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Intellectual property rights and low carbon technology transfer: Conflicting discourses of diffusion and development

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ABSTRACT

Intellectual property rights (IPRs) and the transfer of low carbon technologies to developing countries have been the focus of sustained disagreement between many developed and developing country Parties to the United Nations Framework Convention on Climate Change (UNFCCC). We argue that this disagreement stems from two conflicting political discourses of economic *development* and low carbon technology *diffusion* which tend to underpin developing and developed countries' respective motivations for becoming party to the Convention. We illustrate the policy implications of these discourses by examining empirical evidence on IPRs and low carbon technology transfer and highlight how the two discourses are based on an incomplete understanding of the role of technological capacity in either economic development or technology diffusion. This has important implication for the success of post-2012 international climate agreements.

1. Introduction

Low carbon technology transfer to developing countries has a central role to play in mitigating[1] carbon emissions from future economic growth and is a key issue in the international climate negotiations under the United Nations Framework Convention on Climate Change (UNFCCC). Although it was nominally designed to facilitate low carbon technology transfer, the success of the Convention in achieving this (Feldman, 1992) has been widely questioned with many developing nations left feeling frustrated at the lack of progress that has been made in achieving technology transfer in practice[2] (Khor, 2008). Negotiations on the issue have become increasingly fraught, with clean technology nearly falling off the agenda in Bali 2007 due to disagreements between the United States (US) and G77/China.[3]

Some progress has been made since then, most recently at the Copenhagen Conference of the Parties (COP) to the UNFCCC. The final Copenhagen Accord (UNFCCC, 2010) is not binding, and it only has the status of a political declaration. However, it has support from both developing and developed countries, and includes new and specific commitments to significant financial assistance to developing countries for mitigation, adaptation and avoided deforestation. These include funding 'approaching $30bn for the period 2010–2012' (UNFCCC, 2010), and a commitment by developed countries to 'a goal of mobilizing jointly USD 100 billion dollars a year by 2020' (UNFCCC, 2010). It was also agreed that a Copenhagen Green Climate Fund would be established, with several aims including facilitating technology transfer.

Despite this continuing high profile of technology transfer within international negotiations, inadequate empirical evidence exists upon which to base policy. The different stages of development of low carbon technologies, from research and development (R&D) through to commercial diffusion, introduce new and unique barriers, opportunities and policy challenges which are not yet properly understood (Ockwell et al., 2008). These challenges are confounded by the need for urgent action if dangerous climate change is to be avoided (Stern, 2006; IPCC, 2007).

One issue in the area of low carbon technology transfer that has provoked particularly thorny debate between developed and developing countries, and which epitomises the lack of empirical evidence available to guide decision making, is the issue of intellectual property rights or IPRs. IPRs are legal rights over ideas,

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[1] Technology transfer also occurs in relation to adaptation technologies but the focus of this paper is on technologies for mitigation.

[2] It is important to note that a lack of effective technology transfer to the developing world (and particularly least developing countries) is not limited to low carbon technologies. See Foray 2008, cited in Oliva (2008, p. 3), which looks at technology transfer to least developed countries more broadly, within the context of the World Trade Organization (WTO).

[3] The Group of 77, established in 1964, as well as China, often referred to G77/China, is the name of the key bloc of developing nations within the UNFCCC process.

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creative processes and products. They include copyrights, trademarks, and patents—where holders can prevent the use of these technologies; thus patents are likely the most important type of IPRs within this context (Harvey, 2008, p. 5). There are essentially two sides to this debate. On one side commentators assert that low carbon technologies are public goods, contributing as they do to the mitigation of future carbon emissions, and that the IPRs to these technologies should therefore be bought up by an international fund and made freely available to developing countries, similar to agreements made over certain anti-retroviral drugs for treating HIV/AIDS. On the other side of the debate some argue that low carbon technology transfer will be better facilitated if developing countries tighten up their legal frameworks for IPR protection, and the enforcement thereof.

In the UN climate negotiations over the past two years, these polarities continued to surface as some developing countries including India and China asserted the need to address IP issues within the discussions on technology. By contrast, some developed countries, such as the United States, espoused the view that IP was a catalyst and not a barrier for technology transfer (Oliva, 2008, p. 4). In 2009, a major difference of view emerged at the Bonn intersessional negotiations of the UNFCCC, with the US again opposing developing country calls for IPR regimes to be relaxed or modified to promote access by their firms to low carbon technologies. The Copenhagen conference in December 2009 failed to resolve these differences—and the Copenhagen Accord does not specifically address IPR issues at all (UNFCCC, 2010; UNDP, 2010).

Some observers and Parties to the IPR debate are pinning their hopes on further empirical analysis providing a basis for guiding new policy responses or for supporting the maintenance of the status quo. As emphasised by a delegate at a seminar on IPRs and low carbon technology at Chatham House (2007): "Proposed changes to the existing [IPR] system must include significant evidence that a clear and identifiable need exists and that the change is the most appropriate way of addressing the need." In this paper, however, we argue that the debate on IPRs in the context of low carbon technology transfer is symptomatic of a broader divide between Parties to the international climate negotiations. We characterise these as two conflicting political discourses of technology development and technology diffusion. These conflicting discourses are based on different ideas of what technology transfer seeks to achieve and have significant implications for what policy measures are considered appropriate for encouraging technology transfer.

The discourses we refer to are evident in negotiations between industrializing and developing countries during UNFCCC Conferences of the Parties (COPs) and other related meetings such as technology transfer workshops and intersessional negotiation meetings. Our portrayal of them in this paper is based on our extensive engagement with negotiators at high level policy events. Through our own research over the past four years, we have also organized and participated in a number of focused workshops involving firms, government representatives and other stakeholders in developed and developing countries—all with a focus on low carbon technology transfer (see Section 4). It is, however, also possible to trace these discourses through analysis of written country positions on technology transfer to the UNFCCC secretariat or its subsidiary bodies, as demonstrated by Haum (2010).

In this paper we demonstrate how these conflicting discourses imply that the IPR issue, and low carbon technology transfer more generally, are likely to continue to represent a sticking point in the international negotiations. In fact, as we highlight at the end of this paper, the conflicting discourses that underpin the political stalemate on low carbon technology transfer are both based on an incomplete appreciation of processes of technological capacity development and technology diffusion. The paper goes on to show that post-2012 international climate agreements – whether or not they are based on the Copenhagen Accord – must recognise and reflection on the limitations of these discourses. It argues that they must also make substantive effort to implement policy that will, in practice, achieve the dual aims of development and diffusion.

This paper comprises five further sections. In Section 2 of the paper, we explain in more detail the two sides to the IPR debate before expanding in Section 3 on the two more general discourses of development and diffusion that characterise the political debate on low carbon technology. Section 4 then reviews the limited empirical evidence available to date on IPRs in relation to low carbon technology transfer. This is used to illustrate how the policy implications of this evidence can be interpreted very differently by policy makers according to whether they adhere to the discourse of development or the discourse of diffusion. In Section 5, there is a brief discussion that demonstrates the shortcomings of both the development and diffusion discourses and outlines a basis for reconciling the aims of both these political discourses under future climate agreements. Section 6 completes the paper with some key conclusions.

2. Two sides of the IPR debate

As mentioned above there are essentially two sides to the IPR debate in relation to low carbon technology transfer. Firstly, drawing on assumed parallels with the pharmaceutical industry and access to, for example, anti-retroviral drugs,[4] some observers claim that a lack of access to IPRs for new low carbon technologies is a key barrier to their transfer and deployment in developing countries. This argument sees low carbon technologies as public goods (due to their contributing to avoiding future carbon emissions) that should be freely available. Proponents of this argument highlight how IPRs can prohibit access to new technologies by, for example, enabling firms that own patented technologies to keep prices prohibitively high. They also observe how IPRs can reduce the scope for imitation which, in countries such as South Korea and Japan, and even the US, has been a key source of learning and technological change (UNCTAD-ICTSD, 2003, p. 85).

Such arguments have played out in the negotiations under the auspices of the UNFCCC where calls have been made for multilateral funds to be created to buy up IPRs for low carbon technologies and make them freely available to developing countries (see, for example, Third World Network, 2008). Critics of such a fund, however, highlight the fact that access to a patent is unlikely to prove sufficient to enable access to that technology. There is often a lot of undisclosed tacit knowledge associated with patents that is essential to understanding and working with new technologies (UNCTAD-ICTSD, 2003, p. 86). Nevertheless, patent ownership is strongly skewed towards the North (IPCC, 2000, p. 98) suggesting that, especially within the context of stronger IPR regulations under TRIPS,[5] it may become increasingly difficult for developing countries to access clean technologies with favourable terms.

[4] It should be noted that significant differences exist between pharmaceuticals where often a single patent determines its use and low carbon technologies where several patents often exist in relation to different components and technological developments (Harvey, 2008, p. 9). This has important implications for the proportion of IPR related costs across these different industries.

[5] TRIPS, the agreement on Trade Related Aspects of Intellectual Property Rights, aims to create uniform IPR protection across developed and developing countries. It is administered by the WTO and has brought IPRs into international trade negotiations for the first time. Developing countries were given longer to conform to the agreement than developed countries and least developed countries have until 2016 to conform.

The opposite end of the IPR debate revolves around a claim that a lack of IPR law or the enforcement thereof in developing countries is the main barrier to low carbon technology transfer. Further, IPRs are asserted to be central to innovation and encouraging the diffusion of technologies as patents force inventors to disclose their technology publicly (Harvey, 2008, p. 6). The argument is made that trans-national companies (TNCs) are unlikely to deploy cutting-edge technologies that they have spent significant resources developing in countries where they cannot ensure adequate patent protection. IPRs are seen as a catalyst rather than a barrier to the creation and deployment of low carbon technologies, providing the incentive needed for businesses to invest in risky ventures, giving legal clarity and certainty, and stopping others from blocking the use of a technology by follow-on derivative inventions (Harvey, 2008, p. 3). This argument is reflected in the TRIPS agreement, one of its stated rationales being that the protection and enforcement of IPRs will contribute to both increased FDI and the transfer and dissemination of technology (UNCTAD-ICTSD, 2003, p. 85).

Others see this as simple protectionism on behalf of powerful western economies. The US manufacturing sector in 1995, for example, had in excess of a $20 billion trade surplus on licence fees and royalties on industrial processes sold abroad (UNCTAD-ICTSD, 2003, p. 37), which could be seen as a strong political incentive for pushing for stricter patent enforcement in developing countries, particularly within rapidly expanding markets such as China and India. This kind of surplus is not, however, reflected in all developed countries. The UK had a small surplus in 1995 ($1.71 billion), whereas Japan and Germany both had deficits ($3.35 billion and $2.66 billion respectively). These were higher than those in many developing nations, e.g. India $68 million and Brazil $497 million (Patel and Pavitt, 1995 in UNCTAD-ICTSD, 2003, p. 37). This is, however, likely due to the fact that countries such as Germany and Japan rely more on exports to exploit their technological advantage, whereas the US and UK opt more for foreign direct investment (FDI) which involves more royalty payments. This raises important questions with regard to the overall benefits to developing countries of such trade relationships in the context of their access to, and technological capacity to work with, low carbon technologies—a point central to the development discourse described below.

It is our argument in this paper that political support for ideas such as creating a multilateral acquisition fund to buy up IPRs for low carbon technologies, or, at the opposite polarity, support for tightening IPR regimes *a la* TRIPS, or neither, depends on which of the two conflicting political discourses (described below) is being subscribed to. In the next section we describe the nature of these two discourses in more detail.

3. Conflicting discourses of diffusion and development

The conflicting political discourses (Ockwell and Rydin, 2006) of diffusion and development that characterise the policy debate on low carbon technology transfer within the UNFCCC arena have their roots in a historical north-south divide concerning the motivation for involvement in an international climate agreement (akin to international agreements on many other, non-climate related issues e.g. agriculture, trade, security). For developed nations the key motivating factor was recognition of a need for global action to mitigate carbon emissions so as to avoid the future costs of climate change (e.g. Stern, 2006). Developing countries, on the other hand, have a very different perspective. They are acutely aware of the fact that the majority of the current stock of atmospheric greenhouse gases, and hence the majority of associated warming over the next few decades, is a result of the economic activity of developed nations over the last two hundred years. On this basis they feel fully justified in pursuing a primary goal of economic development and poverty alleviation. Any involvement in an international climate agreement is tempered by the caveat that emissions reductions should not be pursued at the expense of such development. Furthermore, a north-south gap historically exists in terms of technology ownership (Missbach, 1999) and technological capacity, with developed countries having a clear technological advantage.

To some extent this north-south tension was resolved through the emergence of the discourse of sustainable development in the 1980s following the publication of the Bruntland report (World Commission on Environment and Development, 1987). This report also highlighted the fact that environmental problems in developing countries were at least in part a result of economic and technological deficiencies in the south. Recognition of a north-south economic/technological divide has, in the context of the UNFCCC, played out in the idea of common but differentiated responsibilities where developing nations are not subject to binding emissions targets. But not putting the brakes on economic development was not in itself a justification for developing country involvement in the UNFCCC. The main carrot came via the idea of "Activities Implemented Jointly", including Joint Implementation (JI) (Bush and Harvey, 1997; Kim, 2001) and the Clean Development Mechanism (CDM), and in particular the idea that developed countries would meet some of their emissions through the transfer of new, clean technologies to developing countries (Gupta, 1997; Grubb et al., 2001; Neumayer, 2002; Ravindranath and Sathaye, 2002, p. 253).

Individual country positions on how to implement technology transfer differ within the group of developing and the group of developed countries. For example, the European Union (EU) has a different official position than Australia. Similarly, the Chinese government position is different to those of some other developing countries. However, if country positions are analysed in detail, one finds strong similarities amongst developed countries and strong similarities amongst developing countries regarding the mechanisms suggested for the implementation of technology transfer. This often plays out in the UNFCCC negotiations in the form of negotiating texts supported by the G77/China being significantly different from those proposed by Annex I countries. These generic developed and developing country negotiating positions have remained relatively stable over time (Haum, 2010) and are were evident in the proposals from governments on technology transfer that were put forward in the lead up to COP15 in Copenhagen.[6]

3.1. Developing country discourses

Developing country governments understand that increased access to technology is one of the pre-requisites of industrialization, self-reliant development, and poverty alleviation. By becoming Parties to the UNFCCC, developing countries therefore saw an opportunity to access new, low carbon technology and thus contribute to reducing their technological dependency on the north (Roberts and Parks, 2007) and become technology producers and innovators in their own right. They recognise the role that new technologies and technological change within existing industries can play in improving competitive advantage through increased factor productivity and/or the development of new, competitive products (Murphy et al., 2004) and broadening the industrial base of a country via the establishment of new industry sectors with associated employment benefits, profits and public income

[6] See for example, the divergent views put forward at the Bonn intersessional UNFCCC meeting in August 2009 as reported in the Earth Negotiations Bulletin: http://www.iisd.ca/vol12/; and echoed in more informal presentations of country positions.

through taxes (Lall, 1998; Gereffi, 2001).[7] Access to new technology not only offers the possibility of moving up the value chain, it also provides opportunities to diversify into new products similar to the ones originally imported (Bell, 1997).

The negotiating positions of developing countries (represented by G77/China) on technology transfer focus on policy mechanisms that prioritise access to advanced technologies. Recent proposals have included funds for technology acquisition, obligatory licensing and funds for buying up IPRs relating to cutting-edge technologies and making them publicly available (e.g. Kogan, 2010). They also emphasise the importance of government intervention in the transfer process and argue that transfer should take place at non-market rates in order to overcome the higher costs associated with new, low carbon technologies. Mechanisms that support the domestic uptake of low carbon technology, which many consider as necessary to achieve emission reductions, like effective standards, the implementation of specific environmental policies, establishment of regulatory agencies, are much less prominent in developing country negotiating positions (e.g. UNFCCC, 1999, 2000, 2008a,b). This is not to say that developing countries disregard the role that domestic policy might play in encouraging uptake of low carbon technologies. Indeed, countries like India, China and Brazil have adopted important domestic policies—and put forward strengthened commitments in the run up to the Copenhagen negotiations (Stern and Taylor, 2010). Nevertheless, their main priority within their negotiating positions on technology transfer at the international level is access to new technology. Emission reduction at this level is therefore viewed as a function of technology access.

Developing countries' understanding of the role that technology transfer can play in their economic development has firm roots in the academic literature on the subject (see Fig. 1). Bell (1990) offers a useful starting point for understanding the various issues and processes that are at play here. 'Technology' first needs to be understood as both 'hardware' (physical equipment) and 'software' (knowledge and processes). Bell's model illustrates how three qualitatively different flows can be identified within the process of transferring technology from a technology owner or supplier to a technology recipient. Flow A comprises the capital goods and services needed to create the physical facilities of a new production system. Flow B refers to the skills and know-how needed to operate and maintain the newly installed production facility. Some of these skills might already exist in the host country, but usually, as Bell highlights, if transfer projects involve elements of flow A, at least some elements of the whole transfer process fall into category B. Flow C refers to the skills and knowledge necessary to generate technical change.

Although, as Bell points out, there is no sharp distinction between C- and B-type flows, C-type flows are significantly different from, and additional to, the knowledge needed to operate a production facility. Whilst flows A and B lead to the creation of new production capacities in the recipient country, C-type flows enable the additional benefit of augmenting technological capacity. This includes the capacity to adapt the technology to local, changing needs, to replicate it, enhance it and eventually create a new product. The development of new technological capacity is thus central to a firm, industry or country's ability to improve their competitive advantage and expand existing industries and the overall industrial base (Criscuolo and Narula, 2008). Hence the contribution of low carbon technology transfer to developing new technological capacity is a central concern for developing countries within the context of their economic development priority.

3.2. Developed country discourses

Developed nations approach the issue from a very different perspective. As highlighted above, developed nations' motivation for involvement in the UNFCCC is first and foremost the mitigation of greenhouse gas emissions. From this perspective, the primary objective of transferring low carbon technologies to developing countries is to achieve rapid and widespread *diffusion* of these technologies so as to reduce the emissions associated with future economic development in these countries. Developed countries' negotiating positions generally focus on policy mechanisms to diffuse low carbon technologies via, for example, establishing markets for these technologies, or providing market incentives to overcome higher costs (Haum, 2010). For example, the provision of carbon credits under the Clean Development Mechanism (CDM) for investment in new technology based infrastructure in developing countries is widely cited as a vehicle for achieving technology transfer. However, despite this aim being mentioned in the Marrakesh Accords, the CDM was not originally designed for such a purpose. Furthermore, there is a lack of evidence that the intentions of many CDM projects to transfer technologies have been realised through improved low carbon capabilities in developing country firms.[8] Developed countries also tend to favour encouraging developing countries to implement domestic policies like feed-in-tariffs to support renewable energy technology diffusion rather than contributions to international funds for technology acquisition.

From the perspective of the developed country discourse then, private companies' responses to market based mechanisms or regulation driven demand for low carbon technologies tend to form the primary vehicle for achieving technology transfer. Government interventions in the form of mechanisms that directly support access to technology in the form of international and intergovernmental funds (as preferred by developing countries) are rarely proposed and tend to have a very limited role (e.g. UNFCCC, 1999, 2000, 2008a,b). One potential exception is the recent decision by some developed countries to set up new time-limited funds administered by the World Bank (the Climate Investment Funds) which offer concessional loans for low carbon technology deployment. However, as with other international financial mechanisms such as the CDM and the Global Environmental Facility, careful analysis is required to determine whether these funds will deliver comprehensive technology transfer as characterised by Fig. 1.

Therefore, for developed countries, the impact of the diffusion of low carbon technologies on technological capacity and economic development in developing countries is not a priority. In fact, despite the political rhetoric on poverty alleviation, many developed countries, and many leading low carbon technology firms with substantial roots in those countries, have a vested interest in maintaining completive advantage over developing countries.[9] This kind of political consideration is influential on the

[7] Our analysis of country positions on technology transfer within UNFCCC negotiations makes no assumption about the economic benefits (or lack of them) from the domestic development of particular low carbon technologies by particular developing countries. In practice, developing countries will face 'make or buy' decisions with regard to low carbon technologies. Whilst it may be economically beneficial to produce a certain low carbon technology in developing country 'A' it might not be the same in developing country 'B'. We are therefore observing that developing countries usually adopt a common negotiating position that is rooted in the established literature on industrial development.

[8] Much of the literature on the CDM and technology transfer analyses intentions of CDM project developers but not technology transfer outcomes. See for example de Coninck et al. (2007).

[9] These positions generally relate to political negotiators within the UNFCCC arena. Business perspectives might be considerably different. National discourses on the subject are also often more complex than the negotiating positions that play out during the international climate negotiations. Although we are fully aware of reciprocal effects of these discourses, we focus on the generalised discourses summarised above in order to highlight how differences in perspectives between North and South under the UNFCCC negotiations obstruct a more constructive international solution to achieving low carbon growth in developing countries.

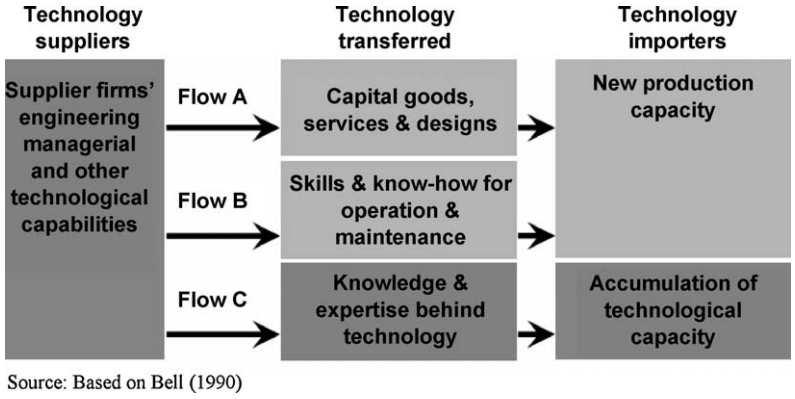

Fig. 1. The technological content of international technology transfer.*Source*: Based on Bell (1990).

negotiating positions of several powerful developed nations, most notably the United States. Whilst it is still possible for such nations to support low carbon technology deployment in developing countries, they are not likely to be particularly supportive of international agreements that directly contribute to significant 'catching up' by potential competitor firms in developing countries.

The divide between the discourses of development and diffusion is central to the lack of agreement between developed and developing countries within the negotiations on low carbon technology transfer under the UNFCCC. As Forsyth (1999, p. 60) puts it: "Technology transfer has become a symbol of the long-standing resentments between North and South ...". In the next two sections we demonstrate how this plays out in the debate on how policy ought to deal with the issue of IPRs in relation to low carbon technology transfer. We begin by reviewing the empirical evidence available to date on IPRs and low carbon technology transfer before examining this evidence with respect to the two contrasting discourses.

4. IPRs and low carbon technology transfer: empirical evidence

Empirical evidence available to date on IPRs in the context of low carbon technology transfer is limited. Nevertheless, there have been a number of recent pieces of research on this issue. These include four pieces of research based on case studies and three more general studies. The first, by Barton (2007), tackles it via a case study based review of the markets for three renewable technologies (solar PV, wind and biofuels). The second, by Lewis (2007), presents an in-depth analysis of the wind power industry in China and India and is drawn on extensively in Barton's analysis. In the third, Harvey (2008) addresses this issue by examining IPRs more generally amongst developing countries, homing in on the potential role of China and international institutions, such as the World Trade Organization (WTO). The International Centre for Trade and Sustainable Development (ICTSD) has carried out two studies that examine the role of intellectual property for climate technologies. The first document (ICTSD, 2008, Ch. 4), entitled "Climate Change and Trade on the Road to Copenhagen" dedicates a chapter to the potential role of IPRs. The second (Oliva, 2008), "Climate Change, Technology Transfer and Intellectual Property Rights", provides an overview of the issues, drawing from evidence from studies of technology (not necessarily low carbon) transfer to developing countries and discusses how IP might be dealt with under the UNFCCC process.

Our own empirical research has been conducted in parallel with these studies. Two phases of case study-based research were conducted by us in partnership with researchers from the Institute of Development Studies (IDS) of the University of Sussex in the UK, The Energy and Resources Institute (TERI) in India, and Margaree Consultants in Canada. The first study (Ockwell et al., 2006, 2008) used technology case studies in India to look more generally at low carbon technology transfer and was able to make some tentative insights on IPRs. But it did not have enough of an explicit IPR focus to be able to explore these in any depth. The case studies analysed by Ockwell et al. were integrated gasification combined cycle (IGCC) technology for coal-fired power generation, LED lighting, hybrid vehicles, biomass generation and improving the combustion efficiency of existing power stations. The second study (Mallett et al., 2009) focused explicitly on IPRs. Again the research was case study based and examined five case studies from India—hybrid vehicles, solar photovoltaics (PV), energy efficient technologies in small and medium-sized enterprises (SMEs), wind energy and integrated gasification combined cycle (IGCC) for power generation. The emphasis throughout the study was on a consultative approach that engaged directly with industry, government and researchers, both to yield grounded empirical insights and to raise awareness of the study amongst potential end users. Across the two studies over 300 people were consulted. The majority of informants were based in India. However, where possible, discussions were also held with stakeholders from the industrialized world.

Data collection focused on both primary and secondary sources, including face to face interviews, discussions through research team presentations and workshops, and desk based analysis of academic and non-academic literature. Semi-structured face to face and phone interviews with key players in the low carbon energy sector were undertaken in the periods June to November 2006, October to November 2008 and January to February 2009. These included over 60 interviews with specialists in specific case study technologies. Interviewees were asked questions regarding the present status of technology development in their organization and future plans, issues and apprehensions related to intellectual property rights (IPRs), perceived risks and constraints, collaborative RDD&D initiatives, and government engagement with their sector. Presentations and workshops that were used to gather empirical evidence included a scoping workshop for industry representatives and academic researchers in New Delhi in September 2006, a further project workshop in November 2008 with industry, government and academic representatives and four separate side events at UNFCCC COPs and intersessional meetings. The analysis set out below summarises our findings regarding the role of IPRs in low carbon technology transfer based on our own research as well as the other aforementioned studies. As will become clear, one important caveat to these findings is that most of the evidence relates to the two largest developing countries: India and China.

4.1. Access to low carbon technologies

Whilst these studies are inconclusive on the overall impact of IPR regimes on technology transfer (e.g. Oliva, 2008), almost all found that developing country firms had access to the technologies they examined. That being said, in the Indian case studies analysed by Mallett et al. (2009), many Indian firms felt that IP was slowing down the rate at which they could become producers of these technologies as they spent time acquiring the necessary financial resources, skilled personnel and appropriate partners. Smaller firms often found it more difficult to access newer 'cutting edge' vintages of particular low carbon technologies. Moreover, companies indicated that IP barriers may play more of a role in the future as Indian firms move increasingly towards these newer vintages (for example, thin film technology for solar PV). In addition, they may also be more important as these technologies increasingly rely on integrating technologies from different areas (such as chemistry and electronics in the case of hybrid vehicles).

Harvey's study also affirms this general conclusion on access to low carbon technologies. He asserts that companies often do not bother filing for patents in Least Developed Countries (LDCs), as they focus their patenting efforts on more substantial markets. He also argues that companies are willing to sell products at a lower price in developing countries if there is no concern about leakage, or that these lower cost products might be re-exported back to their 'home' markets. Thus, many of those interested in using low carbon technologies in developing countries can do so (Harvey, 2008). He suggests a series of options in those instances where IPRs may be hindering access to low carbon technologies in LDCs. These options include licensing at zero cost or on favourable terms and/or government subsidizing the cost of using a patented technology. Like Harvey, Oliva (2008) proposes the use of existing tools to assist technology transfer in the climate regime in cases where IPRs may have a negative effect. However, these suggestions are different and include exemptions to patentability, patent rights, or compulsory licensing.

It is important to note that publicly funded intervention to help developing country firms acquire technology licenses has been tried before in the low carbon field. One example is the Global Environmental Facility's efficient boiler project for China. This was a difficult and much-delayed project which arguably had some success in subsidizing licenses to Chinese firms—but only from 'second tier' international suppliers (Birner and Martinot, 2005). It also demonstrated how difficult it can be to offer terms that are attractive to leading international firms.

Barton and Lewis' analysis demonstrates how access to wind technologies in India and China has been facilitated via the acquisition of licenses from developed country firms and, in the case of India, also by strategic acquisition of developed country firms. In the case of solar PV, China has pursued a strong policy of indigenous technology development. For biofuels, Barton notes significant indigenous ethanol industries in China, India, Pakistan, Japan, Thailand and Malaysia as well as the notable success of Brazil in this sector.

These findings are similar to those in our own studies where Indian firms have been applying various strategies to acquire technologies. These strategies include purchasing technology licenses from foreign or domestic first or second-tier firms (e.g. Mahindra and Mahindra had purchased technology from Siemens and Bosch to turn their concept hybrid car into a demonstration vehicle). They also include collaborating with developed country firms (e.g. Moser Baer PV Ltd. gained "significant equity"[10] in a number of American firms including Solaria and Stion Corporation, involved in frontier PV technology), and acquiring developed country firms (e.g. Tata Motors' acquisition of the Norwegian electric vehicle company Miljo Grenland/Innovasjon). Finally, they include conducting in-house research (sometimes through acquiring personnel having worked abroad, e.g. Mahindra and Mahindra and Tata Motors had technical experts who had worked at Ford and studied at the University of Minnesota respectively).

Importantly, developing country firms were generally not observed to have access to the most recent 'cutting edge' variants or vintages of the particular low carbon technologies that were examined (see below). One exception is a Chinese firm, Sichuan FAW, that has gained access to Toyota's cutting edge hybrid vehicle technology via a joint venture arrangement. The extent to which they have access to the key underlying knowledge is, however, questionable as Toyota currently manufactures its Hybrid Synergydrive drivetrains in Japan and ships them to China for assembly (Ockwell et al., 2006, 2008).

Barton (2007) makes an important contribution in his analysis by highlighting the role that industry structure plays in determining access to new technologies. He argues that at least two of the renewable technologies that he studies (wind and solar PV) have a moderately concentrated market, dominated by a limited number of large players. Nevertheless, these industries are loosely enough structured to allow for new entrants, and future market opportunities in developing countries are likely to incentivise technology diffusion. Barton also highlights the relevance of the economics of access to these technologies. Because there is sufficient international competition in wind for example, getting a license is not prohibitively expensive for some developing country firms.

These findings concur with our own findings in the areas of solar PV and wind technology. In the case of IGCC however, as there are very few suppliers worldwide for this technology, thereby tending to make barriers to entry by developing country firms higher—and licenses more expensive and difficult to obtain. In general, it is important to recognise however that a key reason why conventional, high carbon technologies are often more attractive than advanced, low carbon technologies is that conventional technologies tend to be cheaper. How much of the additional cost of low carbon technologies is related to the costs of obtaining IP is unclear. However, in many instances it is unlikely to be significant enough that if the IP costs were reduced to zero through subsidies, low carbon technologies would become financially competitive. An IGCC plant, for example, might be 30% more expensive than a supercritical conventional coal-fired power plant, but only a small proportion of that cost is likely to be associated with IP. In addition to licensing fees, these higher costs are also traced to the fact that IGCC is particularly capital intensive, and as it is a technology that is still moving from demonstration to commercialisation it possesses many 'first of a kind' costs generally associated with newer technologies.

4.2. Access to the cutting edge

Despite the overall optimistic tone of Barton's analysis, it is notable that for all of the case studies he examines, uncertainty is expressed as to the likelihood of developing country firms gaining access to the most advanced versions of these technologies. Companies owning patents to new thin film solar PV technologies and new enzymes being developed for biofuel production may be hesitant to make these available to developing country firms, and the industries are concentrated enough that developed country firms could price developing country firms out of the market. Khor (2008) also suggests – using experiences from the Montreal Protocol – that access to cutting-edge technologies by developing countries is limited.

[10] It is not clear if this amount constituted majority ownership (i.e. acquisition versus partnerships).

To some extent Suzlon, India's most successful wind technology manufacturer with the fifth biggest share of the global market, has overcome these issues by buying majority shares in developed country firms in order to gain access to cutting-edge technologies such as variable speed turbines. Having said this, Barton identifies wind as the riskiest area in terms of access to future cutting-edge technologies and markets for these. He cites the case of the US where GE has successfully used litigation over patent infringement to block foreign access to the market.

This point is reinforced by Lewis who explains how Suzlon and China's leading wind technology manufacturer, Goldwind, acquired access to wind technology by licence purchases from second tier developed country firms. This, she argues, was due to the disincentive for leading companies to license to potential developing country competitors; a concern accentuated by the cheaper labour and materials available in developing countries. As in the GEF project to subsidize licences to Chinese boiler companies (see above), the only international companies willing to sell licenses are therefore smaller companies with less to lose in terms of competition and more to gain in license fees. Lewis notes, however, that this does not necessarily imply technological inferiority compared to larger companies, but the fact that the technology has been used less implies less operational experience and hence less opportunity to perfect and prove the technologies.

Another issue for developing country firms highlighted by Barton is that, even where they are not working at the cutting edge, access to finance for new technologies could be an issue. Venture capital funds tend to favour new start ups with strong proprietary positions with regard to patented new technologies.

Similar issues in terms of access to the know how behind cutting-edge technologies were also raised by Indian firms in relation to wind, solar PV, hybrid vehicles, IGCC and LED lighting in our studies (Ockwell et al., 2006, 2008; Mallett et al., 2009). We also observed that differences both *between* and *within* the case studies occurred regarding access to frontier technologies. For example, in solar PV, some companies such as Tata BP solar were focusing on silicon-based technologies in the near to medium term due to the amount of investment already made in this area. Others, however, such as Moser Baer were focusing on thin film solar PV technology. The bulk of more recent advances within PV, such as Organic PV and Building Integrated PV (BIPV) were mainly being undertaken in India by universities and research institutes. At the time of study (2006) Indian LED manufacturers were also not yet working with white LED lighting, which are at the cutting edge of LED technology, although their Chinese counterparts were.

5. Policy implications: looking through the lenses of development and diffusion

The analysis above suggests two things. Firstly, IPRs do not seem to prohibit access *per se* by developing country firms to the low carbon technologies that the studies examined. This is particularly the case in rapidly developing countries such as India and China. Secondly, although IPRs might not prohibit access to these technologies, they do seem to play a part in prohibiting access to variants of these technologies at the cutting edge. In this section we examine the policy implications of these two observations through the lens of the two alternative discourses of development and diffusion outlined above.

From the perspective of the diffusion discourse, the fact that IPRs do not seem to be prohibitive to developing country firms accessing these low carbon technologies suggests that no specific IPR-oriented policy intervention is needed. Current market arrangements in relation to IPRs seem adequate to allow the diffusion of these technologies as long as additional policies are in place to overcome broader economic barriers. As Lewis (p. 22) puts it, "It took China and India less than ten years to go from having companies with no wind turbine manufacturing experience to companies capable of manufacturing complete wind turbine systems, with almost all components produced locally. This was done within the constraints of national and international intellectual property law, and primarily through the acquisition of technology licenses or via the purchasing of smaller wind technology companies." At the same time, it does call into question the necessity of the TRIPS approach of tightening up IPR regimes in developing countries. If international firms are already making clean technologies available under current IPR arrangements then diffusion is being achieved under the status quo—at least in some developing countries.

There does, however, seem to be some variability in terms of the level of diffusion of the different technologies that have been studied. Wind, for example, seems to be a particular success story, especially in China and India. In the case of other technologies such as IGCC and hybrid vehicles it remains to be seen how well these technologies might diffuse through developing country, or for that matter developed country, economies. Without further empirical work in these and other technologies it is impossible to say whether IPRs form a barrier for low carbon technologies across the board. This is especially problematic as the studies reviewed above are sectorally limited mostly to power generation technologies (the exception being hybrid vehicles and LED lighting). It is reasonable to assume that other types of technology, such as transmission and end-use technologies might encounter different issues due to different market structures, different recipient country capacities, and so on. Nevertheless, the evidence reviewed above does suggest that IPRs are unlikely to be the only barrier to diffusion. Other issues, such as capacity of recipient firms to work with such technologies (Ockwell et al., 2006, 2008), often referred to as their absorptive capacity (a concept we cover in more detail below), or cost of new technologies (Lewis, 2007), will play an equally important role in facilitating access.

As well as simply providing access to low carbon technologies, the diffusion discourse is also concerned with making sure these technologies diffuse throughout developing economies and that this diffusion occurs as rapidly as possible in order to respond to the urgency of climate change. From this perspective, then, policy interventions to encourage wide and rapid diffusion may be necessary, but on the basis of the evidence reviewed above, IPRs are unlikely to be a focal point of such interventions. The main concern here is not with providing access to the cutting edge of these technologies. Rather it is to put in place policy frameworks to make technologies with lower carbon emissions more attractive so as to achieve maximum possible emissions reductions as rapidly as possible.

If, on the other hand, we move to the opposite polarity and look through the lens of the development discourse, then some important questions arise as to the adequacy of current market arrangements for dealing with IPRs. As highlighted above, the development discourse focuses on strengthening technological capacity within developing economies. A central plank of this relies on access to the knowledge that underpins cutting-edge technological developments, and exposure to the tacit knowledge that contributes to absorptive capacity for these technologies. This raises concerns as to the extent to which proprietary ownership of IPRs might reduce developing country firms' access to the knowledge necessary for sustained, low carbon technological capacity building. This is not the same as arguing that access to IPRs *per se* will facilitate such capacity building. Rather, it is to argue that access to IPRs may play an important role in enabling developing country firms to understand and work with/imitate the knowledge that underlies new low carbon technologies. This is a particularly relevant concern in the context of strengthened IPR

regimes under the TRIPS agreement which could limit the scope for developing countries to develop capacity through processes of innovation based on imitation. In the past, this strategy has been a central part of 'catching up strategies' for some developing country industries and firms. For example, Hyundai used this strategic approach to accessing knowledge (Kim, 1998).

This issue is recognised by Lewis who highlights that countries are likely to pursue different strategies for obtaining low carbon technologies depending on the country's level of development. If the desire is to access advanced foreign technology without assimilating that technology into the local manufacturing base, IPR issues are likely to be less substantial as foreign companies can continue to sell that technology without the risk of local competition. If, however, the desire on behalf of the developing country is to assimilate new technologies and hence increase technological capacity, then developed country firms are more likely to use IPRs to prohibit access. Tebar Less and McMillan (2005) also note that strong IPRs provide incentives for companies mainly from industrialized countries, and so more research and analysis is needed to determine the benefits of strong IPRs to developing countries.

Barton (2007) seems to recognise a similar concern in his conclusions. In relation to the development of cutting-edge technologies, Barton highlights a potential future need for developed country governments to avoid the levels of national favouritism for patents developed by public funding that have traditionally characterised the development of renewable technologies. He draws parallels with humanitarian licenses that have been granted in relation to agricultural and pharmaceutical technologies in the past. Barton also stresses the need to consider the subsidization of research and development activities in developing countries. In a paper on the global scientific and technological commons, Barton (2008) goes even further to argue that it would be globally beneficial to establish a WTO style international treaty that attempted to remove barriers to the access of scientific and technological knowledge.

6. Shortcomings of the political discourses

The previous section demonstrates how the political discourses of diffusion and development can lead to conflicting policy positions in relation to IPRs—and in relation to technology transfer and diffusion. However, both these political discourses are based on an incomplete understanding of the processes that contribute to achieving technological capacity development and technology diffusion.

The development discourse fails to recognise that there are a wide range of other processes that contribute to technological capacity development, above and beyond simple access to Bell's Flow C (the knowledge that underlies a new technology) as shown in Fig. 1. In order for this knowledge to contribute to technological capacity, recipient firms first need to possess certain competences that will enable them to work with particular technologies (Hammond and Stapleton, 2001). Or, in other words, they need to possess sufficient absorptive capacity to work with the technology in question. This is influenced by a wide range of factors, such as tacit knowledge, the internal organization of the firm, interactions via inter-firm linkages, supply chains and networks, past learning efforts, investments in human capital and 'learning by doing', market structure and competitive pressure, government interventions to correct the failure of markets for knowledge (education, R&D training), government led institutional arrangements to facilitate innovation (R&D labs, technology intermediaries), and finally access to finance (Bell and Pavitt, 1993). Without any of this, providing access to the IPRs for a new, low carbon technology would be a bit like giving a plumber access to the blueprints for a fighter plane—it is highly unlikely that the plumber would be able to successfully build the plane.

A further important shortcoming of the development discourse is that it sometimes neglects or downplays the importance of market creation. New low carbon technologies will only diffuse and have an impact on both emissions and industrial development if they are deployed in significant numbers. Policy incentives are required within developing countries so that customers – whether they are householders or electric utilities – have a clear incentive to invest in these technologies. Furthermore, deployment of low carbon technologies has a key role to play in the innovation process, in facilitating learning by doing and processes of continual improvement.

Similarly, whilst the development discourse sometimes ignores these factors, the diffusion discourse also ignores the vital role that technological change plays in achieving diffusion. The diffusion discourse implies that learning to use or apply a technology is a sufficient condition for its diffusion. But complex technologies often do not diffuse in a new environment unless they are adapted to local conditions. Going further than this, diffusion may also involve the ability to replicate a technology, enhance it and eventually create a new product through 'learning by doing' (Bell and Pavitt, 1993). The diffusion of complex technologies like more efficient coal power technology, for example, seems crucially to depend on a high level of technology transfer and related in-depth knowledge flows (Orshita and Ortolano, 2002; Watson, 2002).

Thus, a level of assimilation of a technology at a level higher than just the operational level (acquisition of designs, equipment, operational know-how) is often a necessary condition for diffusion (Bell and Pavitt, 1993; Mukoyama, 2006). Assimilation via replication (acquiring skills to replicate technology), adaptive assimilation (acquiring or developing skills for adaptation/incremental improvement), and innovative assimilation (developing and acquiring capabilities for substantial development) all play an important role in ensuring the diffusion of a technology throughout an economy (Bell, 1997). On this basis it becomes clear that the development of technological capacity in developing countries can play an important role in contributing to technology diffusion—and not just to the economic development of recipient countries.

On the face of it, the weaknesses of the two political discourses outlined above suggest that they may, in fact, have more in common than may be apparent from some political statements. Technological capacity development is central to technology diffusion, particularly in the long term, thus contributing to the goals of both discourses. And access to IPRs in isolation from other key factors, such as tacit knowledge and national networks of innovation, is unlikely to result in technological capacity development, thus lending some support to those commentators who refute the value of funds for buying up IPRs for low carbon technologies. Nevertheless, these commonalities are based on an in-depth understanding of complex processes that are difficult to study and do not provide easy, one-policy-fits-all solutions (Ockwell et al., 2008). They are therefore in tension with the need for international negotiation processes to come up with clear generic agreements. More than that, these commonalities do not overcome some of the more political concerns about technology transfer due to the interests of national firms and industries and the influence of technology transfer on a nation's relative competitive advantage. These concerns can only be overcome to some extent if the potential rewards of technology transfer (e.g. in terms of market access) are worth the risks.

7. Conclusion

The two discourses of development and diffusion described in this paper go to the very heart of the negotiating positions of

different Parties to the UNFCCC. By looking in detail at the evidence available on IPRs and low carbon technology transfer it is clear to see how these competing discourses can imply very different policy options. From the perspective of the diffusion discourse, the evidence implies that little policy action is required in the area of IPRs. The development discourse, on the other hand, implies a very different take on things. From this perspective, the fact that proprietary IPR for low carbon technologies seems to have prevented access to the cutting edge is of central concern if sustained low carbon technological development is to be achieved.

The IPR debate is perhaps the thorniest issue within the current international negotiations on low carbon technology transfer and represents a central dividing point between many developed and developing countries. But even without the IPR issue, low carbon technology transfer *per se* remains as one of the most difficult issues in the UNFCCC negotiations. By clarifying political discourses of development and diffusion this paper goes some way to demonstrating one of the central underlying reasons for such contested positions within the negotiations.

One conclusion from this might be that a positive post-2012 agreement on technology transfer relies on both developed and developing countries taking time to reflect on their positioning with respect to the two discourses—and the emerging empirical evidence that supports a more nuanced, complex postition in which the discourses have some common ground. To a large extent then, reconciling differences between the Parties might be helped by a better understanding of the full extent of the processes that underpin technological capacity development and the related role of this in facilitating technology diffusion. It will, however, also rely on some level of compromise by all nations. This applies whether they are developed nations that are most concerned with maintaining the competitiveness of their incumbent firms and industries. It also applies to developing countries who have an over ambitious wish to develop significant indigenous expertise in all low carbon technologies.

Whilst there has been some progress on issues of technology transfer since the near failure of the technology negotiations during the Bali COP in 2007, the more recent Copenhagen Accord is at best unfinished business. Although the Accord agreed by many Parties in December 2009 represents a step forward, it remains to be seen whether the specific commitments to climate finance it contains can be a basis for resolving these historic tensions. Without a process of reflection on these tensions by all Parties, and significant effort to reconcile the very different needs of developed and developing countries, it will be difficult to overcome the fundamental impasse that has plagued the UNFCCC since its inception in 1992.

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