross-border in another nation.[207] Such an investment can be the commercial entity establishing business operations, acquiring assets, or taking up stakes in businesses in the other nation.[208] The investment may involve the transfer of capital, management, technology, and organizational skills.[209] FDI likely contributes positively to international transfer of technologies to developing nations. Factors such as the market size, policy clarity and transparency, human capital, and availability of IPR protection of the recipient nation all would enhance inbound FDI.

FDI by commercial entities, such as the MNCs, provides developing nations with more access to foreign technologies. Developing nations may also benefit from FDI's spillover effects, i.e., the demonstrations of foreign technical and business operations, labor turnover by personnel movements, and interactions among businesses in the chain of moving a product or service to the end users.[210]

Multiple factors affect a nation's ability to receive FDI. Similar to international technology licensing, market size, policy clarity and transparency of the recipient nations affect FDI.[211] A study testing the effects of inbound FDI on growth in 69 developing nations found that inbound FDI contribute more to domestic growth than domestic investments do, but only when the recipient nation has a minimum threshold stock of human capital.[212] Multiple studies show a positive correlation between perceived strength of IPR protection in developing nations and the volume and quality of FDI they attract.[213] When developing nations

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[206] Latif et al., *supra* note 29; STUDY B, *supra* note 84, at 50-58.

[207] *Foreign Direct Investment Definition,* FIN. TIMES, http://lexicon.ft.com/Term?term=foreign-direct-investment (last visited July 12, 2015).

[208] *Id.*

[209] *Id.*

[210] Hoekman et al., *supra* note 74, at 1588.

[211] *Id.*

[212] E. Borensztein et al., *How Does Foreign Direct Investment Affect Economic Growth?* 45(1) J. INT'L ECON. 115, 117 (1998).

[213] *See, e.g.*, Branstetter et al., *supra* note 169, at 322; Jeong-Yeon Lee & Edwin Mansfield, *Intellectual Property Protection and U.S. Foreign Direct Investment*, 78(2) REV. OF ECON. AND STAT. 181, 181 (1996); Edwin Mansfield, *Intellectual Property Protection, Direct Investment, and Technology Transfer*, (Int'l Fin. Corp., Discussion Paper No. 27, 1995).

failed to provide patent protection for foreign inventions, foreign firms resorted to use "less than best-practice technologies" in developing nation.[214]

iii. International Trade

International trade likely increases developing nations' access to foreign technologies. IPR protection and the capacity to absorb and adapt foreign technologies will attract trade inflows. However, for LDCs or other developing nations that are still at the beginning stages of their domestic technology development, strong IPR will likely be restrictive for the development of local industries.

International trade is the cross-border exchange of capital, goods, and services.[215] Similar to the spillover effects caused by FDI, openness in trade facilitates international technology transfer by allowing the recipient nations to access foreign technologies via exposure to new equipment, foreign business and technical operations.

Besides being open to international trade, developing nations' capacity for absorbing and adapting foreign technologies is important for foreign technologies to effect local technical change. [216] When a developing nation lacks such capacity, it may utilize open trade to learn of foreign practices and/or use FDI to acquire technology.[217]

Meanwhile, IPR likely attracts the inflow of trade, at least for some developing nations. An empirical study of international trade flows from 1984, when there were still huge gaps in IPR systems among different nations, shows that stronger IPR significantly expands bilateral imports.[218] A more recent study on the impact of IPR on China's import industries indicated that strong IPR stimulates imports, especially for knowledge-intensive products.[219]

However, IPR's positive effect on technology transfer via trade may not apply to all developing nations. Through open trade, developing nations can rise up

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[214] M. Scott Taylor, *TRIPS, Trade, and Technology Transfer*, 26(3) CAN. J. ECON. 625, 637 (1993).

[215] Reem Heakal, *What Is International Trade?*, INVESTOPEDIA, http://www.investopedia.com/articles/03/112503.asp (last visited Aug. 18, 2015)

[216] Hoekman et al., *supra* note 74, at 1588.

[217] *Id.*

[218] MASKUS, GLOBALIZING INFORMATION, *supra* note 127, at 5.

[219] Titus O. Awokuse & Hong Yin, *More Bilateral Trade? Evidence from China's Imports*, 38(8) WORLD DEV. 1094, 1104 (2010).

the "duplicative imitation, creative imitation and inventing" ladder of technology development by imitating and reverse engineering advanced foreign technical and related business operations.[220] If a developing nation is in the duplicative imitation stage, in the absence of technology licensing, strong IPR would raise developing nation's imitation costs, restrict technology diffusion, and reduce long-term incentives to innovate. Currently, many developing nations are at the duplicative imitation stage, hoping to absorb foreign technologies into labor-intensive export production and evolve into higher value-added stages such as creative imitation or inventing over time. In particular, the LDCs have barely stepped onto this ladder of technology learning.[221] Therefore, for these developing nations, differentiated IPR systems reflecting these developmental realities likely make more sense than the strong IPR systems used in developed nations. Such developing nations probably would also benefit from having access to mechanisms – e.g., international aid, subsidies or differential pricing schemes – that reduce the cost of importing IPR-protected goods or services.[222]

C. Summary

As discussed in Part I.B, addressing climate change is a pressing issue; in order to meet the 2°C goal, we need to reduce 60% of the anthropogenic GHG emissions by 2050, using 2000 as a base line.[223] Rapid development and deployment of clean technologies to meet this goal requires developed and developing nations to act independently and collaboratively.

The stalemate between developing nations and developed nations regarding IPR's role in improving international transfer of clean technologies must cease. As the analysis in Part II.A shows, the existence of IPR has not been a major roadblock for the transfer of clean technologies to developing nations.[224] Instead, lack of proper IPR protection for clean technologies may impede the international transfer of clean technologies. Commercial sectors in developed nations play a significant role in the development and transfer of clean technologies, and they are concerned about losing their control of the technologies to be transferred if developing nations do not offer proper IPR protections. Therefore, developing nations need to offer IPR in order to attract inbound transfer of clean technologies.

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[220] Hoekman et al., *supra* note 74, at 1593.
[221] *Id.*
[222] *Id.*
[223] *See IPCC Fourth Assessment Report*, *supra* note 49.
[224] *See* analysis *supra* Part II.A.

However, developing nations should be allowed to customize their IPR protections to address the realities of their countries' economic development. Strong IPR protections may not benefit all developing nations equally. For developing nations that currently rely on duplicative imitation of foreign practices for technology development, strong IPR protections will likely inhibit such practice and hence the growth of domestic industries.

Meanwhile, IPR is just one of the conditions enabling developing nations to attract inbound transfer of clean technologies. According to the analysis in Part II.B, in order to attract inbound transfer of foreign clean technologies, a developing nation also needs to have certain capacity. Such capacity includes a good investment environment (such as market conditions, policy clarity and transparency) openness to trade for attracting international technology transfer, and domestic scientific infrastructure and human capital for absorbing and implementing foreign technologies into the local production process.

Likely due to a lack of some of such capacity, most developing nations—especially the MDCs and the LDCs—have had difficulties attracting foreign clean technologies. Meanwhile, as the examination in Part I.C shows, emerging economies have been attracting most of the limited international transfer of clean technologies to developing nations. This is likely due to the fact that emerging economies have most of such capacity, e.g., market sizes and profitability, more established IPR systems and domestic ability to absorb and implement foreign clean technologies. The MDCs and the LDCs have yet to build up such capacity to attract inbound transfer of foreign clean technologies.

Developed nations can help developing nations—especially the MDCs and the LDCs--build up such capacity. Because of climate change's global impact and developed nations' historical contributions to climate change, developed nations have the self-interest and moral duty to help developing nations address climate change, e.g., via international aid. Furthermore, the governments of developed nations can set up domestic initiatives and mechanisms to encourage their commercial sectors to transfer clean technologies to developing nations.

III
PROPOSAL: FOCUS ON DOMESTIC INNOVATION, INTERNATIONAL AID, AND INTERNATIONAL TECHNOLOGY COLLABORATION

This article proposes that domestic innovation, international aid and international technology collaboration should be the focus, rather than international transfer of clean technologies, in order to effectively address climate change via clean technologies. The proposal aims to encourage the rapid and sustainable

development and deployment of clean technologies, while addressing the factors that likely have induced the limited amount of transfer of clean technologies to developing nations during the past two decades.

The proposed solution has three prongs. First, both developed nations and developing nations should stimulate domestic innovations on clean technologies by leveraging diverse tools for encouraging innovations. This includes developed nations optimizing their IPR systems to encourage advancements in clean technologies, along with developing nations building customized IPR systems reflecting their national realities. Second, developed nations and even the emerging economies should provide financial and technical aid to developing nations, especially the MDCs and the LDCs, to help them combat climate change and build the sustainable national capacity to attract, absorb and implement foreign clean technologies. Third, when applicable, developed nations and developing nations should construct collaboration platforms for clean technology developments that would benefit both parties.

A. Domestic Innovation

Both developed nations and developing nations should focus on encouraging domestic innovations in clean technologies by leveraging diverse means for cultivating innovation. Such means include optimizing existing IPR systems (e.g., in developed nations) or building up customized IPR systems that reflect the nation's developmental realities (e.g., in developing nations). They may also include utilizing, where appropriate, open source movement, open innovation, prizes, patent pools and patent commons.

1. Developed Nations

Developed nations should focus on advancing the development of clean technologies, as discussed in Part I.B, to make the needed technical breakthroughs and provide clean technologies as attractive and affordable alternatives to the traditional high-carbon technologies. Developed nations have the resources and human capital to invest in advancing clean technology innovations, and are thus well suited to take leadership in driving them. To do so may require that developed nations optimize their existing IPR systems for rapid development and deployment of clean technologies. It also may require leveraging other tools for promoting innovations.

Ideally, developed nations will optimize their existing IPR systems so as to encourage advanced development of clean technologies and facilitate outbound transfer of clean technologies to developing nations.

Different proposals have been put forth regarding how to optimize the existing IPR systems to facilitate development of clean technologies.[225] Accelerated patent examination, reduction, waiver or cancellation of administration fees for patent applications on clean technologies, earlier publication of clean technology patent applications, priority for clean technology patents at the opposition and infringement stage, and better classification of the clean technologies are a few possible approaches for encouraging the patenting of clean technologies.

Quite a few nations have implemented special IPR treatments for clean technologies. For example, patent offices in the U.K., the U.S., Japan, Australia, China, Korea, Israel, and Brazil have instituted fast-track examinations for clean technology patents applications.[226] Expediting the examination process for patent applications on clean technologies means less delays in granting protection to a patentable clean technology. Under the U.K. fast track program for patent applications of clean technologies,[227] the examination time is reduced from 2-3 years to 9 months - a 75% reduction of examination time.[228] Such reduced delay brings earlier awareness of and access to the patented technologies by the general public, including developing nations.

Optimizing the IPR system is just one approach to advance development of clean technologies. Other means should be explored as well. For example, the open source movement for the software industry may work for fostering development in a specific clean technology field. Prizes for specific clean technology sectors may inspire the breakthrough innovations needed for these sectors. Patent pools and patent commons can also be formed to ease access to proprietary clean technologies.

2. Developing Nations

Developing nations should focus on building environments that foster domestic development of clean technologies while attracting inbound transfers of foreign clean technologies. Most importantly, for their own sustainable

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[225] RIMMER, INVENTING CLEAN TECHNOLOGIES *supra* note 100; Joshua D. Sarnoff, *The Patent System and Climate Change*, 16 VA. J.L. & TECH. 301 (2011).

[226] Antoine Dechezleprêtre, *Fast-Tracking Green Patent Applications: An Empirical Analysis*, INT'L CTR. TRADE & SUSTAINABLE DEV. ISSUE PAPER NO. 37 (2013), http://www.ictsd.org/downloads/2013/02/fast-tracking-green-patent-applications-an-empirical-analysis.pdf.

[227] *Patents: Accelerated Processing*, U.K. INTELL. PROP. OFFICE (June 13, 2014), https://www.gov.uk/patents-accelerated-processing#green-channel.

[228] Dechezleprêtre, *Fast Tracking Green Patent Applications*, *supra* note 227.

development, developing nations need to build up an environment fostering domestic development of clean technologies. This way, developing nations can build their own portfolios in clean technologies, empowering themselves for a low-carbon economy and to have better negotiation positions with entities from developed nations.[229]

Similar to developed nations, developing nations need to leverage diverse tools for promoting domestic innovation of clean technologies. In addition, developing nation's internal knowledge of the geographic regions, traditional technology and indigenous practice may also provide a holistic approach for addressing climate change when integrated with modern clean technologies. In order to increase inbound transfer of foreign clean technologies, developing nations need to build the national capacity identified in Part II.B for attracting, absorbing and implementing foreign technologies. Offering IPR protection is part of such national capacity. IPR may also encourage domestic innovation, when appropriately adapted to a nation's developmental reality.

i. Building National IPR Systems That Reflect Developmental Realities

The reality of today's global economy suggests the necessity of a domestic IPR system for a developing nation. Developed nations have had their dominant imprints on the operations of the global economy, including in integrating their IPR standards into the WTO TRIPS Agreement, with which all WTO member nations are required to comply. Further, as data on global investments in clean technologies discussed in Part II.A show, commercial sectors in developed nations far outpace governments insofar as investments in clean technologies. Such disparity means the governments of developed nations will likely have difficulties in requesting the commercial sectors to forego their preferences for strong IPR, as developing nations' demand of weakened or no IPR on clean technologies would require. Hence, the use of IPR will most likely persist in global trade. Instead of resisting it, developing nations should utilize IPR for their long-term economic development and build domestic IPR systems that address and reflect national developmental realities.

The global economy may offer developing nations additional leverage for technology development besides the traditional model of "duplicative imitation, creative imitation, and inventing." Instead of relying mainly on imitating advanced

[229] Some developing nations such as the emerging economies are more or less doing so. Different national priorities and barriers such as the ones identified by developing nations in the TNA reports may have deterred other developing nations from making domestic development of clean technologies a priority.

foreign practices to jumpstart local technology development, integrating a developing nation's local economy into the global economy and opening it up to global trade may speed up its technology development via the inflow of capital and modern business or technical practices. Such integration likely requires membership in the WTO.[230] The WTO, meanwhile, requires its member nations to comply with the TRIPS Agreement, which sets up minimum IPR requirements.[231]

Joining the WTO and complying with the TRIPS Agreement probably would not prevent a developing nation from having a customized IPR system, which could reflect a developing nation's own needs in technology development.[232] While the TRIPS Agreement establishes minimum requirements for IPR protection in a WTO member nation, it also offers flexibilities that can be leveraged at member nations' discretions.[233] In particular, it recognizes the LDCs' need to have "maximum flexibility" in implementing the requirements of the agreement.[234]

The TRIPS Agreement provides individual WTO member nations policy space for regulating patentability of clean technologies or denying patent protection for certain technologies. For example, it does not define what constitutes an "invention" nor the criteria for patentability,[235] thus each national government can provide its own criteria regulating what inventions can be granted patent protection. The TRIPS Agreement also leaves room for each member nation to deny patent protection to technologies that are necessary to "protect *ordre public* or morality, including to protect human, animal or plant life or health or to avoid

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[230] As of July 2015, there are 196 countries in the world, 161 of them are WTO member nations. *See Understanding WTO, the Organization*, WORLD TRADE ORG., https://www.wto.org/english/thewto_e/whatis_e/tif_e/org6_e.htm (last visited July 13, 2015).

[231] VANDANA SHIVA, PROTECT OR PLUNDER? UNDERSTANDING INTELLECTUAL PROPERTY RIGHTS 51 (2001).

[232] The costs and benefits associated with joining the WTO are not within the scope of this Article. Instead, the discussion here is limited to whether joining the WTO would prevent a nation from having a customized IPR system reflecting the nation's reality in technology development.

[233] *Advice on Flexibilities Under the TRIPS Agreement*, WORLD INTELL. PROP. ORG., http://www.wipo.int/ip-development/en/legislative_assistance/advice_trips.html (last visited Nov. 3, 2015).

[234] TRIPS Agreement, *supra* note 63, at Preamble.

[235] Typical patentability criteria include novelty, inventiveness, and industrial utility. For example, the U.S. requires an invention to be novel and non-obvious, besides being patent eligible and useful. Note the difference between patentability and patent eligibility; the latter means patentable subject matter. TRIPS art. 27 allows "all fields of technology" to be patentable subject matter; but TRIPS did not define patentability, i.e., what is novelty, inventiveness, etc. *See id.* at art. 27.

serious prejudice to the environment."[236] Thus, when necessary, polluting technologies can be construed as posing serious harm to the environment, the health of human, animal or plant life and be denied patent protection, even when such technologies satisfy the patentability criteria.

The TRIPS Agreement also provides a WTO member nation the means to regulate the use of a patented invention. For example, the TRIPS Agreement allows compulsory licensing.[237] However, this article recommends judicious use of compulsory licensing, as it does not bring in the know-how and trade secrets associated with the patented invention and may discourage domestic innovation, FDI, and inbound technology transfer.

Further, the TRIPS Agreement provides competition measures wherein a national government can address IPR licensing practices or conditions that "may have adverse effects on trade and may impede the transfer and dissemination of technology."[238] This means that for technologies locally protected by IPR, a WTO member nation can regulate abusive licensing practices or conditions related to such technologies, including foreign technologies. Therefore, developing nations may leverage domestic competition regulations to address anti-competition practices involving the transfer of foreign clean technologies.

Furthermore, the security provision in the TRIPS Agreement enables a WTO member nation to identify threats to essential national security – e.g., famine, mass migration, and war – and to take proper actions.[239] As predicted by the IPCC, climate change has the potential to cause mass human migration, to threaten national security, and even to cause civil wars when access to key living resources such as water and food becomes an issue.[240] Developing nations may frame climate change as a threat to national security or energy security and take necessary actions to address it.

Hence, even in light of the minimum IPR requirements of the TRIPS Agreement, a developing nation still has the flexibility to determine whether certain clean technologies have IPR protection, as well as whether to leverage compulsory license, competition and/or security measures to regulate the use of IPR-protected clean technologies.

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[236] *Id.* at art. 27.2.
[237] *Id.* at art. 31.
[238] *Id.* at art. 8.2, art. 40.1.
[239] *Id.* at art. 73.
[240] *IPCC Fourth Synthesis Report*, *supra* note 26.

Meanwhile, in building a customized IPR system reflecting a developing nation's own realities, the developing nation needs to balance stimulating domestic innovations and attracting inbound transfer of clean technologies. As indicated in Part II.B, strong IPR helps to attract foreign technologies, but unduly strong IPR may stifle a developing nation's domestic technology development.[241]

ii. Building up National Capacity to Attract Inbound Transfer of Clean Technologies

While fostering domestic innovation in clean technologies, developing nations should also incorporate clean technologies already developed by the global community. To do so, as discussed in Part II.B, developing nations need to build up the national capacities necessary for attracting, absorbing and implementing foreign clean technologies. For example, developing nations can remove entry barriers to make technology transfer more attractive to foreign firms.[242] In practice, many nations seek to attract foreign investments through special economic zones, subsidies, tax holidays and other grants.[243] In addition, developing nations can also use subsidies or similar incentives to encourage domestic firms to adopt risky foreign clean technologies, and/or impose stricter environmental regulations to increase domestic demand for clean technologies. [244] Policy interventions, including implicit and explicit subsidies, paved the way for the miraculous economic development in South Korea and Taiwan.[245]

Meanwhile, developing nations may further invest in local human capital. Human capital, such as well-trained technical staff and technology managers, are essential for local absorption and implementation of foreign clean technologies.[246]

B. International Aid

Developed nations have both an ethical imperative to and self-interest in finding ways to help developing nations combat climate change.[247] Historically, developed nations contributed largely to the climate change. As suggested by developing nations, developed nations should address such negative externality produced by their pursuit of economic development. At the same time, helping

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[241] *See* discussion *supra* Part II.B.

[242] Maskus, *Encouraging International Technology Transfer, supra* note 98.

[243] WORLD BANK, WORLD DEVELOPMENT REPORT 2005: A BETTER INVESTMENT CLIMATE FOR EVERYONE (2005), https://openknowledge.worldbank.org/handle/10986/5987.

[244] MASKUS, GLOBALIZING INFORMATION, *supra* note 127, at 173-176.

[245] *Id.*

[246] Littleton, *supra* note 74, at 20.

[247] *Id.* at 21.

developing nations address climate change is in the interest of developed nations, as they will receive the global impact on environment by developing nations' increasing energy consumption as a result of their economic developments.

Meanwhile, developing nations – especially the LDCs and the MDCs – do need help in combatting climate change. In particular, LDCs that are most vulnerable to climate change require special assistance, since they experience the impact of climate change most acutely while contributing to climate change the least. Further, trade and investment flows to these nations are not as responsive to IPR protection as to the emerging economies.[248] Developing nations request support from developed nations to address climate change via financial aid, technology transfer and capacity building.[249]

The proposal considers that developed nations are able to assist developing nations via capacity building, financial aid, and technology transfer. First, developed nations can contribute the most by helping the MDCs and the LDCs build up sustainable national capacities to attract, absorb and implement foreign clean technologies. Such assistance would benefit developed nations as well. It would enable developing nations to build low-carbon economies so as to reduce their future impact on the global climate and enhance their contributions to the global community. It would also expand the international markets that are suitable for the deployment of the clean technologies owned by developed nations' commercial sectors.

Second, developed nations should also pool resources together to help developing nations address climate change. Financial aid can be an important factor in helping developing nations to access, develop, and deploy clean technologies. The UNFCCC stipulates that developed nations must provide financial resources for developing nations to address climate change.[250] As the discussion of the TNA reports in Part II.B shows, the majority of developing nations perceive the high cost of foreign clean technologies as a barrier to accessing such clean technologies. This article therefore suggests that at a minimum, a global fund such as the Green Climate Fund ("GCF") should be maintained and expanded to facilitate international transfer of clean technologies. Such a fund can be used to pay for the high costs encountered by developing

[248] *Id.* at 15.

[249] *Summary of Climate Summit 2014,* INTERN'L INST. SUSTAINABLE DEV. (September 23, 2014), http://www.iisd.ca/climate/cs/2014/html/crsvol172num18e.html (for example, statements by leaders from India, Equatorial Guinea, Malaw, Guinea-Bissau, Fiji, Lesotho, Mauritania, Namibia, Sweden, Tanzania).

[250] *Id.* at art. 4.3.

nations in importing foreign clean technologies.[251] Developed nations can supply the balance of the fund to fulfill their obligations detailed in the UNFCCC and other international treaties. Other venues for funding can come from carbon tax or auction incomes in the carbon-trade systems.[252]

On the financial aid front, there has been positive progress recently. The GCF reached its 10 billion USD threshold during the Lima climate change conference held in December 2014.[253] This is an encouraging step toward the ultimate goal of developed nations providing financial aid in the amount of 100 billion USD per year by 2020.[254] Thus far, both developed nations and emerging economies have contributed to the fund.[255] In 2014, the U.S. pledged 2.3 billion USD, Germany and France each pledged 1 billion USD, and China pledged 500 million USD.[256] During the latest climate change conference, which occurred in Paris in December 2015, the commitment of 100 billion USD per year by 2020 is reaffirmed, with an aspiration to go beyond this commitment by 2025.[257]

The third approach for developed nations to assist developing nations involves technology transfer. Under the stipulations of international treaties such as the WTO TRIPS Agreement and the UNFCCC, developed nations have committed to facilitate technology transfer to developing nations, especially the LDCs.[258] The governments of developed nations can do so by, e.g., implementing domestic

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[251] *Climate Change Update: Technology*, ICTSD (May 1, 2008), http://www.ictsd.org/bridges-news/biores/news/climate-change-update-technology-ip-issues-on-the-table ("under the Montreal Protocol, the technology funds included money to pay for the necessary license fees").

[252] *Id.*

[253] *Green Climate Fund Exceeds $10 Billion*, U.N. FRAMEWORK CONVENTION ON CLIMATE CHANGE (Dec. 10, 2014), http://newsroom.unfccc.int/financial-flows/green-climate-fund-exceeds-10billion.

[254] United Nations Framework Convention on Climate Change, Conference of the Parties, Copenhagen, Den., Dec. 7-19, 2009, *Report of the Conference of the Parties on Its Fifteenth Session - Addendum Part II: Actions Taken by the Parties at Its Fifteenth Session*, U.N. Doc. FCCC/CP/2009/11/Add.1 (Mar. 10, 2013) (Green Climate Fund established in COP17, to mobilize USD100 billion per year by 2020 by developed nations to address the needs of developing nations for addressing climate change).

[255] *Summary of Climate Summit 2014*, *supra* note 251.

[256] *Id.*

[257] *Historic Paris Agreement on Climate Change: 195 Nations Set Path to Keep Temperature Rise Well Below 2 Degrees Celsius*, UNFCCC (Dec. 12, 2015), http://newsroom.unfccc.int/unfccc-newsroom/finale-cop21/.

[258] TRIPS Agreement, *supra* note 62, at art. 66.2; UNFCCC Treaty, *supra* note 24, at art. 4.1, 4.7, 4.3, 4.5.

initiatives for encouraging transfer of clean technologies.[259] More specifically, the governments of developed nations can award preferential tax treatment for R&D performed in developing nations by firms from developed nations,[260] or for the firms' transfer of clean technologies to developing nations, or making these technologies publically available.[261]

C. International Technology Collaboration

The UNFCCC requires all participating parties to "promote and cooperate in the development, application and diffusion, including transfer, of technologies" relevant to GHG emissions.[262] While international aid may focus primarily on the MDCs and the LDCs, international technology collaboration will likely occur between a developed nation and an emerging economy. The reason is that the emerging economies likely have the necessary IPR systems and national capacities to support mutually-benefiting joint development or deployment of clean technologies.

As described in Part I.C, the 2010 Cancun global climate change conference established the Technology Mechanism to enhance action on clean technology development and deployment in developing nations.[263] This mechanism is expected to be a good platform for bringing developed nations and developing nations together to accelerate development and deployment of clean technologies.[264] For example, a developing nation may identify its needs for certain clean technology development. Technology Mechanism may help identify a developed nation that is interested in working with the developing nation to co-develop the clean technology needed or adapt and deploy the clean technology if the developed nation has already developed it.

Meanwhile, bilateral collaborations on developing clean technologies have started among some nations and should be expanded to a larger scale. For example, the U.S. Department of Energy has established bilateral collaborations with China and India to develop clean energy technologies.[265] It is predicted that such

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[259] Cameron Hutchison, *Does TRIPS Facilitate or Impede Climate Change Technology Transfer into Developing Nations?*, 3 UNIV. OTTAWA L. & TECH. J. 517-537 (2006).

[260] Maskus, *Encouraging International Technology Transfer*, *supra* note 98.

[261] Littleton, *supra* note 74, at 20.

[262] UNFCCC Treaty, *supra* note 24, at art. 4.1.

[263] *The Cancun Agreement*, *supra* note 34.

[264] Latif et al., *supra* note 29, at 2.

[265] *U.S.-China Clean Energy Research Center*, U.S. DEP'T OF ENERGY, http://energy.gov/ia/initiatives/us-china-clean-energy-research-center-cerc (last visited Nov. 13,

collaboration between developed nations and the emerging economies can be a "win-win solution."[266]

Additional international collaboration for the development and deployment of clean technologies can occur at the global community level. Some examples might include the formation of global patent pools, a global clean technology information repository, or a global patent clearing house.

IV
APPRAISAL: ADVANTAGE AND CONCERNS REGARDING THE PROPOSAL

As discussed throughout this Article, in spite of the emphasis by international instruments such as the UNFCCC and the TRIPS agreement, international transfer of clean technologies to developing nations has been limited in the past two decades. This article proposes that we focus on domestic innovation, international aid and international technology collaboration instead, so to facilitate the much needed rapid development and global deployment (including international transfer) of clean technologies. The proposal offers several advantages and may raise addressable concerns as well.

A. Advantages

The proposal de-emphasizes the focus on international transfer of clean technologies to developing nations, which has not been effective in the past two decades or more. Instead, the proposal addresses the possible reasons for the failure, and re-focuses attention on the critical need for a global collective effort in sustainable development and deployment of clean technologies.

The proposal is based on four major insights gained from empirical analysis of evidential data on clean technologies and international transfer of clean technologies. First, rapid development and wide deployment of clean technologies is critical for addressing climate change. Second, IPR has not been a major barrier, but is a necessary element for attracting foreign clean technologies to developing nations. Third, to increase inbound transfer of clean technologies, developing nations need to have national capacities for attracting, absorbing, and implementing foreign clean technologies. Fourth, developed nations have the

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2015)*; U.S.-India Clean Energy Cooperation*, U.S. DEP'T OF ENERGY, http://energy.gov/ia/initiatives/us-india-energy-cooperation (last visited Nov. 13, 2015).

[266] Maria van der Hoeven & Didier Houssin, *Energy Technology Perspectives 2015: Mobilising Innovation to Accelerate Climate Action*, INTN'L ENERGY AGENCY (May 4, 2015), http://www.iea.org/newsroomandevents/speeches/150504_ETP_slides.pdf.

obligation and self-interest to aid and/or collaborate with developing nations in addressing climate change.

The proposal is constructed to address the more plausible reasons that the current transfer of clean technologies to developing nations is limited. It addresses developing nations' lack of pulling power on inbound transfer of foreign clean technologies by suggesting that developing nations build up sustainable national capacities for attracting, absorbing, and implementing foreign clean technologies. The proposal also asks that developed nations facilitate better international transfer of clean technologies by helping developing nations build up such national capacities, and by installing domestic initiatives to encourage outbound transfer of clean technologies to developing nations. The approach also explores the potential of expanding international technology collaborations that benefit both a developing nation and a developed nation.

Considering the importance of rapid development of clean technologies on a global scale, the proposal further suggests all nations focus on domestic innovation of clean technologies. Realizing the significant weight commercial sectors carry in the development and deployment of clean technologies, the proposal suggests that IPR remain as one of the incentivizing tools to stimulate domestic innovation in clean technologies in each nation and to attract inbound transfer of clean technologies.

B. Concerns

One concern for the proposal is that some developing nations, such as the LDCs, lack resources such as capital and IPR assets, and therefore that they may lack the bargaining powers for meaningful technology collaboration with developed nations. The proposal addresses this concern by suggesting that developed nations provide international aid particularly to such developing nations to assist them in combatting climate change and in building up their sustainable national capacities for attracting foreign clean technologies. Developed nations have the obligation and the self-interest to provide such aid.[267] The more advanced developing nations, i.e., the emerging economies, may join developed nations in providing such aid. As the proposal suggests, international technology collaborations will likely occur between developed nations and developing nations that can offer certain resources such as established IPR systems, or human/financial capital.[268]

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[267] *See* discussion *supra* Part III.B.

[268] *See* discussion *supra* Part III.C.

A second concern is that some developing nations may not want to employ clean technologies, since traditional technologies may have already been in place and are cheaper to use. These nations may prefer to pursue economic development regardless of its environmental costs, since developed nations did not pay attention to environmental issues in the early stages of their own economic development. This article recognizes this concern but doubts that such developing nations will persist in this inclination. Currently, it seems like all nations are engaged in the recent global climate change conferences. For example, all 196 nations attended the Lima and the Paris climate change conferences, which occurred in December 2014 and December 2015 respectively. This attendance rate indicates that all nations are engaged with the climate change issues and are interested in addressing it together as a global community. Such an interest, coupled with persuasion, pressure, and aid from the international community would gradually push a disinclined nation toward pursuing economic development regardless of its environmental costs.

A third concern is that international financial aid and government subsidies that aim to encourage the development and deployment of clean technologies may be used as a means to sustain the high costs of accessing clean technologies, therefore distorting the operations of the market economy. This article agrees with this concern. Yet, as of now, under the operation of the free market mechanism, the MDCs and the LDCs essentially are not receiving the needed clean technologies,[269] which is a market failure. When there is a market failure, intervention is necessary. Interventions such as international aid and government subsidies may help the MDCs and the LDCs to develop or gain access to the needed clean technologies.

Another possible intervention is to weaken or remove IPR protection for clean technologies in general, as proposed by developing nations, but such an intervention seems unrealistic. First, the commercial sectors, whether in developing or developed nations, won't respond well to such an intervention. As discussed in Part II.A, IPR is an important tool for incentivizing commercial investments in clean technologies. Second, also shown in Part II.A, in developed nations, commercial investments in clean technologies far overweigh government investments, which means governments in developed nations won't be able to heavily influence their commercial sectors' preferences on IPR, i.e., the preference for strong IPR for clean technologies.

[269] *See* discussion *supra* Part I.C.3.

CONCLUSION

The focus on the international transfer of clean technologies to developing nations in order to address climate change has not worked well during the past two decades. This article analyzes evidential data on clean technologies and their transfer and finds that the existence of IPR has not been a major barrier to such transfer, as suggested by developing nations during the debates with developed nations on how to improve the situation. This article also studies possible reasons for the currently limited transfer of clean technologies to developing nations and concludes that developing and developing nations need to work together to improve the situation. Specifically, developing nations need to improve their national capacities in attracting, absorbing, and implementing foreign clean technologies, and developed nations have the moral duty and self-interest to provide concrete and effective assistance to developing nations in building such capacities and in helping developing nations address climate change. By understanding and addressing these possible reasons, this article proposes that we focus on domestic innovation of clean technologies, international aid and collaboration, instead of international transfer of clean technologies. This approach makes possible and sustainable the needed rapid development and deployment – including international transfer – of clean technologies, which is essential for us to successfully address climate change.