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RIS Discussion Papers

Climate Change, Technology Transfer and Intellectual Property Rights

K.Ravi Srinivas

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Climate Change, Technology Transfer and Intellectual Property Rights

K.Ravi Srinivas

Abstract: Technology development and transfer has been identified as a key element in the Bali Action Plan. In the negotiations on a global climate treaty the developing nations have put forth ideas and plans to ensure that intellectual property rights (IPRs) do not become a barrier to transfer of climate friendly technology. In this discussion paper, this question of technology transfer, intellectual property rights is addressed in the context of climate change. Patent statistics shows the dominance of developed countries in specific technologies. The analysis on specific technologies indicates that IPRs is an important issue in development and transfer of technology and it is a barrier. Data indicates that although developing countries have made some progress, the dominance of developed countries in terms of patents, royalty and licensing income and expenditure on Research and Development remains as before. The historical experience is that stronger IPRs do not always result in more technology transfer and technology absorption. Hence the argument that developing countries should provide stronger protection of IPRs to encourage technology transfer has to be challenged. The technology transfer under UNFCCC and Kyoto Protocol has been minimal and insufficient to meet the needs of developing countries. The harmonization of IPRs through TRIPS has limited the options of countries to use compulsory licensing and competition policy. TRIPS has not facilitated technology transfer, particularly to Least Developed Countries (LDCs) and the North-South divide on this issue has resulted in a stalemate. Under these circumstances it is futile to expect that TRIPS alone will result in more transfer of climate-friendly technologies. Using Common But Differentiated Responsibility principle in technology development and transfer is desirable. Many proposals and suggestions have been made to stimulate technology development and transfer. Montreal Protocol is a successful example that is relevant in the context of climate change. The proposals including the proposals made by developing countries deserve a serious consideration and innovative solutions have to be found. Humanity does not has the luxury of finding solutions over a century to solve problems created by global climate change. Developing countries need both development and access to technologies that will facilitate the transition to less carbon intensive economy within the next two or three decades. So it is essential that IP issues do not become a barrier in this transition. The challenge of climate change calls for out of the box thinking to find solutions that can make a difference. The IPR issues in technology transfer need to be tackled by a combination of policy measures, incentives and bringing in changes at the global IP regime under TRIPS.

1. Introduction

Climate-friendly technologies cover technologies in many fields and this term is used in the literature in a broad sense. There is no agreed definition on climate-friendly technologies. What is a climate-friendly technology also depends on the context of use and the state of technology. Climate-friendly technologies can be considered as part of Environmentally Sound Technologies (ESTs). In this paper we do not distinguish between climate-friendly technologies on the basis of their usefulness in mitigation and adaptation to climate change. The term ESTs covers a broad range of technologies and there is no universally agreed definition in the literature.[1]

There is no universally accepted method to assess whether a technology is really climate friendly or not. In general technologies that result in reduction of greenhouse gases' emissions and technologies that increase the energy efficiency can be considered as climate friendly technologies. Examples will include, advanced and cleaner fossil-fuel technologies (carbon capture and storage, cleaner coal technologies such as Integrated Gasification Combined Cycle (IGCC) and pre-combustion technology, combined heat and power) and, hydrogen cells and hybrid vehicles. In many technologies while first generation technologies are well established the subsequent ones are in pipeline or in various stages of R&D. The role of technology has been well recognized in the multilateral instruments on climate changes and both UNFCCC [Article 4.1 (c)] and Kyoto Protocol [Article 10 (c)] specifically mention about development, application and diffusion of ESTs relevant to climate change, including the know-how, practices and processes. The Bali Action Plan of 2007 has identified enhanced action on technology development and transfer as a key element of the Action Plan. The role of Intellectual Property Rights (IPRs) in development and transfer of technologies in the context of climate-change has attracted much attention in the recent literature and debates on climate change, including the Stern Report and the documents from UN.[2] This discussion paper can be considered as a contribution from RIS to the debate, paying attention to the demands and needs of developing countries and as a continuation on the research work done at RIS on technology development and transfer issues as evident in various publications including working papers. [3]

Patent Statistics and Technologies

Patents and trade secrets are the two most important models of intellectual property right protection in climate-friendly technologies. The relationship between innovations, intellectual property rights (IPRs), a particularly patenting is controversial and there are strong views on both sides of the debate. [4] The standard argument is patent system is capable of providing substantial benefit for the environment, as it produces environmental good through incentives for commercialization of technologies *ex-ante*.[5]

The role of IPRs in climate-friendly technologies varies from technology sector to technology sector. Basic technologies in production and distribution and transmission of energy and basic technologies in transportation are mostly in public domain. One technology can be covered by more than one patent and the technology described in one patent might be applicable in more than one technology sector. Firms apply for many patents so that patents can be used for strategic advantage. Thus they tend to apply for many patents around a technology so that inventing around is difficult and a patent thicket can be built around that technology. Measuring innovation through number of patents is difficult and is fraught with methodological limitations. Another problem is that many patents may not be commercialized for many reasons.

Whether it is conventional climate-friendly technology or renewable technology extensive technology mapping through the study of patents and use of patents in applying technology is not yet done.[6] The number of patents applied and number of patents granted in each sector can give a rough idea and as there is a time lag between applying of patents and the final decision to grant or reject, figures have to be understood with caution. Countries do not adopt uniform standards in assessing patents in terms of non-obviousness, utility and novelty for grant of patents.[7]

As a result measuring innovation through patents is an exercise that is subject to many limitations. Still mapping patent landscape and analysis of ownership and using patent as a guide to assess trends in technology is important as it helps in understanding the dynamics in technology and the state of the art. Thus, although patent statistics and studies based on analysis of patents and can only be taken as a crude indicators of innovation in

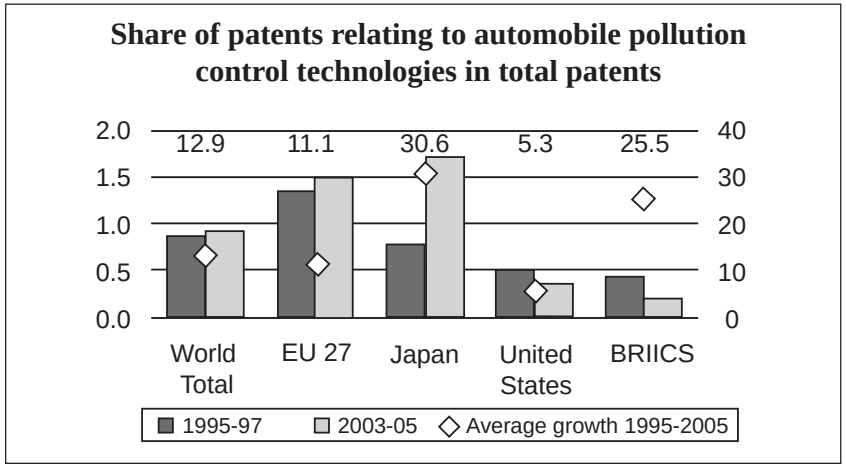
different sector they are important. They help us in understanding the dynamics of invention and concentration in terms of geography and spatial dimension of the innovation.[8] Although patent statistics is available from many national and international agencies there are theoretical and methodological issues in deriving meaningful conclusions from them. As there is no separate classification for climate-friendly technology is U.S. Patent and Trademark Office or in any of the major patent offices, studies using different assumptions and methodologies have been done. [9] Still the studies indicate that patenting activity is not even in all technologies and most of the innovation is concentrated in few countries.

A study using the PATSTAT database in 13 climate-related technology related classes between 25 years i.e. 1978-2003 concludes "Innovation in climate change technologies appears to be highly concentrated in a limited set of countries, mostly in Japan, Germany and the USA. The performance of Japan is particularly impressive as it ranks first in 12 technology fields out of 13. It even accounts for more than half of worldwide innovation in the areas of methane destruction, waste and lighting. The contribution of emerging economies is not negligible as they globally represent about 16 per cent of inventions. But this mostly concerns three countries (China, South Korea and Russia), mainly in climate-friendly cement and in renewable energies (ocean, hydro, geothermal and solar). Interestingly, a law of comparative advantage seems to operate, as the more geographically concentrated the innovation, the higher the number of inventions. Specialization gains are seemingly important in climate change innovation.[10]"

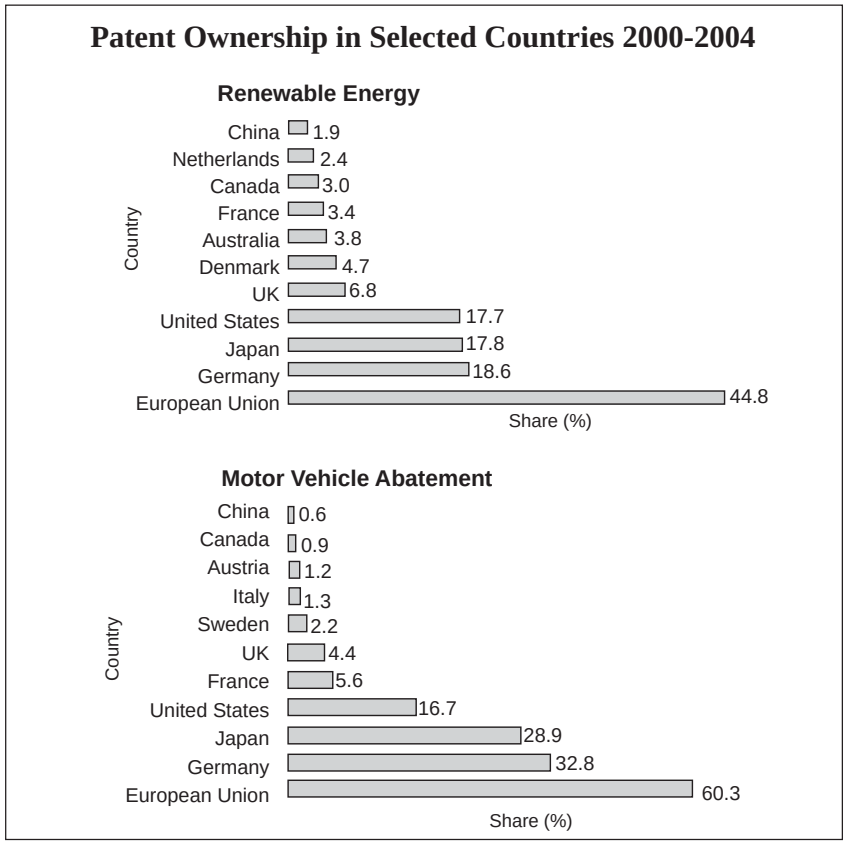
According to a study done by Prof. Dora Marinova based on the data from U.S. PTO the relative share of environmental technologies has declined from 2.5 per cent in 1977 to 1.5 per cent in 2003 although in terms of numbers there is an increase from 500 in 1977 to more than 3500 in 2003. Similar trends are found in patents on anti-pollution and renewable energy.[11] According to *World Patent Report 2007* published by WIPO the number of patents filed in environmental technology has decreased over the years.[12] Examining US PTO data and Patent Co-operation Treaty Data from 1998 to 2007 Miller et. al. conclude that number of patents filed in cleantech industry is increasing and is likely to increase in the future. They argue that continuing

investments and competition in cleantech will result in more patent prosecution and litigation. The data furnished by them indicates that renewable energy sector tops in the number of application followed by biomass and system integration.[13]

According to another study there has been a slight decrease in the number of patents granted by U.S PTO (United States Patents and Trade Mark Office) in the second quarter over the first quarter. Patents on Fuel Cells are topping the list during the second quarter. But over the years the number of 'green patents' have increased from 424 in 1998 to 1068 in 2007. [14] But these figures tell us little about how many of them will be commercialized. According to a publication by OECD, BRIICS (i.e. Brazil, Russia, India, Indonesia, China and South Africa) account for 6.5 per cent of renewable energy patents in 2005, while, EU accounts for 36.7 per cent,



USA 20.2 and Japan 19.8. But in patents for automobile pollution control technologies BRIICS share is just 0.7 per cent while EU accounts for 48.9 per cent in 2005. [15] According to the OECD, "Large countries such as Germany, Japan and the United States have the highest number of patents". It notes that Denmark is leading in renewable energy with 161 patents in 2003-2005, on wind energy. Similarly Stuttgart region of Germany leads in automobile pollution control technologies with 37.4 per cent of car emissions control patents.[16]



Source : UNDESA (2008)

Many commentators have pointed out that investment in energy R&D has decreased over the years.[17] This may be one of the reasons for decline in number of patents in environmental technology although it is difficult to correlate between the two based on two sets of data on number of patents and investments. As Stern review points out while the annual investment in clean energy technologies including nuclear energy is $33 billion the current subsidies are in the range of $150 to $250 billion per annum.[18]

Climate Technologies in Different Sectors and IPRs

In this section we analyze some technologies to examine the role of IPRs in technology development and transfer.

Solar energy: At present the three core technologies are silicon-wafer based, thin-film photovoltaics (PV) and focused solar thermal power. Although it is in its infancy this technology has enormous potential and the output is expected to increase by manifold in the next few decades. The annual growth is expected to be in the range of 30 to 35 per cent and the installed capacity is likely to increase to 400 giga watts by 2020.[19] In all the three there are many established players and new entrants. Basic technology is in public domain. In thin film solar technology the first generation was silicon based. The second generation includes improvements that can lead to cheaper PV cells. In this four of five firms hold the majority of the market using slightly different technology. At present it is not clear as to whether patent portfolios will be a barrier to new entrants or whether there are patterns of cross-licensing.[20] It is expected that developments in nanotechnology will play an important role in actualizing the potential of solar energy through materials that will increase the rate of conversion to energy in solar energy panels.[21] For example, carbon nano-tubes can increase the efficiency of nano-particle based solar cells.[22] But as nano-technology is a platform technology it is likely that many technologies covered by patents in nano-technology are likely to be very relevant for application in solar energy although it is difficult to state precisely the relationship between both [23]

There is a substantial increase in patent applications in PV and newer technologies are likely to be more extensive patenting than older silicon slice technology. There had been a consolidation in the industry in 1990s and later, and today although the major players are based in developed world, firms in developing world are not lagging behind

The success of Suntech Power Co Ltd, based in China is an example of a developing country firm acquiring technology through overseas acquisition and emerging as the fourth largest producer of PV indicates that growth of developing country firms many not be hampered by patents.[24] In this technology economic viability is determined by support for renewable energy in the form of subsidies and decline in cost of generating solar power. Cost competitiveness depends on the cost of conventional electricity. This means that access to advanced technologies that can result in lowering of cost of production is necessary for diffusion of this technology. But IPRs can become

a barrier in cases where licensing and use of technology is restricted on account of restrictions imposed by the patent holder.

Wind energy: Here too basic technology is in public domain. There are relatively fewer players in this sector on a global scale. Of the top ten players two are from developing nations (India and China). Patent statistics reveals that patents on wind energy are increasing. Overseas acquisition is a route that results in access to technology. The case of Suzlon of India and Goldwind of China indicate that both firms have their R&D units and are investing heavily in R&D besides getting access to technology by acquisition, and through technology agreements with vendors abroad. Suzlon has grown rapidly and has R&D centres in Europe also and technology developed there is deployed in India. Suzlon is now the fourth largest producer of wind turbines in the world and has presence in many countries. Its model of growing by acquisition, setting up R&D centers in more than one country and absorbing technology deserve an in-depth study.

The implications of IPRs on acquiring technology are not clear although obtaining advanced technologies may be difficult. The disputes over patents in wind energy sector indicate that patents are of critical importance to firms that offer specialized products.[25]

According to a study on transfer of technology in wind energy sector in China foreign technology providers were reluctant to transfer technology to Chinese firms on account of local content requirements and concerns about IPRs. However, as the Chinese market is large they did not challenge the local content requirements and tried to exercise control through IPRs. Irrespective of ownership model, very few companies transferred wind power technology.[26]

While developing country firms are generally offering less than 1 MW turbines, companies like General Electric and Vestas are offering turbines with 1.5 M.W capacity and 2 M.W capacity. The technological gap in this sector between developed nations and developing nations needs to be bridged. It is suggested that developing nations like India and China should do joint R&D in developing higher capacity turbines so that they are able to compete in the global market for higher capacity turbines. As Intellectual Property is

an issue in transfer of technology in this sector, developing technological capacity by developing nations will result in diffusion of technology.

As in solar energy the industry's economics is affected by government policies and costs of production of energy in comparison to conventional electricity.

The study by Joanna Lewis indicates that firms in India and China have adopted different strategies to acquire the relevant technologies in wind power, including acquisition of firms, creating strategic partnerships and have benefited from national policies like local content requirements and incentives for wind energy. Suzlon had acquired controlling stake in many wind turbine technology and component manufacturing companies. It has expanded its R&D facilities to many countries and is into collaborative R&D. She points out that developing country firms acquire technology from smaller companies abroad as leading wind turbine manufacturers are not keen to license proprietary information to potential competitors.[27] Both India and China are examples of technology leapfrogging in wind energy and have demonstrated that the right policies with innovative firms, it is possible to achieve remarkable progress in technology absorption and development in a decade or so.[28]

Bio-Fuels: Biofuels technology can be classified into three generations. The first generation bio-fuels include ethanol and are made from sugar cane, starch, and/or vegetable oil as raw materials using traditional technology. They have become controversial as their long-term sustainability and their environmental impacts have been questioned. [29]

Fears that large scale use of these bio-fuels can result in food shortage, increase in food prices and diversion of land, particularly forests for bio-fuel production have been expressed. Another issue is the question of their competitiveness in the absence of government subsidies and support. Second generation technologies include biofuels derived from lignocellulosic materials using biomass to liquid technology. The inputs and feedstock can be from sources as diverse as straw, grasses and wood. The utilization of plant materials and crops like straw and grasses will reduce the need to divert land and thus competition with food and feed crops.

Third generation bio-fuels are based on synthetic biology and micro-organisms are expected to be of critical importance in this. While much R&D is being done on second and third generation bio-fuels, some of the technologies may be years away from commercialization and in case of synthetic biology although the potential is recognized there are regulatory and other issues that need to be addressed before widespread use.[30]

The number of patents is increasing as it is evident from the table below. In terms of location of the patent owning entity, USA is leading. Of these majority are owned by corporate entities and only 11 per cent are owned by universities/research institutions. (http://media.cleantech.com/2329/biofuel-patents-are-booming).

Year	Patents published
2002	147
2003	271
2004	302
2005	391
2006	640
2007	1045

In terms of technologies, in patents published in 2006-2007, biodiesel leads with 299, followed by agricultural biotechnology with 110 and biomass accounts for 41 only while enzymes account for 35. The scale of activity in biofuel patents can be gauged from the fact that biofuel patents account for 1045 patents in 2007 while solar power accounts for 555 and wind power 282. According to one study the number of bio-ethanol patent applications increased from less than 30 in 2002 to more than 70 in 2006-2007. [31]

It is also pointed out that Novozymes accounts for 23 per cent of the bio-ethanol applications in 2006-2007 , Genencor 7 per cent and Diversa 4 per cent.[32]. Although the basic technologies in this technology are quite old, the technological advances are expected to come from new processes as well as new products like enzymes and catalysts. Enzymes and catalysts are important as enzymes are needed to break down starch into sugar and cellulose into fuels. An enzyme that performs better in terms of conversion efficiency can thus result in competitive advantage to the producer of enzyme.

While comparison with bio-technology may sound far-fetched, the emergence of small firms that specialize in R&D and their alliances with players in other fields/related industries is emerging as a trend in bio-fuels. Rai cites three such alliances (Diversa/Cellulol with Syngenta/Dupont/KhoslaVentures, Iogen with Shell, Goldman Sachs, and Genencor with Cargill/Dow/KhoslaVentures).[33] A report by ETC Group cites fourteen such alliances in synthetic biology in what it calls as 'Synbiotech's Sugar Economy' .[34] According to one report "As more and more, cost-saving technology is engineered into the already price significant feedstock, the economics of biofuels production will crown feedstock patent portfolios as some of the most valuable through the biofuel patent landscape"[35].

The increase in the patenting activity in this technology has given raise to many questions including possibility of patent thickets, freedom to operate, and use of standards to create essential/critical technology. Patent thickets can result in concentrated ownership under monopoly/duopoly market conditions, restrictions in licensing, and holding up further innovation.

For developing countries which have an interest in bio-fuels these issues are important. Another issue is whether they should grant patents on enzymes and micro-organisms. Enzymes and micro-organisms can be considered as products of nature and excluded from patentability. However, this approach is not without problems. As we have discussed this question elsewhere we will not go into details here.[36]

It should be pointed out that developing nations will have to look at various options before deciding on this question. For example, even if a developing country decides not to grant patents on micro-organisms it cannot prevent a developed country from granting patents on micro-organisms. Similarly, on enzymes, it is difficult to classify them en masse as products of nature. Advances in synthetic biology are expected to result in new processes and methods in which genetically modified (GM) micro-organisms have an important role to play.

The group led by Keasling at University of California, Berkeley is doing research on using GM bacteria to produce fatty acids and isoprenoids with

the objective of producing bio diesel and bio kerosene. Right now the intellectual property landscape in synthetic biology is not clear. Although many patents have been applied for, some initiatives are also there to use Open Source models in synthetic biology.[37]

Developing countries have a huge stake in bio-fuels as bio-fuels can reduce the dependence on imported oil, and can generate employment, create new industries besides making the agricultural sector more productive. Brazil is in the forefront of using sugar-cane feedstock and refining processes to produce ethanol while India is a pioneer in use of using jatropha as a feedstock to produce bio diesel. Hence developing nations have to use IPRs to their advantage so that innovators rights are protected and innovation is encouraged.

The increased interest of TNCs in biofuels and the alliances/research partnerships that are being formed in science and technology related to biofuels indicate that IP is going to be an important issue in this sector.[38]

Broad patents that cover basic technologies can result in monopolies and refusal to license technologies. In a technology that is in its infancy the patent thickets can result in what is known in an anti-commons situation where there are too many patent holders over the technologies and for use there has to be many licenses and cross-licenses that increase the transaction costs.[39] *Scientific American* in an Editorial in May 2006 expressed its concerns about the potential negative impacts of patents in this discipline.

To sum up, new technological developments in bio-fuels offer immense scope for development of bio-fuels as climate friendly technologies. But patents can become a hurdle in technology transfer and diffusion. Developing nations will need to take pro-active policy measures in both encouraging innovation and making the use of IPRs to promote further innovation. There is a need for more research on understanding the implications of trends in technology and claims for IP rights in this sector.

Climate-tolerant Crops: Climate change has enormous implications for agriculture in developing nations.[40] The need for developing drought resistant, flood resistant and salt resistant crops has been underscored and

CGIAR centers and private sectors are involved in this.[41] One of the suggested solutions is to genetically modify plants and develop varieties with traits like drought resistant, flood tolerant, so that they can be useful in adaptation/ mitigation strategies. It should be pointed out that there are traditional varieties with these traits although many of them have been replaced with modern varieties. A study done by ETC group argued that many patents on 'climate-friendly' genes have been filed by the ag-biotech Multinational Corporations (MNCS) which are already dominant in agricultural biotechnology.[42]

Although many patents have been filed it does not mean that all patent applications will result in grant of patents or all patents will be commercialized. It is likely that some of them will be rejected or claims will be modified. Moreover, if the technology is used to develop new varieties, they have to undergo field trails before marketed as varieties. To what extent a variety developed in USA will be useful in China or India is an important issue. One view is that the varieties have to be location specific and what works in California need not work in China and vice versa.[43] These varieties may not perform so well in fields as expected because there are other factors that determine the adaptability of a plant to drought or flood. Traditional varieties with the same traits may be able to perform better as they are many traditional varieties that are specific to geographical regions. There are other issues like regulatory approvals and transferring these traits to different crops and existing varieties. So at present it is too premature to conclude that these patents will be granted and will result in wide spread use of varieties with specific traits.

However, what is important is the use of IP rights over technology and the implications of the same for developing countries. In developed nations like USA, plant varieties can be protected under patents as well under Plant Variety Protection Act (PVPA). PVPA enables a breeder to get Plant Breeders' Rights (PBRS). This dual protection has been upheld by the U.S Supreme Court. In practical terms this means that farmers cannot replant seeds, sell or exchange seeds of the varieties that are protected under patents. Even if the variety is protected under PVPA the farmers' rights do not extend to replanting the seeds or sell them as seeds or exchange them.[44]

Under TRIPS Article 27.3(b) it is not necessary that patents should be granted on plants and plant varieties. Countries can opt for a *sui generis* (i.e. one of its kind) system but have to extend IP protection to plant varieties. Similarly, countries need not follow the UPOV Convention of 1978 or 1991 while enacting or amending laws so that IP protection is extended to plant varieties. Although interpreting Article 27.3(b) has been controversial, many developing countries have opted for *sui generis* systems.

In developing nations, such dual protection need not be available. Many developing nations have enacted laws that provide for PBRS but have excluded plants and plant varieties from patentability (e.g. India).[45] Similarly,the recognition of PBRS has been balanced with recognition of farmers' rights (e.g. India).

It is estimated that agriculture in developing countries is likely to be adversely affected on account of climate change and this can result in reduction in food output. Although estimates vary from crop to crop and country to country, the need for varieties that can be used in adaptation and mitigation strategies is obvious.

To what extent the patents claimed by the ag-biotech MNCS will be useful in this is not clear. But the access to technology may be hampered by them if the patents with broad claims are granted and enforced. Another issue is that when basic technologies are patented, the freedom to operate may be problematic and in developing new varieties, public sector plant breeders may be hampered by lack of access to patented technology or may have to obtain licenses under restrictive conditions like reach-through claims and geographical restrictions in use of technology.

Thus while fears expressed in the report by ETC Group may be exaggerated, there are issues that need to be addressed. Although governments can use options like compulsory licensing to make these technologies available for use by public sector breeders' and others, in the absence of patents, the option of compulsory licensing does not arise. The MNCs may not file patents for such plant varieties in developing countries, nor may be interested in using PBRS as a mode of protection as from their

perspective that is a 'weak' form of protection. So either the governments or private parties may have to enter into licensing agreements for transfer of technology or buy the patented technology for use. The other possibility is that the traits may be transferred to hybrid varieties and they may be sold. But as hybrids do not yield the same output in subsequent generations' farmers will have to buy seeds for each new crop. Here also concerns about use of technology to abuse monopoly position cannot be ignored.

The development of plant varieties using biotechnology for use as feed stock for bio-fuels is another issue that has implications for developing countries' access to climate friendly technology. Here too the issues discussed above are applicable. The combination of patents over enzymes, micro-organisms and plant varieties can result patent thickets and affect transfer of technology. The new varieties for use as feed stock for bio-fuels may or may not be environment friendly although they may be efficient for use as feed stock.

One possibility is to give more importance to public sector plant breeding so that 'climate-friendly' varieties are developed. Another option is to evaluate the traditional varieties that are known to be drought resistant/ flood tolerant and examine the possibility of using them widely. It is also possible to identify the relevant genes in traditional varieties and develop new, genetically modified varieties. Hence developing nations should do an assessment of these technologies and study the emerging patent landscape in these technologies.

Clean Coal Technology: In transfer of climate-friendly technology the experience in Asia shows that patent rights act as a barrier to transfer of technology and sellers of technologies impose conditions on use and transfer of technology.[46] Liu and Vallentin have studied the transfer of clean coal technology to China and point out that fears about copying of technologies acts as a factor in reluctance to transfer of technologies. [47]Another study on transfer of clean coal technology to China pointed out the complex nature of technology transfer and showed that weak protection for IPRs is an issue for domestic manufacturers as well.[48]

According to a recent report on development and deployment of clean coal technologies "While developing country involvement in Australian-,

US- and EU-supported CCS projects suggests that dissemination of knowledge on CCS technology is underway, the response of the IPPs mentioned above indicates that more knowledge transfer and perhaps on-site demonstration in developing countries may be necessary. Consideration should be given to making available low-cost IPRS to CCS technologies. A model for this transfer may be found in the pharmaceutical industry, which has developed methods, in co-operation with international agencies, for transferring drug patents at lower cost to developing countries."[49]

A preliminary survey of the literature in clean coal technologies and their transfer shows that often patents alone are not sufficient to commercialize the technology and when suppliers try to have a tight control over technology by restricting use of technology or its transfer, diffusion of technology is hampered. FDI combined with transfer of technology may be a preferred route for suppliers as that would enable them to restrict free-riding of the technology but from developing countries' perspective this may not be a viable solution. In case of countries like India and China the solution lies in more diffusion of clean coal technology to reduce emissions of greenhouse gases and reduce pollution. Another issue is that issue of non-codified knowledge or tacit knowledge that is important in optimum deployment of technology. According to a study done as a background paper for *Human Development Report 2007*

"Access to relevant IPRs by developing country firms may be a necessary condition for successful acquisition in some cases, but is unlikely to be sufficient. This is because much of the knowledge required to develop, produce and deploy cleaner coal technologies is tacit and is not codified in patents" (P 53) [50] .

A study by Sussex Energy Group and TERI suggests that access to IPRs has to be assessed on a case to case basis as sometime although IPRs may be available that alone would not result in commercialization as commercialization depends on other factors as well.[51]

Thus there is evidence to conclude that IPRs do constitute a barrier in technology transfer in climate-friendly technologies. The past experience with regard to transfer of technologies to protect the Ozone layer also shows that IPRs act as a barrier to transfer of technologies.[52]

The technological dominance of the developed nations is a major factor that cannot be ignored. Another issue is the use of IPRs to restrict use and diffusion of technology. As discussed elsewhere in this paper the developing nations have been pointing out this issue for decades and in the case of global climate change they have come up with proposals to ensure that access to technology and technology transfer does not impede the measures that need to be taken to reduce the emission of greenhouse gases and reduce the negative impacts of global climate change. Some of the other suggestions have also taken into account the issue of IPRs and we discuss them elsewhere in this paper.

Technology Gap, IPRs and Technology Transfer

Technology transfer involves more than transfer of equipment and machinery and involves transfer of technology and machinery, transfer of knowledge and skills and development of capacity to use and adopt the technology. Whether stronger IP protections results in more transfer of technology is a controversial issue. A study by UNIDO after an extensive study of the literature on international technology transfer and IPR protection states, "The results are far from definitive as a consequence. But while it would be premature to make strong claims on the basis of the limited evidence to date, the overall pattern of results justifies certain inferences". (P 45).[53]

The empirical evidence from transfer of technology, technological development and IP protection in developing nations indicates that there is no positive correlation among the three. For example, it has been pointed out by Kim that in the initial stages Korea acquired and assimilated mature technologies and undertook duplicative imitation. He pointed out that at the initial stages learning took place through reverse engineering and duplicative imitation. At those stages strong IP protection would hinder rather than enable technology transfer or development of indigenous capacity to learn by doing.[54] Kumar argues that the experience of developing countries in Asia and Japan shows weak IP protection helped in building up local capacities even if the countries were at low levels of development and stronger IPRs will only benefit the technologically dominant countries.[55]

The technological dominance is reflected in patents and income from

royalties. As we have seen elsewhere in this paper, the developed countries are ahead in renewable technologies in terms of patents and in some technologies, their dominance is very significant. According to Kumar, "This extreme concentration of the technology generation activity with 94 per cent of patents and 91 per cent of technology fees receipts accounted for by just 10 developed countries has implications for the strengthening of IPR regime[s]. It is quite clear that a trend of strengthening of the IPR regime will benefit these countries and will further perpetuate their technological domination over the rest of the world."[56]

(Table 1 from Globalization, FDI& Technology Transfers) at P 14

Table 2.1 Major source countries of technologies, mid 1990s

Country	R&D expenditure 1993[1]		US patens taken, 1977-96[2]		Technology fees received, 1993[3]		FDI outflows 1995[4]	
	(billion ppp $)	% of total	'000	% of total	billion$	% of total	billion $	% of total
USA	166.3	39	985.3	57	20.4	40	95.5	30
Japan	74.4	17	307.6	18	3.6	7	21.3	7
Germany	37.1	9	136.2	8	7.3	14	35.3	11
France	26.4	6	52.7	3	2	4	17.5	6
UK	21.6	5	52.8	3	2.9	6	37.8	12
Italy	13.2	3	22.1	1	0.9	2	5.1	2
Canada	8.4	2	34.4	2	0.9	2	4.8	2
Netherlands	5.1	1	16.9	1	6.2	12	12.4	4
Sweden	4.8	1	17.3	1	0.4	1	10.4	3
Switzerland	4.2	1	25.5	1	2[6]	4	8.6	3
Subtotal 10	361.5	84	1,650.8	95	46.6	91	248.7	79
World	428.58[5]	100	1,732	100	51[7]	100	315	100

Source: Kumar, based on

1. OECD (1996) *OECD in Figures – Statistics on the Member Countries: 1996 Edition*, Paris: OECD, pp. 56-7;
2. US Patterns and Trademarks Office (1997) *TAF Special Report: All Patens, All Types – January 1977-December 1996*, Washington, DC;
3. OECD (1996), pp 60-1;
4. UNCTAD (1996) *World Investment Report 1996*, Geneva: United Nations;
5. UNESCO (1996) *World Science Report 1996*, Paris: UNESCO. This figure relates to 1992;
6. own estimates based on mirroring of payments by major OECD countries; and
7. own estimate providing for non-reporting countries.

Table 2

COUNTRY	GDER billion$ per cent (1) in 2007#		U.S Patents in'000s 97-07 (2)		per cent R&L Fees (3)	per cent	FDI Outflow per cnet (4) in $billion	
USA	343.75	41.00	1019	53	62378	46	333.3	17
JAPAN	138.78	17	374	20	20096	15	73.5	4
GERMANY	66.68	8	115	6	5888	4	167.5	8
FRANCE	41.43	5	42	2	6230	4	224.6	11
UK	35.59	4	43	2	13558	10	229.9	11
ITALY	17.82	2	20	1	1116	0.8	90.8	5
CANADA	23.83	2	43	2	3245	2	49.5	2
NETHER	9.95	1	15	0.7	4126	3	31.2	1.5
SWEDEN	11.81	1	16	0.7	3964	3	36.7	1.8
SWITZER	7.47	0.9	15	0.7	7681(**)	6	51	2.5
SUB-TOT	697.11	81.9	1702	89	128282	93.8	1288	63.8
WORLD	830(*)	100	1906		135278	100	1997	1997(***)

(1) OECD Main S&T Indicators 2008 Vol. 1 – GDER(Gross Domestic Expenditure in R&D) From List of Indicators- Table 1- #Figures Relate to 2007 or latest year

* World Science Report 2005, UNESCO at P 3

(2) U.S. Patent Office Data – All classes of Patents-PTMT SPECIAL REPORT ALL PATENTS, ALL TYPES -JANUARY 1977 — DECEMBER 2007 http://www.uspto.gov/go/taf/apat.pdf (last visited 10th Dec 2008)

(3) Royalty & License Fees 2006 in $millions - World Development Indicators 2008, World Bank, Table 5.12 last visited 11th Dec 2008

** For Switzerland Data taken from OECD Statistics on International Trade and Services Vol. 1, 2008, Page 334, Item No. 266

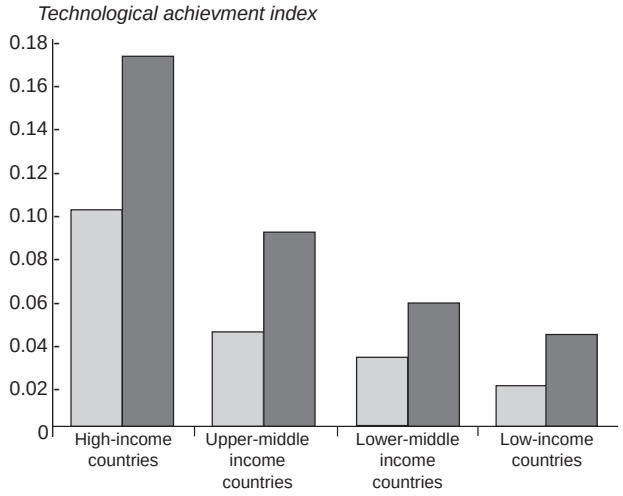
(4) OECD Investment News June 2008

***From World Investment Report 2008, UNCTAD

[Data on Royalty and License Fees is from World Development Indicators and OECD Statistics on International Trade and Services Vol. 1, 2008. The difference in figures from World Development Indicators and OECD Statistics on International Trade and Services Vol. 1, 2008 is not significant]

According to Table 2 even after a decade the developed nations still account for 93.8 per cent of royalties and license fees received, and 89 per cent of U.S patents. In terms of global R&D expenditure also the developed nations are in a dominant position. Although developing countries have advanced technologically the North-South gap still persists. This is evident from the graph below

Grey indicates the position in 1992-94 and blue indicates the position in 2002-2004

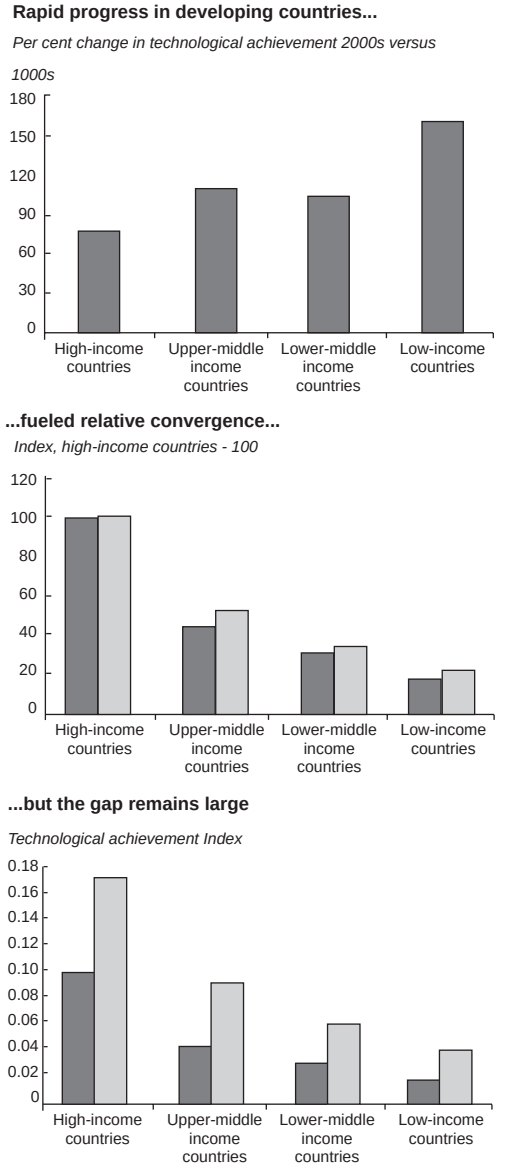


Source: World Bank (2008).

The World Bank study also points out that developing nations import more capital and intermediate goods than before. The ratio of high-technology imports to GDP has doubled during 1992-94 to 202-2004. Although many developing nations have eased norms for FDI and technology transfer, the increase in high-technology imports indicates that their dependence of technology from foreign sources is still high and perhaps has increased. In terms of technological advancement the gap between developed and developing, and, Least Developing countries (LDCs) still remains large.

As indicated elsewhere the North-South divide on technology transfer in WTO has resulted in stalemate on using TRIPS as a source for technology transfer. The existence of weak IPRs in major developing countries has been identified as a barrier by the Office of U.S. Trade Representative, in export of 'Greenhouse Gas Intensity Reducing Technologies'. [57] The North-South divide was reflected in the recent Beijing Conference also.[58]

Figure 3 Technology achievement
Converging, but the gap remains large



Source: Global Economic Prospects 2008, P 21

Developing countries, particularly the G77, have stressed the need for access to technology and also put forth comprehensive proposals for technology transfer besides pointing out the need to urgent solutions in the wake of the potential threat of negative impacts of the global climate change. The North-South divide on IP issues is very much evident. In case of IP the private sector dominates and the global harmonization of IPRs under TRIPS has only strengthened the hands of private sector and limited options available for governments.

Thus the use of IPRs to control rather than to promote transfer and diffusion of technology in the context of climate change can result in less than optimum technological solutions to the problems of global climate change.

TRIPS, Technology Transfer and Options under TRIPS

TRIPs (Trade Related Intellectual Property Rights) Agreement is one of the agreements of WTO. It seeks to establish a minimum level of IP protection in member states and establishes norms for IP protection. The TRIPS Agreement was a compromise between North and South. Enforcement of TRIPS Agreement is regulated by WTO. Under the WTO's Dispute Settlement Mechanism (DSM) IP laws and related policies of countries that do not adhere to TRIPS can be challenged by other member countries. This linking of TRIPS with DSM and the provision for cross-retaliation under Dispute Settlement makes TRIPS a strong agreement. The objectives of TRIPS go beyond IP protection and include facilitation of technology transfer to developing nations and LDCs and use of IPR and technology for development of member states.

The key features of TRIPS are as below:

1. Grant of patents in all fields of technology, without discrimination with reference to place of invention, imported or locally produced subject to exemptions under TRIPS (Article 27)
2. Twenty year term of patent protection from filing date (Article 33)
3. Non-discrimination between nationals and non-nationals in IP protection
4. Grant of exclusive rights to make, sell, importing of technology and products
5. Compulsory licensing subject to provisions of TRIPS

Patents and TRIPS: An overview

Regarding patents TRIPS stipulates that patent protection should be available for inventions in any technology and to be eligible for patent protection an invention should be 'new', 'involve an inventive step' and ' capable of industrial application'. These three criteria are known as novelty, non-obvious, and utility/industrial applicability. TRIPS provides some exemptions from patentability under the grounds of protecting *ordre public* or morality, to protect human, animal or plant life, or health or to avoid serious prejudice to environment. However, mere prohibition of exploitation of invention, by law cannot be a valid ground for exclusion from patentability. TRIPS does not define the key terms including 'invention', nor lays down specific norms to assess the three criteria of patentability. Members may exclude diagnostic, therapeutic and surgical methods for treatment of humans or animals. Regarding IP protection for plant varieties, Article 27.3(b) mandates that protection of plant varieties either by patents or by an effective *sui generis* system or by any combination thereof. Here too it does not define what are the components of *sui generis* system nor indicates any specific standard.

Although Paris Convention had many similar provisions, countries were enacting laws that did not adhere to Paris Convention in full. For example countries adopted different norms and standards in grant and enforcement of patents, including the provision for compulsory licensing. But with the advent of TRIPS the scope for nations to interpret TRIPS in any manner and implement TRIPS in any way they want has been reduced. Although still TRIPS leaves it to the countries to choose the mode of implementation, it does mandate that all countries excluding, LDCS will provide patent protection for pharmaceutical products by 1st January 2005. LDCS have been exempted till 1st January 2016 from this.

Although it provides some flexibility in defining inventions, exception to patent rights and in implementing TRIPS, the overall framework is in favor of the rights of the IP holders. Thus it limits the policy space available to countries to use TRIPS for furthering development objectives and for fostering competition and restricting the abuse of patent rights.[59] Developing nations should, therefore, explore options like using competition policy to ensure that patent holders do not abuse their monopoly rights.[60]

TRIPS and Transfer of Technology

In the context of climate change, the key issues are whether TRIPS facilitates or acts as a barrier to transfer of climate-friendly technologies to developing nations and LDCs and whether the provisions of TRIPS empower governments to use compulsory licensing for transfer of technology. Patent holders can abuse their rights by refusing to license, restrictive licensing, by imposing conditions on sharing and transfer of technology, seeking exorbitant licensing or royalty fee.[61] TRIPS can be read as an Agreement that contains rights and obligations, providing some space for countries to balance the competing demands and to circumscribe IP rights.[62]

However in interpreting the provisions of TRIPS the decisions of the Panel of the DSM are final until they are overturned by the Appellate Body. In Canada—Patent Protection of Pharmaceutical Products Report of the Panel (17 March 2000), WT/DS114/R, the Panel interpreted Article 30 and linked it with Article 27.1. This narrow interpretation was in favor of holders of IP rights and restricted the powers of the countries to use Article 30 for meeting public health needs. There is a conflict between IP protection and access and in case of public health needs countries need power and authority to give importance to access over IP protection. The Articles 7 and 8 of TRIPS indicate the objectives and principles of TRIPS. Article 7 in fact mentions about 'balance of rights and obligations'. In interpreting TRIPS the Panel took a narrow approach and a legalistic interpretation of TRIPS provisions ignoring the need to strike a balance between rights and obligations. According to Arup, "But, in the Canada-Patent Protection for Pharmaceutical Products case, the panel stressed that the words of article 30 represented the political compromise between protection and access; the earlier Articles 7 and 8 could not be enlisted to expand the scope of exceptions".[63]

Thus the flexibility in TRIPS and the powers of the governments are limited and subject to the interpretations given by Panels/ Appellate Boards.

The patentee gets exclusive rights (e.g. rights to use, manufacture, sale) and right to prevent infringement (e.g. unauthorized use, manufacture and sale). In return for the monopoly for a limited period (s)he is encouraged to

disclose the invention. While the patentee can prevent free riding by imitators, there is no obligation that the patentee should put the invention to use voluntarily but governments can make non-voluntary use of technologies.64. Thus in case of public need, the government can ensure that the exclusive right does not prevent access to medicines and technologies needed for public health by issue of compulsory licenses.

In the context of technology transfer Article 8.2 is important as it acknowledges the necessity to prevent the resort to practices that adversely affect the international transfer of technology and at the same time has a rider, that the measures should be consistent with the provisions of TRIPS. [65] But Article 40 stipulates that 'rule of reason' approach should be used to assess the anti-competitive measures. Correa points out that the powers available under TRIPS Article 40 are short of what the proposed Code on Technology Transfer provided. According to Correa "Instead, while expressly allowing Members to adopt measures to control or prevent such practices, it takes pains to establish limits to national action in this field".[66]

Article 40.2 gives examples that may be deemed to be restrictive (e.g. exclusive grant back provisions, i.e. those that oblige the license to transfer the improvements made on the licensed technology exclusively to the licensee, obligations imposed on the licensee not to challenge the validity of licensed rights, and coercive package licensing, i.e. the obligation for the licensee to acquire from the licensor other technologies or inputs he does not need or desire. The assessment of restrictive practices cannot be generalized but only on a case by case basis. Article 40.2 states that only if such practices, constitute an "abuse" of intellectual property rights and have an 'adverse effect on competition in the relevant market'.

Thus, what actions are possible under Article 8.2 is circumscribed by Article 40. It severely limits the governments capacity to take steps that prohibit anti-competitive practices in technology transfer. This raises questions about the scope of competition policy in fostering technology transfer and in prohibiting anti-competitive practices.

Thus TRIPS severely restricts the potential for invoking competition

policy to negate the abuse of rights of IP holders. So using competition policy to ensure that technology transfer agreements do not impose conditions that adversely affect the competition or restrict the rights of licensee is difficult, if not impossible.

Refusal to Deal and TRIPS

Compulsory licensing is one option available to developing countries when a patent is filed in the country but the patent holder refuses to license that technology. But the compulsory licensing option has many limitations. First of all the firms may not be able to use the technology as the information in the patents may not be sufficient enough to use the technology. In any case technology that is tacit cannot be learnt from patents. The patent holder is under no obligation to transfer the technology. Is it then possible to obtain compulsory license for supplying or exporting to a market in developing country. ?

According to one commentator the patent owner has absolute right not to sell or license the patent and this practice is not anti-competitive or abuse of his rights. When a firm refuses to deal under TRIPS, grant of compulsory license is not possible, as 'there is no sounder business practice than refusing to engage in commercial deals with competitors'.[67] However the refusal to deal with a competitor on commercial terms adversely affects the transfer of technology and can be an abuse under Article 8.2 as this can 'unreasonably restrain trade or adversely affect the international transfer of technology'. Some abusive practices need not necessarily be anti-competitive but an abuse of patent may include refusal to work or license a patent.

So although refusal to deal is recognized as an abuse of patent in some countries, refusal to license in a WTO country export market cannot be a valid ground for compulsory licensing. Thus the only avenue for compulsory licensing seems to be Article 31. While it is true that these requirements provide flexibility to developing nations in framing laws on compulsory licenses, they restrict its use for exporting technologies. The main purpose of compulsory licensing is to primarily serve the domestic market and export can be only an incidental use. Article 30 may not be of much use here as its language is more limiting than that of Article 31. According to Reichman

and Hasenzhal the possibilities for imposing non-voluntary licenses are broad under Article 31 as the Article 30 has narrow limitations.[68] Thus states cannot grant compulsory licenses for exporting technologies, except under the WTO decision on Public Health, which provides for some exceptions. However, this exception is limited to public health reasons only and even there the coverage is limited. A major shortcoming even then is the limited duration of the compulsory licensing, and this acts as a disincentive. The patent holder is free to compete in the same export market and does not suffer from this disadvantage. For reasons of scale, the licensee should be able to serve more than one market and take advantage of the license as well as the investments made. But the WTO Decision is applicable for single member country export.

The WTO Decision thus limits the scope of the use of compulsory licenses and the Decision puts in place some rules that are cumbersome to follow. The decision thus has not expanded the options available under compulsory licensing.

Thus, according to Correa, "The room available within the TRIPS Agreement to foster technology transfer to developing nations is quite small. The problems of access to technology seem today more fundamental than those relating to the conditions under which the actual transfer may take place[69]".

Regardless of TRIPS one solution that can be used is to introduce a provision similar to one found in U.S. Clean Air Act on use of compulsory licensing to meet agreed standards. The Clean Air Act mandates the compulsory licensing of patented technologies when they are needed to meet agreed standards. In other words, no company can refuse to share a patented technology that is needed to meet standards. If the company refuses compulsory licensing can be used. In 2006 a court in USA granted compulsory licensing of three patents on hybrid transmissions to Toyota and royalty was fixed at $25 per automobile. (Paice LLC v. Toyota Motor Corporation 2006 WL. 2385139). [70]

Developing nations can examine the possibility of inserting similar rules

in their national laws so that IPRs do not become a barrier. Since the Clean Air Act has not been challenged in WTO so far it can be presumed that it is WTO consistent. It has been pointed out the idea of 'public interest' compulsory license used in EU may be relevant in case of climate-friendly technologies and government use license may also be relevant in this.[71]

Although Article 66.2 of TRIPS deals with transfer of technology, not much progress has been achieved under this. While developing nations have been stressing the importance of viewing technology transfer as a part of the larger developmental project developed nations are not keen to facilitate technology transfer as demanded by developing countries.[72] According to a recent study on Article 66.2 and technology transfer to LDCS, the progress so far is minimal and many developed nations are not inclined to even submit a report to TRIPS Council on using Article 66.2 for technology transfer.[73]

To sum up, TRIPS is not conducive to transfer of climate-friendly technologies and hence there is a need to expand the scope of the Doha Declaration or provide for a waiver similar to public health issues, for transfer of climate-friendly technologies, for mitigation and adaptation to climate change.

Standards, Patents and Technology Transfer

Setting standards is essential to facilitate interoperability and to ensure that uniform standards are met by all manufacturers to achieve some objective (e.g. energy efficiency). Standard setting organizations specify the standards. It is possible that a patent holder may hide the fact that the patent holder has applied for or obtained patents that are pertinent to the standards. Later once the standards are set, the patent holder may sue the others who develop/ use processes to achieve the standard for infringing his patents. Although such issues are well known in Information and Communication Technologies where interoperability is crucial, the relevance of using patents to 'capture' standards need to be analyzed in case of climate-friendly technologies also. A well known example is that of the infringement case brought by Unocal against other refineries, regarding composition of low-emission gasoline. Although the patent was overturned for anti-trust reasons, the case highlights the issue of using patents as holdups in implementing standards.[74]

Common But Differentiated Responsibility, Technology, Technology and IPRs

Common But Differentiated Responsibility (CBDR) is a well known and accepted principle in international environmental law.[75] This principle is enshrined in many international environmental agreements including the UNFCCC and Kyoto Protocol. Under this principle, though both developing and developed nations are responsible for taking steps to protect the environment and promote sustainable development, their responsibilities are different. But the scope of their responsibility varies according to their levels of socio-economic development. The Rio Declaration states: "States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem. In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command."

Similarly, in the Framework Convention on Climate Change; it is stated that, parties should act to protect the climate system "on the basis of equality and in accordance with their common but differentiated responsibilities and respective capabilities."

The implications of this principle are two fold. One developing nations acknowledge that environmental issues are of concern to all countries. Two, in differentiated responsibility instead of formal equality importance is given to substantive equality taking into account the needs, capabilities of the countries. Under this developing nations agree to be a party to international treaties and fulfill their obligations to treaties and the obligations are not shared equally. The developed nations are expected to help the developing nations through technology transfer, financial assistance and other means, for fulfilling the common objective. Thus, developing and developing nations are responsible and are expected to co-operate and work together in meeting the goals of the treaties. This principle has been a major factor in the success of Montreal Protocol. In Montreal Protocol, developing nations are

committed to phase out Ozone Destroying Substances in return for financial and technical assistance for the same. Developed nations and developing nations established a mechanism for furthering this.

In climate change, this principle is very relevant. The developed nations are the major emitters of GHGS and historically they have been the cause of the problem. Developing nations have also contributed to the global climate change and their share of emissions is increasing. Still in terms of per capita emissions in the present and emissions over the times, the developed nations have contributed more. Hence they have more responsibilities than the developing nations. Under CBDR some countries have more responsibilities than others. As developing nations need development and economic growth and cannot sacrifice both in the name of sustainable development, the UNFCCC states that developed countries should take "lead in modifying longer-term trends in anthropogenic emissions [of greenhouse gases] consistent with the objective of the Convention". Thus developing nations are not expected to reduce their emissions but are expected to take steps commensurate with their capabilities and capacities and needs for meeting the objectives of the Convention. In the Singapore Declaration on Climate Change, Energy and Environment CBDR is invoked and is reaffirmed by, "Stress that all countries should play a role in addressing the common challenge of climate change, based on the principles of common but differentiated responsibilities and respective capabilities; and that developed countries should continue to play a leading role in this regard". (http://www.aseansec.org/21116.htm) Although Kyoto Protocol which is based on CBDR has not succeeded in reducing the emissions to the desired level, the failure lies not with CBDR principle but on other factors. In fact China has been highlighting the importance of CBDR in finding solutions to climate change. Although technology transfer under UNFCCC/Kyoto Protocol has not been a great success, this principle is still relevant for future negotiations and initiatives.

When applied to technology development and transfer it means that while developing nations have the responsibility to develop and apply climate friendly technologies, developed nations are expected to take the lead and play a major role in development and transfer so that the common objectives

can be met. Since climate change is a problem of global atmospheric commons, developed nations, having been the major cause of the problem, should play a major role in finding technological solutions. This can be achieved only if developed nations accept their responsibility. Since the private sector and bilateral initiatives on technology development and transfer form a significant part of the efforts to use technology as a solution, it will be fair to demand that these also incorporate this principle in development and transfer of technology.

Innovative approaches and ideas

Many ideas and solutions have been suggested for enabling transfer of climate-friendly technologies to developing nations taking into account the potential of IPRs to act as a barrier or an incentive for transfer. The European Parliament has passed a resolution stating that IPRs should not be a barrier in development and transfer of technologies. Nicholas Stern has suggested that the relevant technologies should be made available without patents. Since climate change is a long term problem, it is essential that a long term perspective on technology issues is advocated.

Some of the innovative approaches are discussed below.

1. Under Montreal Protocol a Fund was set up for transfer of technology and for capacity building in developing nations so that Ozone Destroying Substances (ODS) can be phased out and the alternatives can be put to use to meet the dead lines under the Protocol. This is a good idea but there are some limitations. In terms of technology in terms of both diversity and nature climate-friendly technologies differ from alternative technologies, processes and products under the Montreal Protocol. Still the Fund mechanism is an idea worth trying. The Fund under the Montreal Protocol facilitated access to technologies and ensured that patents were not a barrier. It offered technology to developing nations at reasonable licensing terms. When compared to substitutes for ODS, the range of climate-friendly technologies is vast and their applications span many industries and services.

   The number of firms supplying the substitutes to ODS was limited and the technology was also easy to transfer as it needed substitution of one

group of substances with another. Extensive retrofitting and retooling or changes in production processes were not needed. Moreover, the Fund had its job well defined as the phase out for ODS was based on an agreed schedule. In case of Montreal Protocol there was a consensus on the need to replace ODS and there was also sense of urgency to implement the replacement provisions in a time bound manner.[76] Compared to this, the issues and tasks in technology transfer in climate-friendly technologies are daunting and too complex. Still the model can be replicated as it offers a viable working model and the mechanism under the Montreal Protocol is not complicated.

2. Use the Green Revolution as a model and set up centers for technology development and transfer. Under Green Revolution many centers were established for crop development, plant breeding and the technology was transferred without IPRs to developing countries. A similar approach to development and transfer of climate-friendly technologies has been advocated so that the technologies are available in public domain facilitating wider transfer and diffusion.[77]

3. In the UNFCCC meeting at Accra in August 2008 developing nations including India, China and Brazil have put forth many suggestions on IPRs and transfer of climate-friendly technologies. These suggestions which form part of the Comprehensive Technology Plan put forth by China and G77 include setting up Multilateral Climate Technology Fund, under UNFCCC. The Plan has incorporated many suggestions on technology transfer of climate friendly technologies and IPRs. These can form the basis for further action and negotiations towards the Copenhagen Conference.[78]

4. Open Source models and Distributed Innovation: Use of Open Source models to facilitate technology transfer, is an idea which is getting attention now. For example Eco-Patent Commons is an initiative in which 84 patents are offered free for use in ESTs and the patent owners have agreed not to sue for infringement for such uses. Since we have discussed this elsewhere we will not repeat the same points here.[79] It has been suggested that Distributed and Open Innovation methods can be used to develop, disseminate and transfer of climate-friendly technologies.[80]

Some other proposals that can be considered include the following:

1. Patent pools of relevant technologies can be created so that countries will be able to get licenses without dealing with too many parties. Patent pools are widely used in electronics and IT industry. When the different technologies related to single device (say digital camera) or application (MPEG format) are held by many parties and the technology cannot be put to use unless each party licenses them patent pools are created and cross licensing among the parties is encouraged. Such patent pools are created by holders of IP rights, with or without government support or intervention. The technologies in the pool are available for licensing on mutually agreed terms. Governments try to ensure that the pool is not misused and anti-competitive practices are not followed by the members. For climate change technologies also patent pools can be created and a funding mechanism similar to the one in Montreal Protocol can be established for accessing the technologies. The patent pool can be technology specific or sector specific and can include technologies that can cater a wide variety of needs. This idea needs to be developed further.

2. A global R&D alliance similar to one suggested by the CIPR is another suggestion that can be explored. There are similar initiatives in health sector on diseases. In this the PPP model (Private-Public Partnership) is used to find vaccines and drugs for neglected diseases and infectious diseases. The suitability of this model for climate change technologies should be explored.

3. Developing nations including India have made suggestions on technology development and transfer. India's country paper to Gleneagles Summit proposed a network called CLEANET for collaboration in energy R&D modeled on CGIAR and establishing a Global Technology Venture Capital Fund. (Government of India 2007).

4. Maskus and Barton have proposed a global pact on access to Science and Technology so that WTO Agreements, particularly TRIPS do not become a barrier in access to science, technology and knowledge.[81] Their objective is to ensure that access to science is unhampered and free flow of scientific and technological knowledge is ensured for public good. This theme can be extended to climate-friendly technologies as well.

European Patent Office came out with four scenarios for the future patent system. One of this, the Blue Skies Scenario is relevant for discussions on development and transfer of climate-friendly technologies.

The Blue Skies scenario: technology becomes the dominant driver and the patent system is differentiated to face the global crisis. In this scenario the patent system is not a 'one size fits all' model, it differentiates between technologies and mirrors the qualitative step forward in development an invention offers society. 'Soft patents' are developed for climate friendly technologies, while industries as the pharmaceuticals keep hard protection. For some technologies the monopoly rights would be replaced by a license of rights regime for technology intensive and complex products. [82]

Today most of the technology development and transfer projects are under bi-lateral fora rather than under UN or UNFCCC. Similarly, private sector has invested heavily in technology development and it may not be willing to share technology in the absence of IPRs. Many projects among nations involve partnership with private sector and here too the IP issues need to be studied in depth.

In our view there is a need to analyze the ideas and solutions suggested for fostering transfer of climate-friendly technologies and compare them with the positions taken by developed and developing nations and others like NGOs. Although there is a consensus that climate-friendly technologies are a must to meet the challenge of climate change, there is no consensus on issues on IPRs and transfer of technology. Since private sector is a key player in both development and transfer of technologies, private sector's positions on IPRs and various initiatives taken by private sector and organizations representing them have to be considered to find solutions.

The North-South divide on IP issues should not become a stumbling block on transfer of climate-friendly technologies.[83] The discussions on trade in Environmental Goods and Services are also important for transfer of climate-friendly technologies. Although reduction in tariff, classification and standards are the major issues in those discussions, standards are linked to IPRs and can be used for hindering transfer of climate-friendly

technologies, goods and services. How flexible is the global IP regime to meet the challenge of climate change.? Critics of the global IP regime under TRIPS point out that there is an urgent to need caution against strengthening of IPRs in all countries in all technologies.[84]

The analogy with public health crisis is relevant here.[85] The access to drugs and vaccines for HIV/AIDS alerted the global community on the limitations of TRIPS in public health crises and the potential of IPRs to become barriers. In case of climate change although the crisis is not so visible, it is essential that the global community should find just and equitable solutions and should not let IPRs to become barriers to technology development, transfer and diffusion. [86]

Conclusion

Development and transfer of climate-friendly technologies is an important element in the adaptation strategy. The need for new technologies to face the challenge of global climate change is obvious. The Bali Action Plan recognizes the crucial role of technology and highlights the importance of technological development, transfer and use of technologies.

Our brief analysis in this paper shows that in many technologies IPRs can become a barrier to access and transfer of technologies to developing countries. It also shows that patents with wide scope and proliferation of patents, particularly on basic technologies in technologies like bio-fuels can affect wider dissemination and transfer of technology.

Although it is too early to come to categorical conclusions, it may not be an exaggeration to state that developing nations should be aware of these issues and take pro-active measures, including technology assessment and patent landscaping. In some technologies like biofuels and wind energy South-South co-operation and joint development of technologies can offset to some extent the dominant position of firms in developed countries. At the global level the TRIPS Agreement has not been a great source for transfer of technology. Although it does provide for some flexibility, it also limits the options available to governments under compulsory licensing and competition measures.

The experience under the Working Group on Technology Transfer has not been positive.

Many proposals have been put forth to facilitate technology transfer and dissemination. It is noteworthy that among these there are proposals that address the IP issues and try to ensure that IP rights do not become a barrier. In particular the proposals by G77 and India and China deserve to be studied in depth as they can form the basis for negotiations in this issue. Developing nations and UN can study some of the proposals including proposals that advocate replicating the Fund under Montreal Protocol to examine their feasibility and viability. One important issue is the knowledge gap in understanding the relationship between IP rights in different technologies, emerging technological trends and their impacts on transfer of technology. There is an urgent need for theoretical and empirical work in this.

Another important issue is whether IPRs act as a barrier for leapfrogging by developing nations. In our view this aspect should be given importance because in the context of climate change, developing nations do not have the time to try different technologies developed earlier and then to switch to newly developed technologies, as the time for transition to less carbon intensive economy is not even three decades. Technology diffusion and development should facilitate leapfrogging than hampering it. Although leapfrogging is also question of the capability to use recent/advanced technologies and their relevance, many developing nations now, have the capacity to learn and adopt the advanced technologies.

As a recent report points out, "Similarly at the international level, while intellectual property rights (IPRs) are generally considered as a necessary protection by leading firms (Goldemberg 1998), IPRs can at the same time constitute a major impediment for technological leapfrogging. While they do not necessarily prevent the diffusion of cutting edge technologies, they can be used by their owners to keep competitors away from their markets and prevent others to make useful experience for further developments and improvements of the technology (Steinmueller 2001). Such learning processes are fundamental for the creation of knowledge and skills – an important element of technological capabilities required for the leapfrogging of industrial development pathways."[87]

Hence it is essential that IP issues do not become a barrier in technological leapfrogging. The challenge of climate change calls for out of the box thinking to find solutions that can make a difference. In our view the IP issues can be tackled by a combination of policy measures, incentives and bringing in changes at the global IP regime under TRIPS.

FOOTNOTES

1 Agenda 21 of UNCED 1992 provides the following definition of ESTS "Environmentally sound technologies protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substitutes…. Environmentally sound technologies in the context of pollution are 'process and product technologies' that generate low or no waste, for the prevention of pollution. They also cover 'end of the pipe' technologies for treatment of pollution after it has been generated" (United Nations, 1992).

2 In this paper the focus is on role of IPRs in technology transfer and diffusion than on technology transfer debate per se in the context of UNFCCC. An overview of that debate can be found in Intellectual Property Quarterly Update Fourth Quarter 2008, Feb 2009 www.ciel.org

3 To know more about the work of RIS in this please visit www.ris.org.in

4 For a recent analysis that expresses the view that while IPRs are important, they should be seen as one set of instruments in the broad portfolio in the innovation system and that there are alternatives to patents to stimulate innovation see Stiglitz. J. (2008) .

5 See generally Kieff (2002) for a discussion. See also Mandel (2005) for the relationship between environmental innovation and patents and the question of market failure in environmental innovation.

6 There are initiatives at ICTSD and Royal Institute of International Affairs, London to do some mapping exercises in climate-change technologies based on patent analysis and statistics. See also WIPO (2008b).

7 As a result patent claims granted in one country may not be granted in another country or may be granted partially. There are many examples to illustrate this. For example, regarding patents on BRCA gene in Europe and USA see Paradise, J. (2004).

8 See Kemp, R (2008) for an overview of issues in measuring Eco-innovation.

9 See WIPO (2008b).

10 Dechezlepretre D. et. al. (2008) at 30.

11 Dora Marinova *Patent Trends in the development of sustainable technologies* Presented at European Patent Forum 2008 http://documents.epo.org/projects/babylon/eponet.nsf/0/C1B7C875A2C19603C1257443005994B2/$File/dora_marinova_en.pdf.

12 *WIPO Patent Report 2007* at P 23

13 Miller, R.T. et.al. (2008).

14 http://www.hrfmlaw.com/news/index.cfm

15 OECD (2008) at P 21.

16 ibid.

17 Prins.G, Rayner.S. (2007) at 38-39, Kammen, D. (2006). at 308, Holdren, John (2006) at 20. See Gallagher, Kelly Sims, John P. Holdren, and Ambuj D. Sagar (2006): 193-237 for an overview of climate change, energy and innovation in technology.

18 Stren, Nicholas. (2006) at P 367.

19 See Lorenz, P., et. al (2008) for an overview of the technology, technology trends and economics of solar power.

20 Rai, A. (2008) www.law.berkeley.edu/institutes/bclt/entrepreneurship/presentations/Friday/1145am/rai.pdf

21 See Singer , P.A. et.al (2005) http://www.issues.org/21.4/singer.html
http://www.wipo.int/patent-law/en/developments/nanotechnology.html

22 http://www.technologyreview.com/Nanotech/18259/

23 We are not aware of any study that examines the scope of technologies covered by patents in nanotechnology and their application in solar energy technology.

24 Barton, J. (2007a), See also Barton, J.(2007b).

25 e.g. Gamesa Eolica v. General Electric, 359 F. Supp. 2d 790 (WD Wisconsin 2005)
For example, according to Reichman, J. et. al (2008)
"The wind turbine industry is also quite concentrated, with the top 4 firms accounting for almost 75 per cent of the market. In the U.S. market, General Electric is the major player, and it has a reputation for enforcing its patents aggressively. For example, in February 2008 GE asked the U.S. International Trade Commission to bar imports of wind turbines made by Japan's Mitsubishi Heavy Industries Ltd., arguing that Mitsubishi's turbines infringe on its patents."

26 J. Lewis (2006).

27 Lewis, J. (2007)

28 See Sauter. R, Watson, J. (2008)

29 For an overview of the global biofuels situation and issues see FAO (2008)

30 A discussion on the potentials and limitations of these technologies is beyond the scope of this paper. See Breithaupt, H. (2008) for a discussion on some of the technical problems and issues that are of that concern to scientists.

31 Cahoy, D.R. (2007)

32 ibid

33 Rai , A. (2008), supra 12

34 ETC Group (2008a)

35 Ward and Young (2008)

36 Srinivas, K.R. (2008) http://www.southcentre.org/index2.php?option=com_docman&task=doc_view&gid=932&Itemid=69

37 See Kumar and Rai (2007) , ETC Group (2007) for details.

38 For details see Suppan (2008)
http://www.ethanolproducer.com/article.jsp?article_id=4159
Suppan (2007) http://www.tradeobservatory.org/library.cfm?refid=100449
and Srinivas (2009)

39 See Heller, M., Eisenberg, R. (1998) for a discussion on anti-commons.

40 See generally
FAO (2007) for an overview. See also ICAR(2007) Papers from ODI at **www.odi.org.uk/climatechange/** also discuss this issue.

41 See CGIAR(2007) According to CGIAR "Since stresses such as drought and heat have always posed a significant threat to crop production, CGIAR scientists began developing hardier varieties soon after the international agricultural research centers were created. "Climate-resilient" crop varieties resulting from this work have already reached farmers' fields, and more are in the making."

42 ETC Group (2008) http://www.etcgroup.org/en/materials/publications.html?pub_id=687

43 See Breithaupt, H. (2008).
"Research into drought tolerance demonstrates once again that a 'one-size-fits-all' solution is not the best one, as Ian Bancroft from the John Innes Centre commented : " The UK cannot export [varieties] to China and expect that they grow the same".

44 See Aoki, K. (2008) for a discussion on this.

45 See Tripp, R., Louwaars, N., Eaton, D. (2007) for a discussion on plant variety protection in developing countries.

46 Tamura, K. (2005)

47 Vallentin.D.,Liu.L, (2005)

48 Philibert, C., Podkanski, J., (2005) CCS=

49 IEA/OECD/CIAB (2008) at P47
See also Jiang, K., Zheng, S. (2006) http://2050.nies.go.jp/cop12/pdf/7_Kejun_COP12.pdf

50 Watson, et.al (2007)

51 Ockwell, D., J. Watson, et al. (2006)

52 Watal, J. (2000) P 45–55, http://www.unctad.org/en/docs/itcdted6_en.pdf

53 UNIDO. (2006). Cf. Gervais, D. (2007)
"In sum, economic analysis tends to demonstrate that sufficient IP protection is an essential component of increased inward FDI and trade flows in IP sensitive goods, for countries above a certain economic development threshold' at P 33 . Thus it does not make sense to argue that irrespective of state of economic development stronger IPRs would attract FDI or result in more innovation.

54 Kim, (2003)

55 See Kumar, Nagesh.(2002), Kumar, Nagesh (2003).

56 Cf According to Hoekman et.al.
"Total trade in technology intensive goods grew rapidly in the last three decades, with capital intensive exports expanding rapidly. Upper middle income nations constitute the fastest growing market for technology intensive exports from OECD countries. Licensing and other types of arm's length trade in technology measured by royalty income flows are largely the domain of OECD countries. The flows involved are not negligible – over $ 70 billion in 2001 " (Hoekman, Maskus, Saggi 2004 at 6).

57 USTR. (2006).

58 Bridges Trade BioRes Vol 8 No 20, 14th November 2008, http://ictsd.net/i/news/biores/3669

59 See Shadlen., K. (2005).

60 For a discussion on this see Fynn (2008).

61 Bert Metz *et al.*, eds (2000) at p 99

62 Howse,(2000) at 494. See also Arup (2008).

63 Arup ibid.

64 Governments can make non-voluntary use of technologies. See Reichman, J.H., Hazenshal, C..(2003).

65 See UNCTAD/ICSTD(2007) Chapter 29, Part III for a discussion on the linkage between Article 8.2 and Article 40.

66 Correa, C. (2005) at P 237.

67 Carvalho, Nuno Pires de. (2005) at 162, and see also 317, 319

68 Reichman, J.H., Hazenshal, C..(2003)

69 Correa, C. (2005) at P 255.

70 Paice, the patentee sued Toyota for infringing its patents. The Federal Circuit confirmed the decision of the District Court to deny permanent injunction and ordered for paying an 'ongoing royalty' by Toyota to Paice.

71 Reichman, J. et. al. (2008) "Another compulsory license that might be relevant to the environmental sector is the government use license. Under a government use license, a

private contractor may be made an agent of the government for purposes of manufacturing the patented product and making it available to the public at large. Such activity is immunized against an infringement action in the courts. Instead, the patentee must seek adequate compensation from the government itself, which can be measured in terms of local conditions. Government use licenses are also subject to very few prerequisites, they can be rapidly issued for virtually any reason, and the relevant transaction costs are low" at 31.

72 See Correa , supra. See also South Centre (2005) http://www.southcentre.org/index.php?option=com_content&task=view&id=91
Foray, D.(2008).See generally, UNCTAD (2007) for technology transfer and development in Least Development Countries (LDCS)
http://www.unctad.org/en/docs/ldc2007_en.pdf

73 Moon (2008) at 8

74 See Reichman, J. et. al. (2008) and Lee. B (2008) for details.

75 See Rajamani,L.(2007).

76 Andersen. S. et. al. (2007) point out that except in two cases where owners of technology were unwilling to allow use of technology there was no problem in diffusion of technology and in some instances technology transfer was negotiated by Global Environmental Facility (GEF) and Multilateral Fund. (P 256). See also the cases cited in Pp 262 – 266. See also, Watal, J. (2000).

77 Ogonowski, M., et.al. (2004).

78 See Earth Negotiations Bulletin Vol . 12 No 383 for an overview of the conference. See TWN Briefing Papers and Accra News Updates for details of the proposals.

79 See http://www.wbcsd.org/web/epc/ for details on Eco-Patent Commons
Srinivas, K.R. (2008).

80 Milford, and, Barker (2008).

81 Barton, J., Maskus, K. (2006).

82 http://www.epo.org/topics/patent-system/scenarios-for-the-future/scenario4.html

83 But the potential to become so, is there. For example in the Poznan Conference the divide was obvious.
According to Anon (2009),"On a related issue, long-standing divergence between developed and developing countries remained on issues related to intellectual property rights (IPRs). The contact group on 'Delivering on Technology and Financing, Including Consideration of Institutional Arrangements' discussed the matter in depth, but failed to come to any meaningful convergence: developing countries stressed the need to depart from a business-as-usual approach in the treatment of IPRs in addressing the climate change emergency, while developed countries emphasised the importance of IPRs in promoting innovation for technology development and deployment."
http://ictsd.net/i/news/bridges/37981/

84 According to Maskus and Reichmann, " In our view governments in developing countries need to be pro-active in ensuring that the net effect of expanded IP protection is to enhance access to technology and to encourage its domestic adaptation and diffusion. Potential gains in dynamic competition are reason enough for this approach. An additional important factor is that tightened protection raises significant questions regarding the ability to access international technology and information to improve the provision of broader public goods."

85 For a discussion on this see Abbott, F.M (2008).

86 For an overview of the North-South divide in climate change debate see Parks, B.C., Timmons, R.J. (2008).

87 Sauter. R, Watson, J. (2008) at 13

REFERENCES

Abbott, F.M 2008 *Innovation and Technology Transfer to Address Climate Change* Presentation at UNFCCC COP 15, Ponzan Dec 2008

Andersen, S.O. et. al. . 2007. *Technology Transfer for Ozone Layer*. London: Earthscan.

Anon 2009 Ponzan Climate Meeting Matched Low Expectations *Bridges* Vol 12, No 6

Aoki, K. 2008. *The Seed Wars*. NC: Durham: Carolina Academic Press.

Arup., C. 2008. TRIPS as Competitive and Cooperative Interpretation. In *Interpreting and Implementing the TRIPS Agreement,* (Eds) J. Malbon and C. Lawson Cheltenham: Edward Elgar.

Barton, J., Maskus, K 2006 Economic Perspectives on a Multilateral Agreement on Open Access to Science and Technology In *Economic Development & Multilateral Trade Cooperation* (Eds) S. Evanett and B. Hoekman Washington: World Bank

Barton, John. 2007a. *New Trends in Technology Transfer*. Geneva: ICTSD.

Barton, J. 2007b. *Intellectual Property Rights and Access to Clean Energy Technologies in Developing Countries*. Geneva: ICTSD.

Breithaupt, H. (2008). 2008. Up to the challenge? Rising prices for food and oil could herald a renaissance of plant science *EMBO Reports* 9 (9):832-34.

Cahoy, D.R. . 2007. *Intellectual Property Issues for the Emerging Bioenergy Sector*. Presentation at Cross Over Symposium at Smeal College of Business.

Carvalho, Nuno Pires de. 2005. *The TRIPS Regime of Patent Rights*. The Hague: Kluwer Law International

South Centre 2005. *THE AGENDA FOR TRANSFER OF TECHNOLOGY: THE WORKING GROUP OF THE WTO ON TRADE AND TRANSFER OF TECHNOLOGY* Geneva: South Centre.

CGIAR. 2007. *Global Climate Change: Can Agriculture Cope* .D.C: Washington: CGIAR.

Childs, M. 2008. *Do We Need Patents for Eco-Innovation*. Presentation at European Patent Forum, Solvenia, 7 May 2008.

Correa, C. 2005. Can TRIPS Agreement Foster Technology Transfer to Developing Countries? In *International Public Goods and Transfer of Technology*, edited by K. Maskus, Reichman, J.H.,. Cambridge: Cambridge University Press.

Dechezlepretre, A., et. al. 2008 *Innovation and Transfer of Climate Change Mitigation Technologies on a Global Scale: A Study Drawing on Patent Data* Paris: CERNA, Mines ParisTech

EPO. 2008. *Scenarios For Future*. Munich: European Patent Office.

Group, ETC. 2008. *Patenting 'Climate-Genes' and Capturing Climate Agenda*. Ottawa, Canada: ETC Group.

———. 2008a. *Commodifying Nature's Last Straw*. Ottawa: ETC Group

FAO. 2007. *Adaptation to climate change in agriculture, forestry and fisheries* Rome: FAO.

———. 2008. *The State of Food and Agriculture: Biofuels: Prospects, Risks and Opportunities* Rome: 2008.

Foray, D. 2008. *Technology Transfer in the TRIPS Age* Geneva: ICTSD.

Fynn, S. 2008 *Using Competition Law to Promote Access to Knowledge PJIP, Washington College of Law*, American University www.wcl.american.edu/PJIP

Gallagher, K.S., Holdren,J.P., Sagar, A.D.,. 2006. Energy-Technology Innovation. In *Annual Review of Environment and Resources*

Gervais, D. 2007. TRIPS and Development. In *Intellectual Property, Trade and Development*, edited by D. Gervias. Oxford: Oxford University Press.

Heller, M., Eisenberg, R. 1998. Can Patents Deter Innovation? The Anticommons in Biomedical Research. *Science* 280:686-701.

Holdren, J. 2006. The Energy Innovation Imperative. *Innovations* (Spring).

Howse, R. 2000. The Canadian Generic Medicines Panel - A Dangerous Precedent in Dangerous Times. *Journal of World Intellectual Property* 3 (4):493-507.

ICAR. 2007. *Recommendations of National Conference on Agriculture and Climate Change.*

IEA/OECD/CIAB. 2008. *Clean Coal Technologies*. Paris: IEA/OECD.

Jiang, K., Zheng,S.,. 2006. *Low-Carbon Options in China Through Sustainable Development* Presentation at UNFCCC-Side Event at COP 12 (Nairobi).

Kammen, D. . 2006. The Rise of Renewable Energy. *Scientific American*

Keiff, S.F. 2002. Patents for Environmentalists. *9 Wash. U.J.L. &POL'Y* 307.

Kemp, R. 2008 *Measuring Eco-innovation* Research Brief No. 1 Maastricht: UNU-MERIT

Kim, L. 2003. *Technology Transfer and Intellectual Property Rights: the Korean Experience*. Geneva: ICTSD.

Kumar, N. 1998 Technology Generation and Transfers in the World Economy in (Eds) Kumar, N. , Dunning, J.H. , *Globalization, foreign direct investment, and technology transfers: impacts on and prospects for developing countries* Routledge

Kumar, N. 2002. *Intellectual Property Rights, Technology and Economic Development*. London: CIPR.

———. 2003. Intellectual Property Rights, Technology and Economic Development–Experiences of Asian Countries. *Economic & Political Weekly* 38 (3):209–26.

Kumar, S., Rai. A.,. 2007. Synthetic Biology: The Intellectual Property Puzzle 85 *U. Texas Law Review* 1745.

Lee, B. 2008 *IPRs and Diffusion of Climate Technologies* London: Chatham House/RIIA (presentation at Ponzan Conference)

Lewis. J.I. 2006 *International Technology Transfer Experiences in China's Electricity and Transport Sectors*, Arlington: Pew Center on Global Climate Change

Lewis, J. I. 2007. Technology Acquisition and Innovation in the Developing World: Wind Turbine Development in China and India. *Studies in Comparative International Development* 42:208-232

Lorenz , P. et.al. . 2008. The Economics of Solar Power. *The McKinsey Quarterly* (July 2008).

Mandel, G.N. 2005. *Promoting Environmental Innovation with Intellectual Property*

Innovation: A New Basis for Patent Rewards Available at SSRN: http://ssrn.com/abstract=756844

Marinova, D. . 2008. Patent Trends in the development of sustainable technologies Presentation at European Patent Forum, Solvenia.

Maskus, K., Reichman, J.H.,. 2005. Introduction. In *International Public Goods and Transfer of Technology* Cambridge: Cambridge University Press

Metz, B., et. al.,(Eds), ed. 2000. *Methodological and Technological Issues in Technology Transfer.* Geneva: IPCC.

Milford, and, Barker 2008 .*Climate Choreography* Washington: Clean Energy Group.

Miller, R.T., et.al. 2008. Patent Trends in the Cleantech Industry. *Intellectual Property and Technology Law Journal* 20 (7)

Moon, S. 2008 *Does TRIPS Art. 66.2 Encourage Technology Transfer to LDCs? An Analysis of Country Submissions to TRIPS Council (1999-2007)* Policy Brief No 2, December 2008 Geneva: ICTSD

Ockwell, D., J. Watson, et al. . 2006. *UK–India collaboration to identify the barriers to the transfer of low carbon energy technology*. In Report by SPRU, IDS and TERI London: DEFRA.

OECD. 2008. *Compendium of Patent Statistics*. Paris: OECD.

Ogonowski, M., et.al. . 2004. *Advancing Climate Change Technologies Through Shared Intellectual Property Rights,*. D.C: Washington: Center for Clean Air Policy

Paradise, J. . 2004. European Opposition to Exclusive Control Over Predictive Breast Cancer Testing and the Inherent Implications for U.S. Patent Law and Public Policy:. 59 *Food Drug L.J*. 133

Parks, B.C., Timmons, R.J. 2008 Inequality and the global climate regime: breaking the north-south impasse *Cambridge Review of International Affairs* Vol.21 No 4 Dec 2008, Pp 621-648

Philibert, C., Podkanski, J., . 2005. Clean Coal Technologies (Case Study 4)

In *INTERNATIONAL ENERGY TECHNOLOGY COLLABORATION AND CLIMATE CHANGE MITIGATION*:. Paris: OECD.

Prins.G, Rayner.S. . 2007. *The Wrong Trousers: Radically Rethinking Climate Policy*. Oxford: James Martin Institute.

Rajamani, L. 2006 Differential Treatment in International Environmental Law Oxford: Oxford University Press

Reichman, J.H., Hazenshal, C. 2003. *Non-Voluntary Licensning of Patented Inventions*. Geneva: ICTSD.

Reichman, J. et. al. 2008 *Intellectual Property and Alternatives: Strategies for Green Innovation* EEDP Paper 08/03 London: Chatham House/RIIA

Sauter, R, Watson, J. 2008 *Technology Leapfrogging : A Review of the Evidence Sussex Energy Group,* SPRU, University of Sussex

Shadlen., K. 2005. *Policy Space for Development in the WTO and Beyond: The Case of Intellectual Property Rights*. Medford: MA: GADE,Tufts University.

Singer, P.A. et.al 2005. Harnessing Nanotechnology to Improve Global Equity. *Issues in S&T 2*1 (4).

Srinivas, K.R. . 2008. Sink or Swim: Eco-Patent Commons and Transfer of Environmentally Sustainable Technologies. *Bridges Trade BioRes* 2 (2):17-18.

Srinivas, K.R. 2009 (Work In Progress). Biofuels and IPRs New Delhi: RIS.

———. 2008b. Substances Occuring in Nature. In A *Guide to Pharmaceutical Patents*, edited by C. M. Correa. Geneva: South Centre www.southcentre.org.

Stiglitz, J.E (2008) Economic Foundations of Intellectual Property Rights, 57 *Duke Law Journal* 1693

Stren, N. 2006. *The Economics of Climate Change: The Stern Review*. Cambridge

Cambridge University Press

Suppan, S. 2007. *Patents: Taken for Granted in Plans for a Global Biofuels Market*, IATP. Minneapolis

———. 2008. Patent Policy and Sustainable Cellulosic Biofuels Development. *Ethanol Producer,* June

Tamura, K. 2005. Technology Development and Transfer In (Ed) A. Srinivasan Asian Aspirations for Climate Regime Beyond 2012,Tokyo : IGES.

Tripp, R., Louwaars, N. , Eaton, D. 2007 Plant variety protection in developing countries:

A report from the field *Food Policy* 32: 354–371

UNCTAD. 2007. *The Least Developed Counties Report*.

UNIDO. 2006. *The Role of Intellectual Property Rights in Technology Transfer and Economic Growth*: Theory and Evidence. Vienna

United Nations 1992. United Nations Conference on Environment and Development, Rio de Janeiro, Brazil, June 3-14. *Report of the United Nations Conference on Environment and Development, Annex II: Agenda* 21. U.N. Doc. A/CONF.151/26, Vol. III. United Nations, New York

USTR. 2006. *Report of Office of USTR on Trade Related Barriers to Export of Greenhouse Gas Intensity Reducing Technologies* Washington: USTR.

Vallentin, D., Liu.L,. 2005. *The Diffusion of Clean Coal Combustion Technologies For Power Plants in China.* Roskilde: TEKSAM, Roskilde University. .

Ward, R.M., Young, T.J. 2008. *Patenting Inventions Involving Biofuel Feedstock*: Morrison& Foerster LLC.

Watal.J. 2000. Case Study 3: India: The Issue of Technology Transfer in the Context of the Montreal Protocol. In (Eds) edited by V. Jha, U. Hoffman, *Achieving Objectives of Multilateral Environmental Agreements: A Package of Trade Measures and Positive Measures* Geneva: UNCTAD.

Watson, ., et al.. 2007. *Technology and carbon mitigation in developing countries: Are cleaner coal technologies a viable option?* . Background Paper for Human Development Report. New York: HDRO:UNDP.

UNDESA, 2008 *Background Paper: Climate Change : Technology Development and Technology Transfer for Beijing High-Level Conference* New York: DESA,UN

WIPO. 2008a. *WIPO Patent Report 2007* Geneva:: WIPO.

WIPO 2008b *Climate Change and Intellectual Property System Draft 5.0 November 2008 (Informal Consultation Draft)* Geneva: WIPO

World Bank 2008. *Global Economic Prospects: Technology Diffusion in the Developing World*. Washington, DC:

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