Global Challenges Report

Intellectual Property & the Transfer of Environmentally Sound Technologies

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Abstract

The importance of the effective dissemination and use of environmentally sound technologies (ESTs) is becoming more apparent in light of the rising profile of climate change mitigation in global political discourse and expectations that global energy consumption will continue to dramatically increase in the coming decades. ESTs are methods and sources for producing energy that reduce the emission of greenhouse gases during the production or provision of energy.

This report considers the role of intellectual property rights (IPR) in fostering successful EST transfer, along with the utilisation and adaptation of ESTs by entities in developing countries. It also reviews the importance of other economic, political, and social factors in this process. The report aims to provide a foundation for further research on IPR and EST transfer, in order to contribute to the development of evidence-based IP and other policies for EST transfer.

The author reviews the relevant literature and available data, concluding that much of the existing evidence suggests that IPR generally contribute to, rather than impede, EST transfer. The author highlights the importance of context, including geographic location and type of technology, in determining the relationship between IPR and EST transfer, and underscores the interplay between IPR and other factors and policies in fostering EST transfer, use, and adaptation by entities in developing countries.

On the basis of available studies and other evidence, the author identifies: *first*, what is known about the role that IPR, together with other factors, play in promoting EST transfer; *second*, priority areas for further research and analysis; and, *third*, ‘wild cards’ that could influence policy discussions and action to address EST transfer and climate change. These “known-knowns,” “known-unknowns,” and “unknown-unknowns” are elaborated in some detail at the end of the report.

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Section 1:
IPR and EST Transfer – Setting the Stage

1.1 BACKGROUND AND OVERVIEW

This report, which was commissioned by the Global Challenges Division of the World Intellectual Property Organization (WIPO), examines the role of intellectual property rights (IPRs) in the international transfer of environmentally sound technologies (ESTs). Sections 1 through 3 provide an overview of IPRs and of ESTs, and analyse the available data and evidence regarding the role of IPRs in EST transfer. Section 4 presents three key issues that policy-makers must consider when seeking to encourage the transfer, assimilation, and utilisation of ESTs by entities in developing countries.

SECTION 1 introduces and defines technology transfer and ESTs. This section explains how the transfer of ESTs has grown in importance due to: *first*, the rising profile of climate change mitigation in global politics and, *second*, expectations that global energy consumption will increase dramatically in the coming decades.

SECTION 2 reviews the existing literature on ESTs and technology transfer. This review reveals that there are substantial gaps in knowledge regarding EST transfer, and that many studies lack hard evidence regarding the rate of transfer of ESTs between developed and developing countries. The review also reveals that, for methodological reasons, it is likely that researchers have underestimated the overall magnitude of the transfer of ESTs. This is because the current approaches to measuring the transfer of ESTs, particularly in relation to proprietary technologies, are limited in that many studies tend to focus on indicators of patenting activity, and so far, only some examine other IP-related indicators of EST transfer, such as international trade flows or licensing activity.

SECTION 3 provides an overview of some of the existing evidence regarding the relationship between IPRs and the transfer of EST. This section looks at patenting data, international patent filings, and licensing data, as well as evidence of the growth of joint ventures and partnerships between developed country entities and organizations in developing countries.

While not conclusive, much of this evidence suggests that IPRs are not a barrier to the international transfer of EST. The evidence indicates that, in some cases, trade barriers such as tariffs have been more an impediment to EST transfer than IPRs. Available evidence does not reveal much about the extent to which IPRs contribute to the transfer and use of ESTs by entities in developing countries. There is a substantial body of evidence showing that the transfer of ESTs from developed countries to developing countries does occur, and that this transfer is directed primarily at a few large and growing economies, particularly China and, to a lesser extent, Brazil and India.

SECTION 3 also analyses how economic, political, and social factors may affect the transfer of ESTs, specifically: absorptive capacity, technical capabilities and infrastructure, domestic regulatory and political frameworks, education, and other human factors.

SECTION 4 identifies three main considerations for policy-makers, in relation to IPRs and ESTs, which are listed below.

First, based on available evidence, one-dimensional discussions of whether IPR hinder or promote the transfer of ESTs are not the best framework for analyzing the relationship between IPRs and ESTs. Policy-makers would arguably be better served by discussions that focus on concrete policy questions, such as: *How should IPR be used effectively to promote the successful assimilation and utilisation of ESTs by users in developing countries?* Naturally, this question leads to an entire new set of questions, debates, and possibilities for further research. At the same time, it may lead to more pragmatic conclusions.

Second, IPRs cannot be considered in isolation from other factors. Governments seeking to enhance the ongoing, sustainable transfer of ESTs should develop policy frameworks that integrate IP policies with other policies that promote investment. The development of a comprehensive IP policy framework can only partially contribute to EST transfer; a government must also take into account other factors related to the overall macroeconomic climate. In other words, a coherent blueprint for action is needed.

Third, the importance and role of IPRs in the transfer of ESTs vary depending on the context. The EST field is still very much in a nascent stage, not least in terms of the degree of divergence and variance relating to the technologies that fall in this group. For some types of ESTs, IPRs may be the centerpiece of a strategy for their successful transfer, assimilation, and utilisation, while for other ESTs, IPRs may be less relevant. The relevance of IPRs for the transfer of ESTs may also differ based on the country. Developing countries have different objectives and preferences in terms of the types of ESTs they wish to access. Policy-makers must identify and prioritize those areas where the IPR aspects of investment and technology transfer policy are most significant.

SECTION 4 also identifies additional, broad policy considerations. For instance, it suggests that, in order to enhance the transfer of ESTs to the developing world, factors related to both supply and demand must be taken into account. In relation to supply, investors and businesses that aid in the transfer of ESTs seek an “enabling environment” in recipient developing countries, namely the capacity and infrastructure to support the production and management of ESTs, and regulations that encourage the further development of ESTs. On the demand side, in order for ESTs to be successfully absorbed and utilised, there must be local demand, or so-called "pull factors," for the technology. Policies that create grass-root demand for technologies can provide a net social benefit.

EST transfer should not be seen as a passive, one-way process. If developing countries are to develop sustainable strategies to mitigate climate change, the donor-recipient relationship that has existed until now must change. Developing countries must actively foster the transfer of ESTs, by building technical capacity and by creating an institutional framework that enables them to absorb, adapt, and improve ESTs.

Finally, **SECTION 4** reviews the key issues explored in this report and summarizes the report's findings, identifying: *first*, conclusions that can be drawn from existing, albeit incomplete, data and evidence regarding IPRs and EST transfer; *second*, areas where further research, analysis, and data are needed; and, *third*, 'wild cards' that could impact discussions and measures addressing climate change and ESTs. These elements are referred to, respectively, as the "known-knowns," the "known-unknowns," and the "unknown-unknowns."

1.2 POLITICAL AND ECONOMIC CONTEXT

Energy and environmental policies around the world are increasingly being shaped by two concurrent trends: *first*, the rising global demand for energy and, *second*, the agreement that the world's greenhouse gas (GHG) emissions must be reduced.

During the early and mid-1990s, the United Nations Framework Convention on Climate Change (UNFCCC) established a global consensus that the climate and the environment are shared global resources, and set forth an overall framework for international efforts to address climate change.[1] The subsequent Kyoto Protocol, which was signed in 1997 and took effect in 2005, committed its signatories to reduce GHG emissions, either through "national reductions," or by using the so-called "Kyoto mechanisms."[2] Since the establishment of the UNFCCC, climate change has moved to the centre of political discourse in many countries. Indeed, the majority of leaders and policy-makers around the world today recognise the detrimental effect of GHG emissions on the environment.

Over this same period of time, the landscape of the global economy has changed significantly. High rates of growth and sustained economic development have resulted in the emergence of a number of new, high-performing economies including not only China, India, and Brazil, but also the former communist countries of Central and Eastern Europe, as well as a number of countries in Asia, the Middle East, Latin America, and Africa. Even now, in the midst of the most severe global downturn since the Second World War, many of these economies continue to grow and expand. The growing prosperity and economic needs of these countries have significantly increased the global demand for energy. It is expected that demand will continue to grow; the International Energy Agency (IEA) estimates that, by 2030, global demand for energy will be at least double its current level.[3]

How is it possible to reconcile this increasing global demand for energy with the recognized need to reduce GHG emissions? One approach is to reduce reliance on fossil fuels as the main source of energy, replacing them to the extent possible with sources that are less polluting and, in many cases, completely renewable.

Over the past two decades, and especially since the end of the 1990s, renewable sources of energy, such as wind power, biomass, solar, geothermal, and wave, have drawn increased investment and interest from policy-makers, the business community, and consumers. Together with other climate-friendly technologies, these "renewables" are often referred to as "environmentally sensitive technologies" and/or "environmentally sound technologies" (ESTs). The United Nations Environment Programme (UNEP) defines environmentally sound technologies as those that "protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their waste and by-products, and handle residual wastes in a more acceptable manner than the technologies for which they are substitutes."[4]

1.3 THE GROWTH AND DEVELOPMENT OF EST

Environmentally sound technologies are those methods and sources that substantially reduce or even eliminate the emission of GHGs during the production and/or provision of energy.

Many leaders and policy-makers consider ESTs to be the future when it comes to the production of clean, cheap, and plentiful energy. President Obama of the United States frequently refers to renewables and clean energy as central to his environmental and economic vision of the future American economy.[5] According to the White House, the 2009 economic stimulus bill included more than $80 billion in funding for renewables and clean energy.[6] These measures are additional to the already substantial legislative commitments signed into law by President Obama's predecessor, George W. Bush, in the 2005 Energy Policy Act, which, among other measures, mandated the use of corn-based ethanol as a motor-vehicle fuel. In 2007, the European Union announced its flagship environmental policy goals under the banner "20 by 2020." This environmental programme, which was approved by the EU Parliament in 2009, seeks to: reduce GHG emissions by 20 per cent from 1990 levels; increase renewable sources of energy to 20 per cent of total EU energy consumption; and reduce projected primary energy use by 20 per cent.[7]

Many of the major emerging economies have also committed to substantial investments in renewables and ESTs. In China, the government has invested in solar and wind power, particularly through the 2006 Renewable Energy Law and the $586 billion economic stimulus package of 2008.[8] Beginning in the 1990s, India has invested heavily in wind power. It now has the fifth largest wind power capacity in the world, as well as being home to one of the world's biggest wind turbine manufacturers, Suzlon. And Brazil has a long history of using sugarcane-based ethanol and natural gas to power motor vehicles.

Renewables and ESTs are not new, as suggested by the example of Brazil above. Investment and patenting in renewable energy sources such as solar photovoltaic (PV), wind power, geothermal, and biomass have only reached or exceeded 1970s levels in the past 10-15 years.[9] However, the conviction that these technologies will play a major part in future energy production, and the notion that they should be shared and transferred between countries, are new.

1.4 EST AND TECHNOLOGY TRANSFER

The transfer of technologies, expertise, and know-how is one of the most important contributors to the successful diffusion of innovation within and between countries, businesses, and individuals. With regard to ESTs, technology transfer is an integral part of transferring know-how between developed and developing countries.[10] This is reflected in the original UNFCCC Convention of 1992 as well as the subsequent Kyoto Protocol, both of which refer to technology transfer as key to the successful global implementation of the treaty's goals. Article 4, paragraph 5, of the UNFCCC Convention states that:

> The developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties. Other Parties and organizations in a position to do so may also assist in facilitating the transfer of such technologies.[11]

More recent climate negotiations also emphasize the importance of technology transfer. For instance, two of the five pillars of the Bali Plan of Action, agreed in December 2007, focus on technology development and transfer and on the provision of financial resources to enable technology transfer.[12]

Since the early to mid-1990s, policy-makers have grappled with how to facilitate technology transfer between developed and developing countries, and encourage the private and public mechanisms necessary for success. One of the many factors that have been examined is the role of intellectual property rights in the transfer of ESTs to, and their use by, entities in developing countries. It is now accepted among different policy-making communities that there is a dearth of data and evidence regarding this relationship. To address this, policy-makers are prioritizing the collection and production of evidence on IPRs and ESTs in the context of their climate change mitigation efforts.[13]

This report examines the existing evidence on IPRs in the transfer of ESTs. In particular, it considers to what extent available evidence can be used to answer questions about the current and potential roles, and optimal utilisation, of IPR in the transfer of ESTs to developing countries, including from the view of potential users. The report identifies the types of evidence that are still missing, together with the policy questions that remain unanswered. The report consists of this introduction and three main sections.

Section 2 provides an overview of the existing literature. There is a large body of literature on IPRs and technology transfer in the field of ESTs, from a variety of international bodies, national governments, NGOs, and think tanks. However, much of this literature is inconclusive, including regarding whether potential users view IPRs as a positive platform for accessing ESTs or a barrier. Moreover, much of the literature lacks empirical evidence. Fortunately, the need for more evidence has been identified in a variety of forums, including in many of the UNFCCC negotiation texts of the Long-term Cooperative Action framework, and efforts at improving data are underway.

Section 3 identifies the conclusions that may be drawn at this time, based on available evidence, regarding the transfer of EST to developing countries. This section examines what is known about the effective and efficient use of ESTs, and the complementary factors that are essential for the transfer of EST. It also assesses what evidence is missing and, thus, what we still do not know about the relationship between IPRs and EST transfer.

For instance, we do not know the magnitude of the transfer of ESTs, which may be greater than currently estimated. This is because current approaches to measuring the transfer of ESTs, particularly as it relates to proprietary technologies, are limited in that they focus on certain indicators, such as patenting activities, without considering data associated with other activities that facilitate the transfer of technology, such as "buying and selling." Arguably, this leads to selection bias, influencing conclusions about the magnitude and nature of the transfer of ESTs.

It is important that EST transfer not be seen as a passive, one-way process. Developing countries must actively promote EST assimilation and utilisation. They should create institutional frameworks and improve technical capacity, so they can better absorb, adapt, and improve technologies. Active engagement is needed in order for there to be real growth in transfer of ESTs that meet local needs in a variety of developing countries – not just China, Brazil, and India.

Against this backdrop, Section 3 describes current evidence regarding the role of IPRs in EST transfer, focusing on:

- *The ability of users in developing countries to gain access to proprietary technologies and the existing utilisation of IPRs in technology transfer, including via purchasing technologies, licensing deals, and patent transfers;*
- *The role of additional platforms, such as joint ventures, partnerships, and cross-border investing in the creation and transfer of ESTs to developing countries; and*
- *The importance of other factors, including the level of absorptive capacity, key macroeconomic horizontal factors, and behavioural changes, for implementing proprietary ESTs in developing countries*.

Section 4 identifies three main considerations for policymakers, in relation to IPRs and ESTs, reviews the key issues explored in this report, and summarizes its findings. This section identifies: *first*, conclusions that can be drawn from existing (though incomplete) data and evidence regarding IPRs and EST transfer; *second*, areas where further research, analysis, and data are needed; and, *third*, 'wild cards' that could impact discussions of and measures to address climate change and ESTs. These elements are referred to, respectively, as the "known-knowns," the "known-unknowns," and the "unknown-unknowns" and are listed in some detail at the end of Section 4.

1. UNFCCC website, http://tiny.cc/1umyp
2. These mechanisms are: i) Emissions trading, ii) the Clean Development Mechanism, and iii) Joint Implementation.
3. UNFCCC, *Handbook for Conducting Technology Needs Assessment for Climate Change*, Advance document, United Nations Development Programme, New York, p. 2 (2009)
4. *Transfer of Environmentally Sound Technology, Cooperation and Capacity-Building,* UNEP website, http://tiny.cc/4w2c6
5. http://tiny.cc/umdmj
6. *Ibid*.
7. *The EU Climate and Energy Package,* http://tiny.cc/slfxo
8. Dewey & LeBoeuf, LLP (prepared for the National Foreign Trade Council), *China's Promotion of the Renewable Electric Power Equipment Sector,* March 2010, pp. i-iii, http://tiny.cc/3e1an
9. Johnstone, N., Hascic, I. and Kalamova, M., *Environmental Policy Design Characteristics and Technological Innovation: Evidence from Patent Data,* OECD Environment Working Papers, No. 16 (2009), OECD Publishing, pp. 17-18.
10. Developed and developing world are here used rather loosely; a full definition and distinction of various national actors will be provided below in Section 3.
11. UNFCCC, Text of the Convention, http://tiny.cc/3d33a
12. UNFCCC, *Handbook for Conducting Technology Needs Assessment for Climate Change*. Advance document 2009, p. 5.
13. See, for example, paragraph 194 in UNFCCC, Ad hoc Working Group on Long-Term Cooperative Action, Sixth Session, June 2009.

Section 2:
IPR and ESTs - Literature Review

2.1 CONCEPTUAL STUDIES

A number of studies have examined the role of IPRs in the transfer of ESTs in order to understand whether IPRs aid or hinder dissemination across borders.[14] Many of these studies focus on general, conceptual issues related to climate change and the transfer of ESTs, rather than drawing conclusions that are supported by significant or detailed data. Studies have reached very different, even contradictory conclusions, even though they are presumably based on the same - albeit limited - body of evidence.

For example, *Climate Change and Intellectual Property* (2009), a report by the International Chamber of Commerce, concludes that "far from being a barrier to the dissemination of the vast breadth of technologies needed to address the climate challenge, IPRs assure necessary private sector investment in the invention, development, and deployment of the technologies needed to reduce emissions."[15] A publication by the non-profit organisation Third World Network, entitled *Brief Note on Technology, IPRs and Climate Change* (2009), argues the opposite: "Developed countries should not treat patents or IPRs as something sacred that has to be upheld at all costs. That would send a signal that climate change is not a serious threat, as commercial profits for a few are more important on the scale of values and priorities than are the human lives that are at stake due to global warming. Technology transfer to developing countries to enable them to combat climate change should be the far higher priority."[16]

More evidence-based analysis of the role of IPRs in the diffusion of ESTs is needed. However, data is currently insufficient. The need for more complete and reliable data and other evidence regarding this relationship has been widely acknowledged by organisations including the UNFCCC. The UNFCCC has called for greater access to and better coordination of information about ESTs, and for existing technology information platforms to be "strengthened and linked together." [17]

In *Climate Change, Technology Transfer and Intellectual Property Rights* (2008), the Geneva-based International Centre for Trade and Sustainable Development (ICTSD) also notes that more research is needed, to "provide the basis for more productive and evidence-based discussions." It observes that: "specific information on the climate-related technologies most strategic for developing countries, the patent landscape of those sectors and goods, and licensing practices could also assist in identifying problems and solutions."[18] In particular, the paper cites the need for additional evidence regarding flexibilities under the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) of the World Trade Organization (WTO), and argues that evidence does not suggest that TRIPS rules, including those flexibilities, do not support the international transfer of ESTs.

The European Parliament has also noted the need for further research into TRIPS flexibilities. In 2007, it recommended "launching a study on possible amendments to the WTO Agreement on Trade Related Aspects of Intellectual Property Rights in order to allow for the compulsory licensing of ESTs, within the framework of clear and stringent rules for the protection of intellectual property, and the strict monitoring of their implementation worldwide."[19]

Meanwhile, organisations such as ICTSD have begun incorporating evidence to a greater extent in their analyses of the role of IP and EST transfer. ICTSD's *Intellectual Property and Access to Clean Energy Technologies in Developing Countries* (2007) analyses three main clean energy areas - solar photovoltaic, biomass for fuels, and wind - using data, sourced from various reports, on the production, shipments, and market share of major energy companies. This study, authored by the late Stanford University law professor John Barton, concludes that, overall, IP is not a major barrier to the transfer of ESTs. It finds that trade barriers and other market distortions are more formidable obstacles to EST transfer, with variation across the three sectors studied.[20]

2.2 EVIDENCE-BASED STUDIES

Recently, a number of publications have attempted to provide more evidence-based analysis of the role of IPRs in the transfer of ESTs and thus establish a more reliable basis on which to draw conclusions and develop policy. Some of the most recent studies are described below, including their methodology.

Comprehensive literature reviews into two key areas, environmental innovation and technology transfer, are provided by Daniel K. N. Johnson and Kristina Lybecker, both of Colorado College, in their publications *Innovating for an Uncertain Market: A Literature Review of the Constraints of Environmental Innovation (2009) and Challenges To Technology Transfer: A Literature Review Of The Constraints On Environmental Technology Dissemination*.[21] The objective of these studies is to respond to the need for a more rigorous economic and analytical basis for policy debates on the development and transfer of ESTs.

Innovating for an Uncertain Market reviews academic literature on the economics of environmental innovation. It concludes that economists agree on the importance of IPR in overcoming the substantial uncertainty of investment in environmental innovation. Johnson and Lybecker state that "[IPRs] present a double-edged sword: without some guarantee of repayment for the risk and financial sacrifice of the research process, little innovation will occur, but too great an exclusion right may hamper follow-on innovation or may extract inappropriately large monopoly rents from the consumer."[22] They stress the need for policy-makers to balance "encouraging financing for innovation and removing obstacles to the process, whilst still allowing the wisdom of the market to function and the powers of the invisible hand to best guide investments."[23]

In *Challenges To Technology Transfer: A Literature Review Of The Constraints On Environmental Technology Dissemination*, the authors shift their focus from innovation to technology transfer.[24] This study highlights three main impediments to the transfer of ESTs - asymmetric information, market power, and externalities - and notes that the adoption of technology may be complicated by uncertainty regarding the qualities of the innovation and the future prices of inputs.

In these studies, Johnson and Lybecker find no evidence suggesting that IPRs constitute a barrier to technology transfer. In contrast, the authors suggest that, in many places, EST transfer is enhanced by the effective protection of IPR. Johnson and Lybecker argue that by combining IP policies with complementary factors, including infrastructure, effective government, development of knowledge institutions, finance, human skills, and research networks, governments can create an enabling environment that enhances trade in and the local uptake and deployment of ESTs.[25]

Who Owns Our Low Carbon Future? Intellectual Property and Energy Technologies (2009),[26] a report by the UK think tank Chatham House, presents the results of an extensive patent landscaping exercise performed by Chatham House and Cambridge IP over a period of nine months. This exercise, which focused on six energy technologies, analysed the concentration of patent ownership and market adoption rates, resulting in the creation of a database containing around 57,000 patents spanning a 30-year period. It also incorporated other aspects of corporate strategy and practice such as collaboration, licensing, litigation, and mergers and acquisitions (M&A).[27]

The Chatham House study concluded that IPRs are a factor affecting the speed of technology diffusion. In particular, it found that many patent holders are established industrial giants, and that their perception of the level of intellectual property protection in developing countries would determine the rate of roll-out of the next generation of low carbon technologies in those markets. Thus, it could be expected that weak intellectual property protection would slow diffusion to some developing countries, since the willingness of such firms "to license for production or sale may depend on their confidence that they can do so without losing control."[28] This has been confirmed by leading firms, which cite weak intellectual property protection in host countries among the reasons for withholding their latest technologies from certain markets.

This point of view is reinforced by an earlier study performed by the Climate Technology Initiative, the International Energy Agency, and UNEP, entitled *Technology Without Borders* (2001), which presents case studies of successful transfers of ESTs and practices.[29] This report argues that inadequate protection of IPRs is a barrier to technology transfer, and recommends that governments consider "protecting intellectual property rights and licenses in such a way that innovation is fostered, while avoiding misapplication, which may impede diffusion of ESTs."[30]

Other recent research has resulted in a broader evidence basis. For instance the Organisation for Economic Cooperation and Development (OECD) report on *Environmental Policy Design Characteristics and Technological Innovation* (2010)[31] focuses on innovation in ESTs, drawing upon the European Patent Office (EPO)/OECD World Patent Statistics (PATSTAT) database of patent applications from over 80 national and regional intellectual property offices. It sets forth three conclusions. First, innovation in ESTs is more likely to occur in more stringent regulatory environments that allow the price of pollution to rise, thus providing a greater incentive to innovate. Second, innovation in ESTs is adversely affected by uncertain regulatory conditions, since unpredictable or unstable policy environments deter investors and innovators. Third, flexible regulatory environments, which rely less on prescriptive approaches such as setting technology-based standards, enhance EST innovation. In other words, allowing firms the freedom to determine the optimal technological means to meet an environmental objective can foster innovation.[32]

Are IPR a Barrier to the Transfer of Climate Change Technology? (2009), a study by Copenhagen Economics, commissioned by the European Commission, traces patent protection and ownership data for seven ESTs in a sample of developing countries from 1998 to 2008.[33] It concludes that "IPRs do not in themselves constitute a barrier to the transfer of carbon abatement technology from developed countries, neither to low-income developing countries nor to emerging market economies," and that other non-technological and economic factors are more significant barriers. The study does find that IP protection affects the transfer of ESTs. It identifies a gap in EST transfer between "low-income developing countries" and "emerging market economies" and states that, in relation to those emerging market economies with the technological capacity and market size to use innovative technologies, better patent protection can stimulate domestic innovation and the transfer of technologies from foreign patent holders.

The *Survey of Licensing Activities in Selected Fields of Environmentally Sound Technologies* (2010), which was one outcome of a joint project by UNEP, the EPO, and ICTSD, aims to contribute new evidence-based insights to debates about the relationship between IPRs and EST transfer by focusing on licensing, rather than patenting, activities.[34] This report presents the results of a survey distributed among organisations that are highly active in the development, patenting, commercialisation, and transfer of ESTs. Overall, the survey indicates that, together with other macroeconomic factors, the protection of intellectual property is an important factor affecting the decision to license technology to entities in developing countries. The report suggests that, together with IPRs, many factors affect licensing decisions, including market conditions, the investment climate, existence of scientific capabilities, infrastructure, and human capital. Each of these factors appears to influence decisions about licensing to a similar extent.[35]

PricewaterhouseCoopers's (PwC) *Annual Review of Power Deals* (2009) *and Annual Review of Renewables Deals* (2009) also target IP-related EST transfer by examining "buying and selling." Over the past few years, the growth of emerging economies has led to increased investment and investment activities, particularly within the energy and renewables sectors. *Power Deals* and *Renewable Deals* review the aggregated mergers and acquisitions (M&A) in the energy and renewables sectors and find that some of the world's biggest deals in these sectors take place in countries such as China, Brazil, and India. For instance, they find that the biggest renewables transaction of 2009 was the purchase of Three Gorges Industry Co Ltd, by China Yangtze Power Co Ltd; for over $5.9 billion.[36] Table 1 summarises the growth in energy and renewable transactions in developing countries, listing the five biggest deals in the gas, electric and renewables industries in Brazil, China, and India (the largest emerging markets for such M&A activity).

This data reflects a few current trends. *First*, the combined total value of M&A activity in these countries makes up a substantial and growing share of the global total. The top 15 transactions in these countries account for close to 15 per cent - or $17.443 billion out of $131 billion - of the total global M&A activity in gas and electrics.[38] *Second*, M&A activity in China is larger than in Brazil, and dwarfs that in India. Even discounting the skewing impact of the Yangtze Power-Three Gorges acquisition, of these three countries China is the clear leader in this area.

Building on the above efforts, experts continue to gather evidence about IPRs and the transfer of ESTs. The global climate change policy community has recognised the need for more empirical studies that could clarify the role of IPRs in enhancing EST transfer and thus, ultimately, mitigating climate change. The existing, evidence-based studies of this relationship have generally rejected or at least disagreed with the notion that IPRs impede EST transfer. At the same time, however, these studies do not reveal much about the specific role and function that IPR play in the transfer of ESTs. There is still significant uncertainty about how IPRs influence the transfer of ESTs, and there is not yet consensus as to how best to address the challenges that will result from climate change, including how best to promote innovation and the dissemination of ESTs.

Additional evidence is needed regarding some issues, and a better interpretation of current evidence is needed with regard to others. This paper addresses the latter, by reviewing what is currently known about the interplay of IPRs and ESTs, and by suggesting additional areas of inquiry, in light of current knowledge.

14. The findings and data used by many of these reports will be used and cited below in Section 3.
15. *Climate Change and Intellectual Property*, International Chamber of Commerce, http://tiny.cc/c7f8z
16. Third World Network, *Brief Note on Technology, IPR and Climate Change*. http://www.twnside.org.sg/title2/climate/briefings/BP.bangkok.2.doc
17. The Ad Hoc Working Group on Long-term Cooperative Action (Sixth session), *Revised negotiating text*, p.188, http://tiny.cc/so77q
18. International Centre for Trade and Sustainable Development *Climate Change, Technology Transfer and Intellectual Property Rights*, Winnipeg, Canada, p. iv. (2008)
19. European Parliament, *Resolution of 29 November 2007 on Trade and Climate Change (2007/2003(INI))* http://tiny.cc/y5ufn
20. Barton, J., *Intellectual Property and Access to Clean Energy Technologies in Developing Countries, An Analysis of Solar Photovoltaic, Biofuel and Wind Technologies,* ICTSD Trade and Sustainable Energy Series Paper No. 2, ICTSDC, Geneva, p. 31 (2007)
21. Johnson, D.K.N. and Lybecker, K.M., *Innovating for an Uncertain Market: A Literature Review of the Constraints of Environmental Innovation,* Colorado College Working Paper 2009-06, Colorado College: Colorado (2009) http://tiny.cc/e63ry
22. Intellectual Property Institute, *The Economics of Intellectual Property Rights and Climate Change,* http://tiny.cc/ua0nx
23. Johnson, D.K.N. and Lybecker, K.M., *Financing Environmental Improvements: A Literature Review of the Constraints on Financing Environmental Innovation* (2009) http://tiny.cc/9lge6
24. Lybecker, K.M. and Johnson, D.K.N., *Challenges to Technology Transfer: A Literature Review of the Constraints on Environmental Technology Dissemination,* Colorado College Working Paper 2009-07, Colorado College: Colorado (2009) http://tiny.cc/2tl8t
25. See *supra* note 22
26. Lee, B., Lliev, L. and Preston, F., *Who Owns Our Low Carbon Future?* Chatham House; London, United Kingdom (2009)
27. *Ibid*., p. 14
28. *Ibid*., p. 21
29. International Energy Agency, *Technology Without Borders* http://tiny.cc/qj9b0
30. *Ibid*., p. 108
31. http://tiny.cc/9uisv and see *supra* note 9
32. *Ibid*., p. 9
33. Copenhagen Economics and the IPR Company, *Are IPR a Barrier to the Transfer of Climate Change Technology?* http://tiny.cc/xwirg
34. UNEP, EPO and ICTSD, Perez Pugatch, M., *Survey of Licensing Activities in Selected Fields of Environmentally Sound Technologies* (EST) submitted to the United Nations Environment Programme (UNEP), the European Patent Office (EPO) and the International Centre for Trade and Sustainable Development (ICTSD). The full report by the project partners is: *Patents and Clean Energy: Bridging the Gap between Evidence and Policy* (2010) http://tiny.cc/3jnaj
35. *Ibid*., p. 10
36. PricewaterhouseCoopers, *Renewables Deals, 2009 Annual Review,* p. 6
37. PricewaterhouseCoopers, *Power Deals, 2009 Annual Review*
38. *Ibid*., p. 4

Table 1:

M&A ACTIVITY FOR GAS, ELECTRIC AND RENEWABLES, 2009

Top 5 Deals by Value	*China*	*Brazil*	*India*
1	Yangtze Power-Three Gorges **$5.9 billion**	CEMIG-Terna Participacaoes **$1.6 billion**	Jaiprakash Hydro Power Jaiprakash Power Ventures **$1.2 billion**
2	Hubei Triring-Hubei Energy **$1.6 billion**	AG Concessoes SA-CEMIG **$1.4 billion**	Green Infra Ltd-BP Plc (wind energy assets in India) **$134 million**
3	CIC-AES **$1.58 billion**	CEMIG-Light SA **$900 million**	CVCI; Sequoia Capital; BVP-Ind-Barath Power Infra **$100 million**
4	SDIC Huajing-SDIC Electric Power **$1.1 billion**	Cosan SA-Rezende Barbosa **$650 million**	Capital Trade & Investment Pvt-Adani Power **$61 million**
5	Guangdong Golden Horse-Shanxi Lujin Hequ Power Co Ltd; Shanxi Luneng…Electricity & Coal; Shanxi Luneng…Power **$833 million**	Tractebal Energia-CESTE **$340 million**	IDFC-Adhunik Power & Natural Resources **$53 million**
Total:	**$11.013 billion**	**$4.89 billion**	**$1.548 billion**

Source: PricewaterhouseCoopers, Power Deals, 2009 Annual Review

Section 3:

ESTs and Technology Transfer – What is Happening on the Ground

3.1 INTRODUCTION AND DEFINITIONS

The amount of evidence-based literature on the relationship between IPRs and technology transfer in the field of ESTs is minimal in comparison with the literature on ESTs overall. This section, drawing on the growing body of literature, provides data on how IPRs are affecting the transfer of EST between developed and developing countries.

The terms "developed" and "developing" countries are used in this section as follows. "Developed countries" refers to OECD economies, and to Annex II Parties as defined by the UNFCCC. Countries that are party to Annex II are particularly relevant to the discussion in this section in that they have explicitly committed under the terms of the UNFCCC to "provide financial resources and facilitate technology transfer to developing countries."[39] "Developing countries" are discussed in a broad sense as countries that are *not* party to Annex II. There are strong arguments for a more sophisticated definition and categorisation of developing countries, according to GDP per capita, life expectancy, literacy rate, or other socio-economic factors. Nonetheless, for the purposes of this paper, "developing countries" refers to a range of countries - from China and Brazil, to Kenya and Cambodia - unless defined more narrowly in connection with a specific example or issue.

3.2 IPR, EST, AND TECHNOLOGY TRANSFER TO DEVELOPING COUNTRIES - AN OVERVIEW

This sub-section describes the current state of EST transfer to developing countries, and what available evidence suggests about the impact of IPRs on the transfer of ESTs between developed and developing countries.

The transfer of ESTs is occurring via an increasing variety of channels. For example, technologies may be acquired through "buying and selling," which can be measured based on trade flows, mergers and acquisitions, and other indicators. ESTs may also be transferred via in-licensing and out-licensing agreements; this dynamic is most relevant to the acquisition of patented technologies and the associated know-how. International patenting activities, described below, also represent a form of technology disclosure; the patent owner is required to disclose details of the invention to the relevant patent office in order to obtain the patent.[40] ESTs can also be transferred through additional platforms such as joint ventures, strategic alliances, and specific consultancy services. Finally, knowledge about the utilisation of ESTs can be acquired through technical assistance, training, education, or other specialised programmes. These are the most common means of EST transfer.

There is no perfect way to measure EST transfer or the ability of users in developing countries to access proprietary technologies. The reasons for this are twofold: *first*, there are multiple ways in which ESTs may be transferred, and, *second*, the available data sets are an imperfect basis for measuring EST transfer.

Using existing data to measure the different methods of EST transfer is challenging. For instance, reliance on data regarding trade flows or FDI between two countries is an imperfect approach, as such data is broad and does not indicate the levels of EST transfer specifically. Even where trade data is disaggregated to reflect trade in specific categories, such as energy, or environmentally-related goods and services, it is still too broad for use in measuring EST transfer. Moreover, it can be slightly misleading. For example, according to the OECD's 2006 *Indicators of Globalisation*, exports of environmental goods from the OECD area totaled $370 billion, equal to nearly six per cent of total merchandise exports or one per cent of total OECD GDP.[41] According to the same indicators, total exports from the BRIC (Brazil, Russia, India, China) countries were also quite substantial, with total exports of environmental goods reaching a value of one per cent of BRIC GDP.[42] These figures are impressive. However, not all of these goods can necessarily be considered to be ESTs; for instance, wastewater treatment equipment accounts for more than a quarter of these exports.[42]

Similar problems apply to the use of data regarding investment activity, and to the use of data for aggregated mergers and acquisitions in the energy and renewables sectors. The PwC reports on energy and renewable deals (see Table 1) reveal that few of these investments or M&A involve cross-border investments. This is a crucial point. Although these countries' combined share of global power deals is increasing, it is not clear whether these deals involve the transfer of ESTs. For example, in the transactions listed in Table 1, only the third and fourth biggest deals in India involved investment from developed country entities. And, even in these two examples, the investing entities were venture capital and investment funds, as opposed to companies active in energy or EST-intensive industries; in other words, it is not clear whether ESTs were a direct component of the transactions.

Even the use of more targeted data samples to measure EST transfer has its limits. For example, many studies of technology transfer to developing countries focus on data gleaned from either one or several so-called Clean Development Mechanism (CDM) projects.[44] However, to gain real insight into the macro flow of EST transfer, it is better to work with as large a sample as possible.

3.3 PATENTING AND THE INTERNATIONAL TRANSFER OF EST

The OECD Working Party on National Environmental Policies is in the process of developing a set of indicators to measure EST innovation and the international transfer of ESTs. A recent OECD paper on the development of these measures, *Indicators of Innovation and Transfers in Environmentally Sound Technologies: Methodological Issues*, argues that patent data provides the widest and most detailed overview of technology transfer in the field of EST. The authors argue that, due to the cost of patenting, if a patent is sought in more than one location - and certainly in the major developed and developing-country markets - it is highly likely that the technology will be utilized in those countries. They further note that, due to the cost, the act of patenting implies intended usage, and that the detailed nature of the International Patent Classification (IPC) (which includes over 70,000 separate classification codes) makes it possible to narrow the analysis to specific areas of technology.[45]

To illustrate the relevance of patenting data as an indicator for international technology transfer, the OECD paper examines the correlation between the exportation of "wind powered electric generating equipment" and the number of duplicate patent applications for "wind motors."[46] The rationale for this approach is that significant exports and duplicate patenting of a technology or product strongly implies that the international transfer of said technology or product is occurring. While not a perfect match, the figures presented in the paper indicate a strong correlation between duplicate patenting and exports, for wind power. Countries such as Germany, Japan, and Denmark, which are the biggest exporters of wind power technologies, also exhibit relatively high volumes of duplicate patent applications.[47]

Having established that patent data is a useful indicator of EST transfer, the OECD then examines patent data in order to assess current EST transfer trends. *The Clean Development Mechanism and International Technology Transfer* report (2009) looks at the transfer of wind power technology from developed to developing countries, and includes total duplicate patent applications for the last twenty years. Table 2 lists the top ten source and recipient countries identified in this OECD paper.

A number of things stand out from the above table. *First*, the least developed, poorest countries are not on this list. Indeed, looking at their economic performance it could be argued that all the recipient countries are at the least emerging, if not fully emerged, economies. On a per capita basis, Hong Kong is one of the richest places in the world. Other countries on the list, such as Korea, Israel, and Taiwan, are quite similar to the EST source countries. *Second*, this data clearly reflects the dominance of the emerging economies of the south and east, specifically, China and Brazil. Four of the top five recipient countries are fast-growing emerging economies. *Third*, and most importantly, of a total 840 duplicate patent filings from source to recipient country, 528 were filed in either China or Brazil. This represents more than 60 per cent of the total sample, illustrating how attractive the Chinese and Brazilian markets are to wind power technology providers in the respective source countries.

What does the above data suggest about the relationship between protection of IPRs – both *de jure and de facto* – and the transfer of ESTs from developed to developing countries? One tentative conclusion that can be drawn on the basis of this data is that the intellectual property regimes in Brazil and China, which some may consider to be less stringent than those of other developed countries, do not significantly deter companies in source countries from transferring their technologies. As examined in more detail below, more analysis is needed regarding the importance of *de jure* IPR protection to EST transfer, and whether ESTs differ from other IPR-protected products and technologies in that *de jure* IPR protection is less important for the transfer of ESTs.

Does other evidence support the claim that IPR protection is not as important, or is less of a barrier, in the EST field than in other fields of technology?

A 2009 study by Chatham House on IP and energy technologies, *Who Owns Our Low Carbon Future? Intellectual Property and Energy Technologies*,[49] examines patenting patterns for six leading ESTs: wind, solar photovoltaic (PV), concentrated solar power (CSP), biomass-to-electricity, cleaner coal, and carbon capture.[50] One of its main findings is that, even though research and development of many of these technologies had been ongoing since the late 1970s, patenting for most of these technologies has surged since the late 1990s, with most patents concentrated in OECD countries.[51] For the six energy sectors studied, all but one of the top ten geographic locations of patent assignees or owners are OECD economies. Of these, the United States is the clear leader, followed by Japan, Germany, China, Korea, and the UK.

Based on the data in *Who Owns Our Low Carbon Future?*, China is the only non-OECD country in the top ten and is a major location for patenting in the wind power, biomass, CSP, and cleaner coal sectors; in some industries, such as cleaner coal, CSP, and biomass, China is only second to the United States.[52] As indicated by the geographical location of the parent company of patent owners, many of the patents filed in China are filed by foreign subsidiaries. If analysis is restricted to data regarding the patenting activities of domestic parent companies, China's percentage of patenting is considerably lower than that of the United States, Japan, and Germany.[53] This suggests that China is a prize destination for many foreign companies with substantial interest in EST. It also suggests – like the data on wind patents collected by the OECD – that ESTs are being transferred from developed countries to China.

The authors of the Chatham House paper provide several possible explanations for this. *First*, many multinationals have a history of manufacturing in China and continue to maintain substantial manufacturing capabilities there. *Second*, Chinese government policies have stimulated demand for ESTs. Most notable among these policies are the 15 per cent targets for renewable energy by 2020, and the objective of producing 120 GW of wind power by 2020. *Third*, the growth of China's

Table 2: Top Ten Source & Recipient Countries

NUMBER OF DUPLICATE PATENT FILINGS RELEVANT FOR WIND POWER GENERATION, 1988-2007

Recipient Country	*China*	*Brazil*	*Korea*	*Mexico*	*South Africa*	*Morocco*	*Argentina*	*Taiwan*	*Hong Kong*	*Israel*
Source Country										
Germany	144	125	43	42	33	29	20	1	7	6
Japan	52	2	40	3	2	0	0	16	2	0
USA	50	20	1	12	3	0	1	1	3	3
Denmark	51	5	0	4	0	0	0	0	0	0
Spain	20	5	1	5	0	1	2	0	0	1
UK	13	5	2	2	3	0	0	1	0	1
France	9	1	1	1	1	1	0	0	3	0
Norway	7	1	5	0	1	0	0	0	0	0
Sweden	5	3	0	2	1	0	0	2	0	0
Netherlands	6	4	1	1	0	0	0	0	1	0
Total, Recipient Country	**357**	**171**	**94**	**72**	**44**	**31**	**23**	**21**	**16**	**11**

Source: PricewaterhouseCoopers, Power Deals, 2009 Annual Review

economy, in relation to its export markets and rising domestic demand, means that innovation will be a major part of its future economic development.[54] *Fourth*, and above all, China is such a significant market that multinationals want to establish a presence there.

Who Owns Our Low Carbon Future? also examines data regarding specific EST industries, finding that China is the only non-OECD country to have become a key location for patent assignees. For example, with regards to wind power, biomass, and solar, and to a lesser extent CSP and PV, China's share of total international patenting activity has increased substantially over the past five years.[55] China is also emerging as a key filing location for clean coal, CSP, and wind.[56] The only other non-OECD country that is becoming a key location for EST patent filing is Russia, which accounted for three per cent of wind patent filings during this period, a position that is still very far behind China.[57]

With regard to other forms of technological diffusion, the Chatham House study does not find much evidence to support the conclusion that the transfer of ESTs from developed to developing countries is taking place on a collaborative basis. Information and data on licensing and collaborative agreements are very difficult to obtain. Nonetheless, information regarding the co-assignments of patents indicates that the international co-assigning of patents is very rare. Of the patents examined, almost nine-tenths were patents shared within one OECD country, i.e. they stayed within the borders of just one country.[58] Only two per cent were patents that were shared between one OECD country and one non-OECD country.[59]

Nevertheless, it important to note that patent data is not directly indicative of technology transfer, nor is it necessarily specific to the transfer of ESTs.[60] In addition, patenting is likely to take place only in countries with effective patent protection and enforcement. Despite these limitations, patenting data and history are useful for discerning broader technology transfer trends.

Other IP-related indicators of EST transfer are often not readily available, such as data regarding licensing practices. Despite this, there is some recent, evidence-based work on licensing, as described below.[61]

3.4 LICENSING AND CROSS-BORDER AGREEMENTS

Licensing agreements are a very common type of agreement used in the commercial exploitation of a propriety technology, or a piece of intellectual property. Broadly speaking, a licensing agreement is an agreement between two parties, the licensor and the licensee. Licensing is a way for IPR owners or holders of some form of propriety technology (licensors) to allow other entities to use their technology and/or product for either commercial or non-commercial purposes (based on licensees). Licensing agreements can be between private or public entities, and they can be entered into directly by rights holders and end-users. There exists significant variation as to the design, terms and conditions, commercial benefits, and other characteristics of licensing agreements.

In the field of ESTs, there are very few studies of how licensors use licensing in their businesses. Most entities, whether public or private, choose to keep the terms of their licensing agreements private, for strategic and commercial reasons.[62]

A recent study in this area is the *Survey of Licensing Activities in Selected Fields of Environmentally Sound Technologies* (2010), a joint project by EPO, UNEP and ICTSD.[63] Participants in this survey included some of the leading EST organisations, including multinationals, small and medium enterprises (SME), academic institutions, and public entities.

Key findings include:

- *Nearly three-quarters (73 per cent) of respondents consider out-licensing activities to be a key part of their commercial activities. This is especially true for EST-intensive organisations, of which 84 per cent responded that out-licensing activities are important.*

- *Eighty-three per cent of respondents report being involved in some form of collaborative R&D arrangement.*

- *Sixty-eight per cent of organisations see collaborations as being the most intense in the transfer of ESTs.*[64]

According to this survey, relatively few organisations had engaged in the transfer of ESTs to entities in developing countries. A clear majority of respondents (58 per cent) had not struck any licensing deals with a partner in a developing country.[65] China, India, and Brazil were the three countries with which respondents had had the most discussions on licensing. As to why such agreements had not been reached despite the commitment of many respondents to significant, EST-intensive out-licensing activities in their business activities in developed countries, 82 per cent of respondents claimed that the protection of IPRs was an important factor affecting their decision to enter into a licensing agreement with an entity in a developing country.[66] At the same time, other factors, including scientific capabilities, infrastructure, human capital, market conditions, and investment climate, were rated as more important. In fact, all these factors were rated slightly higher than the protection of IPRs, with between 85 and 87 per cent of respondents indicating that these were significant factors in their licensing decisions.[67]

When asked if they would be willing to grant more flexible licensing terms to entities in developing countries, a clear plurality of respondents responded positively. 70 per cent of EST patent holders would show some flexibility, with licensing-intensive EST patent holders being even more willing to show flexibility in their licensing partnerships with players in developing countries (78 per cent, compared with 70 per cent for the overall sample).[68]

Nonetheless, other studies suggest that in addition to IPRs and other variables, the nature of EST themselves may also influence international transfer patterns.

3.5 IPR AND THE TRANSFER OF EST TO BRAZIL, INDIA, AND CHINA

In contrast to other forms of proprietary products and industries, many EST technologies are open to competition and improvement. For example, since "clean tech" products are different from pharmaceuticals, they are protected by intellectual property in a different manner. Moreover, as noted in the ICTSD study by Barton *et. al*., the type of competition that exists between products in the renewables sector is different from competition in other sectors, such as pharmaceuticals.

> [I]n the three renewable sectors considered here (and in many other industrial sectors), the basic approaches to solving the specific technological problems have long been off-patent. What are usually patented are specific improvements or features. Thus, there is competition between a number of patented products – and the normal result of competition is to bring prices down to a point at which royalties and the price increases available with a monopoly are reduced. This will be particularly the case for the products considered here, where there is competition not only between the firms in the specific sector but also between the sectors and alternate sources of fuel or electricity. In effect the benefit of the technologies is shared with the ultimate customers.[69]

On this basis, Barton *et. al*. suggest that IPRs for renewables are less of a barrier to access and entry than in other industries. The authors conclude that IPRs do not impede EST innovation or the full participation of India, China, and Brazil in developing solar, biofuel, or wind power technologies. For most of these technologies and countries, the authors consider other factors, such as trade barriers, to be more of a hindrance to the full development of these technologies. Table 3 presents the paper's conclusions regarding the impact of IPRs on EST transfer to China, India, and Brazil.

Having completed the review of certain larger sets of macro data regarding the international transfer of ESTs through patenting and licensing, the rest of this section will focus on partnerships and national regulations, and will provide specific examples of technology transfer partnerships between entities in developed and developing countries.

Table 3:

INTELLECTUAL PROPERTY IMPLICATIONS: PV, BIOFUEL, AND WIND[70]

Technology	PV	Biofuel	Wind
Intellectual property (IP) access limitations on current market for energy (for reducing emissions in participating CDM).	*Few concerns over IP*	*Essentially no concerns over IP*	*Possible concerns over IP, but likely to involve at most a small royalty.*
Major developing country concerns in future market for energy	*Possible difficulties in obtaining advanced IP-protected technologies*	*Possible barriers or delays in obtaining cellulosic technologies.*	*Possible risk of anti-competitive behavior given concentration of industry.*
IP access limitations on entering the industry as a producer of key components or products	*Possible barriers or delays in obtaining or creating the highest quality production systems.*	*Possible concerns over access to new enzymes and conversion organisms – but at most a royalty issue.*	*Possible difficulty in obtaining most advanced technologies.*
Most important overall concerns in area	*Access to government-funded technologies, standards.*	*Global trade barriers in the sugar/ethanol/fuel context. Access to government-funded technologies, standards.*	*Access to government-funded technologies, plausible anti-competitive behavior, standards.*

3.6 JOINT VENTURES, PARTNERSHIPS AND MERGERS AND ACQUISITIONS

Partnerships and joint ventures (JV) are a growing contributor to the international flow of capital and ideas from developed to developing countries. The scope and types of possible partnerships and JV vary according to national legal and regulatory frameworks, along with the conditions and goals of the individual companies involved. At its most basic level a JV is a contractual agreement between two or more parties to conduct a specific kind of business, typically for a limited period of time. Other types of partnerships, on the other hand, may involve a more binding relationship between the two contracting parties. Definitions of “partnership” and “joint venture” vary across jurisdictions, as does the legal status of these arrangements. In the UK, for example, joint ventures have no legal status, whereas partnerships are recognised under English law.[71]

By forming a joint venture, two or more innovators create a new partnership, usually via a spin-off company, in which they share knowledge assets for the purpose of developing and introducing a new technological innovation to the market. Partners in JV may be motivated by financial interests, i.e. the profits earned on their investment, or their involvement may be strategic, for instance if they consider the innovation to be critical to their future operations in the market or to the overall success of their business.[72]

JV are not only limited to partnerships between two or more innovators. They can also be based on a partnership between an innovating entity and a financial one, for example a venture capital company or so-called “angel investors.” Other forms of joint ventures involve multiple partners, including innovator(s), financial investor(s), and partners with the manufacturing, logistics, and marketing capabilities that are essential for the overall success of the project.

JV may also consist of a more limited partnership. Specifically, companies may enter into a long- or short-term strategic alliance. This approach allows each company to maintain independence and ownership of knowledge assets, while at the same time creating a framework that enables them to complement and exploit one another’s capabilities in order to achieve greater success in the market. For example, two companies that do not compete in the same market may decide to share their respective knowledge assets and capabilities in a process known as “technology partnering,” with the objective of introducing new innovations into their respective markets.[73]

Both joint ventures and partnerships are popular routes for EST-intensive companies to increase their presence in new markets, often in developing countries. Recent examples of significant joint ventures between energy companies that involve the use of EST technologies include the 2010 agreement between Royal Dutch Shell and Cosan S.A., Brazil's biggest ethanol producer, to form a $12 billion JV in Brazil.[74] This deal – which remains subject to finalisation and management approval as this Report goes to print – will result in one of the biggest investments by a traditional oil and gas energy company into biofuels and alternative energy. While specifics about the expected EST technology transfer have not been made public, it is clear from a technology transfer perspective that both companies stand to benefit from the JV. According to news reports, Cosan will gain access to Shell's knowledge and research into second-generation ethanol production.[75] In return, Shell will gain access to Cosan's ethanol production capabilities and domestic capacity.

For some time, Shell and other multinational energy giants – including those from emerging economies such as China and Brazil – have been investing large amounts of capital and resources into building up their EST assets. Companies such as Eni have launched a variety of R&D and investment efforts focused on renewables and ESTs. BP set up its alternative energy division in 2005, at the same time committing to spend $8 billion in the sector over the next decade; in early 2010, the company announced that it would be spending $1 billion on alternative fuels alone as part of this commitment.[76] Brazilian state-controlled Petrobras has also invested heavily in biofuels, and has made renewable energies a central part of its future investment plan.[77]

Much of this growing investment in renewables and alternative energy has been carried out through JV and limited partnerships. The Shell-Cosan JV, described above, is just the latest in a series of significant deals between developed and developing country energy giants. For example, General Electric (GE) and Petrobras have, together, successfully developed a bio-ethanol-fired gas turbine power station.[78] Here, too, the transfer of technologies was central to this project, with GE providing the turbines and modifying them to allow for the use of ethanol.[79]

Not all EST-related JV and partnerships between developed and developing-country entities will include or result in the transfer of ESTs. The general trend is for large multinational companies from both developed and developing countries to invest in what they deem to be lucrative markets around the world – and gaining access to propriety technology and local knowledge is undoubtedly part of this equation.

Significantly, this is not a unidirectional trend (from developed to developing countries). Many businesses based in developing countries are investing and buying assets in developed countries, in order to gain access to new markets and acquire new technologies. For instance, in 2008, the Chinese wind power giant Xinjiang Goldwind Science & Technology (Goldwind) acquired a 70 per cent stake in the German wind turbine maker Vensys Energy AG.[80] The Chinese company's rationale for this acquisition was to access the technological expertise and know-how of Vensys.

Cross-border investment activity and mergers and acquisitions within the energy sector are also an increasingly significant route for technology transfer. Today, global M&A activity related to renewables constitutes a substantial proportion of the value of total energy deals. In 2009, total global acquisitions of, and deals between, renewable companies were valued at $33.4 billion by PwC.[81] Deals in emerging markets such as China, India, and Brazil were a major, increasing part of the total. One of the biggest acquisitions was the purchase by China Investment Corporation, a Chinese sovereign wealth fund, of a 15 per cent stake in American AES Corporation. AES is one of the biggest energy generating companies in the world, with considerable investments in renewables.[82] Similarly, in 2008, the Indian wind power giant Suzlon Energy Ltd acquired a 30 per cent stake in REpower Systems AG, a German turbine manufacturer.[83] At a value of $770 million, this was the seventh biggest renewables deal in the world.[84]

3.7 THE IMPORTANCE OF OTHER FACTORS

Thus far, Section 3 has mainly focused on the element of IPR and IP-related activities in the transfer of EST, especially to developing countries. However, intellectual property rights should not be considered in isolation. There are other factors that affect EST transfer, most of which concern the situation on the ground in recipient countries, in particular their technical capacity and infrastructure, the regulatory and political climate, and human factors.

The results of the *Survey of Licensing Activities in Selected Fields of Environmentally Sound Technologies* reveal that companies engaging in EST transfer consider these "other factors" and the protection of IPRs to a similar extent when deciding whether to enter into licensing agreements.[85] Because these factors and IPRs are different pieces of the same puzzle, a holistic strategy for promoting EST transfer that takes all of them into consideration will be most successful. Governments should therefore complement effective IPR protection alongside the appropriate policy infrastructure, governance, and competition systems, in order to create effective conduits for technology diffusion.[86]

3.7.1 TECHNICAL CAPACITY AND INFRASTRUCTURE

Successful technology transfer to developing countries depends to a great extent on each country's ability to absorb new technologies. "Absorptive capacity," commonly referred to in the study of business and innovation, is defined by Cohen and Levinthal as the "ability to recognise the value of new information, assimilate it, and apply it to commercial ends."[87] In the context of ESTs, it is clear that developing countries need the technical know-how to be able to understand, use, and update new technologies. The knowledge gap that currently exists between developed and developing countries implies an absence of technologically skilled workforce in many developing countries. Education, training, and other strategies that enhance technical capacity are key to establishing the intellectual infrastructure necessary for the introduction, use, and development of ESTs.

EST transfer requires a foundation of basic technical skills in the recipient country, which can be used to assure the operational and maintenance needs of the new technologies. Producers of ESTs, such as the Israeli company Netafim, which manufactures products for effective irrigation, have realised that appropriate training is necessary for the successful creation of markets in developing countries. The company has trained users in Kenya, a country with a limited supply of water, in the belief that farmers who have received training on how to use Netafim's products are more likely to maximise the potential of the technology.

With regard to licensing deals, the importance of complementary know-how ultimately depends on the type of technology that is being transferred. Licensing agreements that involve a simple and straightforward use of the technology by the potential licensee, i.e. without the licensee needing or desiring to understand how the technology works, can be entered into regardless of the technical capacity of the technology user. In such cases, some training may be necessary, but the associated know-how can be compared to an instruction manual. This type of licensing deal is very similar to the simple "selling and buying" model of international technology transfer.

Licensing agreements that include the provision of associated know-how – as in the case of complex technologies, or where potential licensees need or desire to understand how the technology works – are a much more valuable tool for technology transfer.

Significant public investment in research and development is also valuable in terms of promoting EST transfer. The establishment of indigenous knowledge helps to ensure that EST transfer is more than just a one-off technological solution. Public investment enables national innovation strategies to thrive, and supports the creation of an innovation culture. This culture can then be enhanced through cooperation and partnerships with international organisations.[88] Public investment is also central to the development of infrastructure in developing countries, which is vital for the assimilation, utilisation, and development of ESTs.

Who Owns our Carbon-Free Future?, by Chatham House, cites a compelling example to illustrate the importance of technical capacity and infrastructure to technology diffusion: electric and combustion engine cars in the early 1900s. Although, initially, more electric than combustion engine cars were sold, with the subsequent mass production of combustion engine cars, the discovery of oil in the United States, the growth of fuel stations and petrol refineries, and the inefficiency of electricity, the combustion engine was adopted more rapidly and extensively. Nearly 100 years later, electric cars are becoming a viable alternative, due to high petrol taxes, high oil prices, and concerns about the environment. In the absence of these factors (i.e. infrastructure changes), a technology that "on paper" is the more efficient would perhaps be considered too expensive to adopt.[89]

The Climate and Development Knowledge Network engages in capacity-building with the objective of enhancing the transfer of ESTs to developing countries. This alliance of organisations, led by PwC, commissions applied research in response to requests from decision-makers in developing countries, offers technical and capacity-building assistance, provides access to the most current information on climate-compatible development, and supports the exchange of knowledge and the creation of partnerships among governments, civil society, donors, institutions, and private sector organisations.

Simply giving ESTs to developing countries could possibly contribute to reductions in carbon emissions and the mitigation of climate change. However, ESTs cannot be considered to have been successfully transferred unless it is accompanied by a better understanding of the technology by both industry and society. EST should not be viewed as externally-imposed technological solutions. Improvements in domestic technical capacity can enable societies to absorb ESTs more effectively, and should be a priority for policy-makers. Developing countries should build autonomous capacity that can be used to further develop ESTs.[90]

3.7.2 REGULATORY AND POLITICAL CLIMATE

The UNFCCC has acknowledged the importance of an "enabling environment" in fostering the transfer of ESTs to developing countries. ESTs are most likely to be transferred to countries with stable macroeconomic, legal, and political environments, where the administration of government regulations is transparent and predictable. Political tension and uncertainty, inadequate or uncertain enforcement of contracts, corruption, or an unfavourable business environment can dampen investment interest and can also increase the cost of adopting new technologies. Sound management of the economy by the government is also vital, as high unemployment and low economic growth can negatively impact the market for EST. The wrong macroeconomic policies can make EST transfer more expensive and/or more difficult.

Possibly the most important role of developing country governments in promoting the transfer of ESTs is as regulators. The growth of renewables in the developed world has been driven by regulation, not market forces, and it is unlikely that the approach will be any different in developing countries.[91]

India is a prime example. It has rapidly progressed to become the fifth largest producer of wind power in the world. Suzlon

Energy, a homegrown company, is now the third largest wind turbine manufacturer in the world. This development of the wind power sector in India was facilitated by a broad national program, which was led by the Ministry of Non-conventional Energy Sources (MNES). This program provided incentives to aid the growth of the wind power industry. Among these policies were: low-interest loans to renewables companies; a 100 per cent tax rebate for the first ten years of operation; and the legal obligation for power companies to provide preferential conditions for wind farms.[92] In addition, the government set a production target of 5,000 MW of green electricity by 2012, and is currently negotiating a mandatory minimum percentage target. Such incentives have led companies such as the Essar Group of Mumbai, an industrial conglomerate active in shipping, steel, and construction, to consider establishing a wind farm near Chennai given the regulatory climate in India such a move is financially attractive.[93] With 70 per cent of demand for wind turbines in India coming from industrial users seeking alternatives to the unreliable power grid, India's regulations appear to have been highly effective.

The Chinese government has also used restrictions on foreign ownership, together with a variety of other regulations, to promote the transfer of technologies from investors to Chinese entities, as well as the development of local Chinese capabilities. One of the main tools used to regulate foreign investment is the *Catalog of Industrial Guidance for Foreign Investment*, a document published since the 1990s by China's National Development and Reform Commission and the Ministry of Commerce. The *Catalog* contains a list of industries and economic sectors in which the Chinese government either encourages or discourages foreign investment.[94] Modifications to this document reflect wider economic policy decisions made by the Chinese government and have significant ramifications for foreign investment in specific industries. With regard to EST specifically, various Chinese regulations promote local manufacturing capacity. For instance, until 2010, Chinese regulations required foreign wind farm developers to source 70 per cent of their components locally.[95]

3.7.3 HUMAN FACTORS

Because 40 per cent of all carbon emissions are attributed to personal behaviour, for ESTs to reduce the overall level of emissions, there will need to be significant change at the individual level. A change in personal behaviour can make the need for effective ESTs less urgent. If more people choose to bicycle or walk, there is less urgency to develop ESTs in relation to public transportation systems. Through such behavioural change, it is possible to modify the influence of human beings on the climate, and to limit the dangers resulting from climate change.[96]

Changes in personal behaviour are needed to facilitate the transfer of ESTs, and communities and individuals need to be called upon to aid in the development and use of ESTs. For societies to move toward less carbon-intensive lifestyles, individuals will need to be convinced about the benefits of EST. Studies are increasingly looking at the psychology underlying perceptions of climate change. In addition to creating an enabling environment and improving technical capacity related to ESTs, governments can provide financial and other incentives for the public, to encourage greater uptake of ESTs. These could include financial incentives for businesses and households to go "green" or an added tax on pollution.

There is also a need for education, which may be provided directly by the government and by organisations such as the University of Nairobi, Wangari Maathai Institute for Peace and Environmental Studies, which was established to promote education as the basis for a more sustainable society. This organisation, headed and named after the former Nobel Prize winner of the same name, operates on the premise that targeted training and public education can transform community attitudes and values about resource utilisation and management.[97] By supporting the use of education to increase awareness of environmental issues, governments may find that EST transfer takes place more rapidly and effectively.

39. *Glossary of Climate Change Acronyms*, UNFCCC website, http://tiny.cc/vxi2i
40. Some may argue that there is still a big difference between disclosure and transfer of technology.
41. OECD, Working Party on National Environmental Policies, *Indicators of Innovation and Transfers in Environmentally Sound Technologies: Methodological Issues*, OECD, p. 12 (2009)
42. *Ibid*.
43. *Ibid*.
44. See Section 2 above for a full discussion of the existing EST literature.
45. See *supra* note 41, pp. 11-12
46. *Ibid*., pp. 15-16. Duplicate patents are patents that are registered and filed in more than one location and with more than one patent office.
47. *Ibid*., p. 16
48. Hascic, I. et. al., OECD Environment Directorate, *The Clean Development Mechanism and International Technology Transfer Empirical Evidence on Wind Power using Patent Data*, OECD Working Paper Series
49. See *supra* note 26
50. *Ibid*.
51. *Ibid*., p. 14
52. *Ibid*.
53. *Ibid*., p. 15
54. *Ibid*., p. 17
55. *Ibid*., pp. 22-38
56. *Ibid*.
57. *Ibid*., p. 23
58. *Ibid*., p. 47
59. *Ibid*.
60. See *supra* note 48 for a thorough discussion of the pros and cons of using patenting statistics when assessing technology transfer.

61. Perez Pugatch, M., *Survey of Licensing Activities in Selected Fields of Environmentally Sound Technologies (EST)*, UNEP, EPO, ICTSD: Geneva (2010)
62. General licensing surveys are more common – see for example, Zuniga, P. and Guellec, D., *Who Licenses Out Patents and Why? Lessons from a Business Survey*, STI Working Paper No. 2009/5 or the annual surveys of the Licensing Executive Society Foundation (2009) http://tiny.cc/wek9h
63. See *supra* note 61
64. *Ibid*., pp. 8-10
65. *Ibid*., p. 10
66. *Ibid*., pp. 30 - 31
67. *Ibid*.
68. *Ibid*., pp. 36-37
69. See *supra* note 20
70. *Ibid*., p. 18. This table is a verbatim copy.
71. *Joint Ventures and Partnerships*, Hamilton Pratt Business and Franchise Solicitors, http://tiny.cc/o34dv
72. Smith, G. V. and Parr, R. L., *Valuation of Intellectual Property and Intangible Assets*, John Wiley & Sons (2000), Chapter 12; Perez Pugatch, M., Chapter 2 (2005)
73. Narula, R. and Hagedoorn, J., *Innovating Through Strategic Alliances: Moving Towards International Partnerships and Contractual Agreements,* Paper No. 25, Research Memoranda from Maastricht: MERIT, Maastricht Economic Research Institute on Innovation and Technology (1998); See also Hagedoorn, J., *Inter-firm R&D Partnerships. An Overview of Major Trends and Patterns since 1960*, in Jankowski, J.E., A. N. Link and Vonortas, N. S., *Strategic Research Partnerships: Proceedings from an NSF Workshop*, National Science Foundation: Washington DC, pp. 63-92 (2001)
74. Shell News and Media Releases, *Shell and Cosan sign MOU to form joint venture in Brazil* (2010) http://tiny.cc/l2he8
75. Reuters, *Shell bets on ethanol in $21 billion deal with Brazil's Cosan*, http://tiny.cc/mnw3c
76. *BP Set for Renewables Splash*, Upstreamonline.com (2010) http://tiny.cc/ig5kq
77. Petrobras, About Petrobras, Renewable Energies, http://www.petrobras.com.br/en/energy-and-technology/sources-of-energy/
78. *GE and Petrobras in Biofuel-fired Aeroderivative Generation Play*, Renewablenergyworld.com (2010) http://tiny.cc/7z499
79. GE, Press Release, *Brazil Energy Milestone: GE, Petrobras Using Sugarcane-Based Ethanol to Produce Electricity,* http://tiny.cc/5etkh
80. *China's Xinjiang Goldwind to acquire 70 pct of German Wind Turbine Make* (2008/02/01) http://tiny.cc/9rz4z
81. See *supra* note 36
82. See *supra* note 37
83. See *supra* note 36
84. *Ibid*.
85. See *supra* note 61
86. World Bank blog - *Technology Transfer in the Climate Context: Who is responsible?* http://blogs.worldbank.org/climatechange/node/530
87. Cohen, W. and Levinthal, D., *Absorptive Capacity: A New Perspective on Learning and Innovation,* pp. 128-152 (1990) http://tiny.cc/rahoy
88. Intergovernmental Panel on Climate Change, *Methodological and Technological Issues in Technology Transfer,* http://tiny.cc/ru2os
89. See *supra* note 49
90. Department of Economic and Social Affairs United Nations Forum on Forests Secretariat, *Transfer of Environmentally Sound Technologies for Sustainable Forest Management,* http://tiny.cc/cwox5
91. See *supra* note 20
92. United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), *Wind Turbine Technology Transfer in Asia,* http://tiny.cc/q5as8
93. *The Ascent of Wind Power,* New York Times (2006) http://tiny.cc/ti3fk
94. *China Revised Its Investment Guidance Catalog and Its Impact on Foreign Investment,* HG.org, Worldwide Legal Directories, China Sunbow & Associates, http://tiny.cc/xhkvx
95. China Briefing, *Foreign Investment Restrictions on Wind Power Relaxed'* (2010) http://tiny.cc/qqry4
96. Lorenzoni, I. and Pidgeon, N., *Defining Dangers of Climate Change and Individual Behaviour: Closing the Gap* (2005) http://tiny.cc/scklm
97. University of Nairobi Wangari Maathai Institute for Peace and Environmental Studies – Background, http://tiny.cc/1ocmh

Section 4:

Conclusions [98]

This section summarises key findings of this report, describes possible avenues for future research, and identifies considerations for policy-makers aiming to promote EST transfer through the enactment of appropriate IPRs and other policies.

Devising policy on the basis of evidence is a challenging task. By definition, 'evidence-based' policymaking is dependent on the accumulation of a significant body of evidence and data. One of the main findings of this report is that, while the data and evidence on the transfer of ESTs is growing, there is still much that is unknown. However, uncertainty and lack of complete data does not mean that policy-making should not be attempted at this time. The very essence of policy formulation is that it is based on different political, ideological, logistical, and other constraints. Partial information is one of the constraints that policy-makers must take into account.

It is essential that the transfer of ESTs be considered from a broad policy perspective that takes into account factors additional to IPR. For instance, in order to promote EST transfer to developing countries, both supply and demand-related factors must be considered. With respect to supply, investors and businesses that are active in the transfer of ESTs to the developing world must find an enabling environment. This environment should include capacity and infrastructure that facilitate the production and management of ESTs, and it should be regulated in a way that encourages further development of ESTs. From the demand side, a basic condition for the successful absorption and use of ESTs is the need for a local grassroots demand (so-called "pull factors") for the technology. Here, by using different instruments to make ESTs more attractive, governments can increase demand for technologies that can provide a net social benefit.

In addition, ESTs should not be viewed as a passive, one-way process. For climate change strategies in the developing world to develop, the donor-receiver relationship that has existed up to now must change. Governments of developing countries must create an institutional framework that is capable of absorbing, adapting, and improving upon technologies. On the basis of such frameworks, real growth in ESTs that meet local needs in developing countries will be possible.

The following three insights stemming from this report may be useful for policy-makers interested in IPRs and the transfer of ESTs.

First, one-dimensional discussion as to whether IP hinders or promotes the transfer of ESTs should no longer be the framework of analysis. Most of the evidence-based studies that are cited in this report suggest that IPRs are not a barrier to the transfer of ESTs, and that, overall, they contribute to facilitation of the transfer of ESTs, in conjunction with the other factors noted below. This initial conclusion must be built upon; more research is needed regarding the specific IP policies that should be in place in order to promote the practical assimilation and utilisation of the technologies transferred. For example, even if a patent is determined to not block, and even to facilitate, the transfer of ESTs to a potential user based in a developing country, this does not determine whether or not that ESTs will be used effectively by the end-user.

Policy-makers may wish to focus on the following concrete question: *How should IPRs be used effectively and practically in order to promote the successful assimilation and utilisation of ESTs by users based in developing countries?* Naturally, this question opens up an entire new set of debates and possibilities for future research. At the same time, it may lead to more pragmatic conclusions.

Second, for the purpose of devising policy, IP cannot be considered in isolation from other factors. This report has emphasised the importance of additional factors – including macroeconomic, technological, and human factors – that are key to the successful assimilation and utilisation of ESTs. Governments that aim to enhance the ongoing, sustainable transfer of EST should develop frameworks that integrate IP policies with other types of pro-investment policies, developing a coherent blueprint for action. A comprehensive IP policy framework to favor EST transfer will be more effective if developed in consideration of various other factors related to the overall macroeconomic climate.

Third, as policy debates give way to the actual transfer of technology, it should be acknowledged that the importance and role of IPRs varies from one context to another. As noted in this report, the term ESTs is very broad and encompasses different forms of technologies. Unlike other fields of technologies, such as software and pharmaceuticals, the EST field is still very much in its nascent stages, not least in terms of the degree of divergence and variance relating to the relevant technologies.

For some fields of ESTs, policy discussions about IPR may illuminate the best policies and practices for the successful transfer, assimilation, and utilisation of ESTs. In contrast, for other areas, a focus on IPRs may be of limited usefulness. The relevance of IP may also differ according to country, as different countries have different objectives and preferences in terms of the types of ESTs they aim to attract and further develop. Policy-makers must seek to identify those areas where the impact of IPRs on EST transfer is most significant.

These three, broad considerations for policy-makers are modest, and additional research is needed in order to provide a foundation for mature, evidence-based IP policies that will promote the transfer of ESTs. This report seeks only to provide an initial basis for further work; it is a first step in the very long journey towards the more widespread and effective use of environmentally sound technologies. On the basis of the studies and other evidence reviewed in Sections 2 and 3, we can identify the following elements, which are listed below.

- ***The so-called "known-knowns,"*** *which are the lessons that have been learned so far about the ability to use and harness IPR for the sake of encouraging, or at least not disrupting, the transfer of ESTs to developing countries.*

- ***The "known-unknowns,"*** *which are those areas that require further research and analysis, the additional evidence and data that are needed, and the questions that researchers should be asking in view of obtaining a more informed, evidence-based foundation for policies that foster EST transfer.*

- ***The "unknown-unknowns,"*** *which are the 'wild cards' that could affect further research into IP, technology transfer, and ESTs, including political tensions and geographic or climatic change.*

The "known-knowns":

- *ESTs are increasingly viewed internationally and in most major economies as a key part of global climate mitigating efforts and a source of new energy supply.*

- *The transfer of ESTs from the developed to developing world is today mainly going to the biggest emerging economies such as China, Brazil, and India. Nevertheless, the flow of ESTs is not unidirectional. It takes place between, within, and across developed and developing countries.*

- *There are many ways in which ESTs are being transferred from one entity to another, and from one place to another. The transfer of ESTs is taking place via different channels and models including: the most frequent and straightforward form of "buying and selling"; in-licensing and out-licensing agreements (mostly with regard to patented technologies and associated know-how); creation of more sophisticated platforms aimed at developing, transferring, and utilizing ESTs, such as joint ventures, strategic alliances, research and development services; acquisition of knowledge about different ESTs through specialised programmes, technical assistance, training and education. Therefore, it makes sense to collect and analyze different types of data concerning the transfer of ESTs rather than focusing on only one set of measurements (for example, patenting activities).*

- *In relation to IPRs, most of the evidence-based studies surveyed in this report seem to suggest that IPRs are not a barrier to the transfer of ESTs and that generally they may play a positive role in the facilitation of the transfer of ESTs (together with other factors). Such findings do not provide enough of a basis to draw firm policy conclusions; more data is needed about how IP policies facilitate the practical assimilation and utilisation of the technologies that are being transferred.*

- *EST transfer, whether IP-based or based on more collaborative activities (such as joint ventures, strategic alliances, cross-border investments), in which IPR may have a secondary or complementary role, is increasingly attractive to different stakeholders in the field of ESTs. However, the majority of IP-related activities (in which IPRs play a direct or indirect role) take place among entities in developed countries, which are the major owners of IPR.*

- *Factors other than IPRs (macroeconomic, technological, and human) are also key to the successful assimilation and utilisation of ESTs. IP policies should therefore be linked to other national and international policies that address the transfer, absorption, and utilisation of ESTs.*

The "known-unknowns":

- *We need more data on the use of IP-related ESTs by entities based in developing countries.*

- *We need more survey data on the perspective of potential users in developing countries with regards to IP as a positive or negative platform for gaining access to ESTs.*

- *We need more data on the specific components (a so-called "drill down analysis") of technology transfer activities that involve the transfer of proprietary ESTs via IP-related deals. Ideally such data will allow us to learn about the extent to which different platforms and models associated with the transfer of ESTs (i.e. including collaborative activities such as mergers and acquisitions, joint ventures, etc.) contribute to the effectiveness of such transfers across different fields, to different developing countries.*

- *We need to further study the extent to which the transfer of ESTs contributes to innovation in developing countries.*

- *We need case studies (of both failure and success) in relation to the different types of ESTs transferred by IP owners based in developed countries, and the developing countries that have been able to absorb and utilise them.*

- *We need more data on the current situation in developing countries with regard to other complementary factors for successful technology transfer, including their capacity to absorb and utilise technologies.*

- *We need a better understanding of the macroeconomic incentive structures, including national innovation and technology transfer strategies, that can support a more effective framework of technology transfer in developing countries.*

The "unknown-unknowns":

- *Because international debate on climate change is to a large extent dependent on national debates on climate change, national political developments will have a strong* *influence on developing further mechanisms to encourage the transfer of ESTs.*

- *The effects of the global economic downturn are still being felt, and the political and economic fall-out of the biggest recession since World War II is still to be determined.*

- *The risk for political tension within countries and between countries is always present and has the potential to change the nature of technology transfer and the transfer of ESTs.*

- *The rapid development of technology itself and its effect on the environment can shape the manner in which we discuss the relationship between IPRs and ESTs at any given time.*

- *Unexpected natural events (such as floods, earthquakes, unusual weather patterns, or oil spills and nuclear plant accidents) could significantly affect the way in which we discuss or collectively address the global issues of climate change and the environment.*

- *Our growing understanding of climate change and environmental science will shape the manner in which we discuss and debate these issues, affecting at the same time discussions of IPRs and EST transfer.*

98. An extended discussion is also published as follows: Perez Putgatch, M., *When policy meets evidence: What's next for the discussion on intellectual property, technology transfer and the environment?* Global Challenges Brief, WIPO, Geneva (2011), www.wipo.int/globalchallenges

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