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Technology Diffusion Through Intellectual Property Rights: Innovating to Combat Climate Change

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South African Institute of International Affairs

African perspectives. Global insights.

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ABSTRACT

The technological revolution required by climate action, aimed at mitigating the impact of climate change, can be achieved by existing technology, but would benefit immensely from continued innovation to lower costs. Such a revolution will enable developing countries to 'leapfrog' technologies prevalent in developed countries. However, the sheer scale of investment required necessitates the wholesale participation of the private sector, motivated to innovate by intellectual property rights (IPRs). This paper shows evidence that IPRs can accelerate the diffusion and transfer of new climate-friendly technologies, and that their benefits are greater than their costs.

IN MEMORIAM

The management and staff of SAIIA are deeply saddened by the recent sudden loss of Peet du Plooy. We offer our heartfelt condolences to his family and other loved ones. SAIIA wishes to pay tribute to Peet's life and work through the publication of this final article he submitted to the Institute in late 2012.

ABOUT THE AUTHOR

Peet du Plooy was Programme Manager of Sustainable Growth at the Trade and Industrial Policy Strategies. Peet obtained a degree in mechanical engineering from the University of Pretoria. After working in energy R&D at the national utility Eskom, he joined the global environmental NGO, WWF, as Trade and Investment Advisor for South Africa. He was elected in 2009 as chair of the South African Green Industries Association, the Environmental Goods and Services Forum. His areas of expertise were in networked infrastructure (including energy, transport and ICT) and the economics of sustainability.

ABBREVIATIONS AND ACRONYMS

CSP	concentrating solar power
IDC	Industrial Development Corporation
IEA	International Energy Agency
IP	intellectual property
IPR	intellectual property right
LDC	least-developed country
OECD	Organisation for Economic Co-operation and Development
PV	photovoltaics
R&D	research and development
TRIMs	Trade-Related Investment Measures
TRIPS	Trade-Related Aspects of Intellectual Property Rights
UM	utility model
UNFCCC	UN Framework Convention on Climate Change
WBCSD	World Business Council for Sustainable Development
WTO	World Trade Organization

INTRODUCTION

For many years the threat of climate change has been in the headlines, but the next decade is critical. Current trends do not suggest that the needed 50% reduction in carbon emissions (in order to limit the long-term global temperature increase to between 2° and 2.4°C) will be achieved by 2050.[1] Advocates of climate change mitigation (described as slowing, aimed at stopping global warming) and adaptation (described as protecting against the impacts of climate changes already in progress)[2] agree on the need for a large-scale reindustrialisation of the world's energy and transport systems. Developing countries are the most affected by environmental degradation and yet lag behind industrialised nations in their access to, and adoption of, technologies.[3] Therefore, a technological revolution is needed that will enable developing countries to 'leapfrog' the unsustainable technologies prevalent in developed countries and result in greater economic growth for their regions. Intellectual property rights (IPRs) can be an enabler for technological innovation and for accelerating the diffusion and transfer of new technologies.

INTERNATIONAL IPR NEGOTIATIONS AND CLIMATE CHANGE

Some of the earliest consideration given to the issue of IPR protection was embodied in 'Agenda 21' (adopted at the 1992 UN Conference on Environment and Development), which recommended the '[p]urchase of patents and licences on commercial terms for their transfer to developing countries on non-commercial terms as part of development cooperation for sustainable development, taking into account the need to protect intellectual property rights' (section 34.18(e) (iii)).

The UN Framework Convention on Climate Change (UNFCCC), adopted in 1992 and entered into force in 1994, and the 2008 Bali Action Plan both expressly mention the transfer of technology. As article 4.5 of the UNFCCC states:

> The developed country Parties […] shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties.

In addition, articles 4.3 and 4.7 of the UNFCCC require developed countries to provide the financial resources needed by the developing countries to meet the costs of implementing their obligations, including the costs for the related transfer of technology.

The 2008 Bali Action Plan encourages effective mechanisms for providing financial and other incentives for transferring and promoting access to environmentally sound technologies to developing countries.

The UNFCCC and Kyoto Protocol, which essentially gives effect to the UNFCCC, do not specifically mention intellectual property (IP) in their provisions on technology transfer. However, in 2008 the Expert Group on Technology Transfer discussed IP as being both an element of, and a potential obstacle to, an 'enabling environment' for the transfer of technology. The IP issue had gained traction previously in 2007 when the European Parliament raised the need to review IP regimes. During the Bali Action Plan negotiations, developing countries like Cuba, India, Tanzania, Indonesia and China identified the need to address IP as a barrier to technology transfer.

Developing countries have been overshadowed by developed countries in respect of ownership of patents, royalties, licensing incomes, as well as expenditure on research and development (R&D). Through the Bali negotiations, the US and Australia reaffirmed their view that IP is a catalyst for technology transfer.

The World Trade Organization (WTO) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) introduced IP rights into the international trading system and TRIPS remains the most comprehensive international agreement on the topic. Article 66.2 of the TRIPS Agreement establishes an obligation on the part of developed-country members to incentivise enterprises and institutions to transfer technology to least-developed countries (LDCs). However, there has been little actual transfer.

INVESTING IN CLEAN ENERGY

The investment needed in clean energy technologies to make the transition would be approximately 35% ($36 trillion) more by 2050 than would be required if controlling carbon emissions were not a priority.[4] Using existing technologies, the world could transition to low-carbon energy.[5] However, the fuel saving by using energy efficiency, hydrogen energy technologies, advanced bioenergy, and wind and solar technologies[6] is estimated at about $100 trillion by 2050.[7] The International Energy Agency (IEA) estimates that by 2050 every additional dollar invested can generate three dollars in future fuel savings.[8] According to the IEA, new technologies offer the potential to reduce emissions, enhance energy security and result in a return on investments.

Between 2004 and 2009, new clean technologies accounted for investments of nearly $130 billion in North America and over $196 billion in Europe.[9] Renewable energy continues to gain market share, with growth in wind and solar photovoltaic (PV) installations continuing unabated despite the global financial crisis of 2008/09.[10]

By 2009, for the second year in a row, investment in renewable energies exceeded investment in fossil fuel-based power generation.[11] However, the investment falls short of what is required.

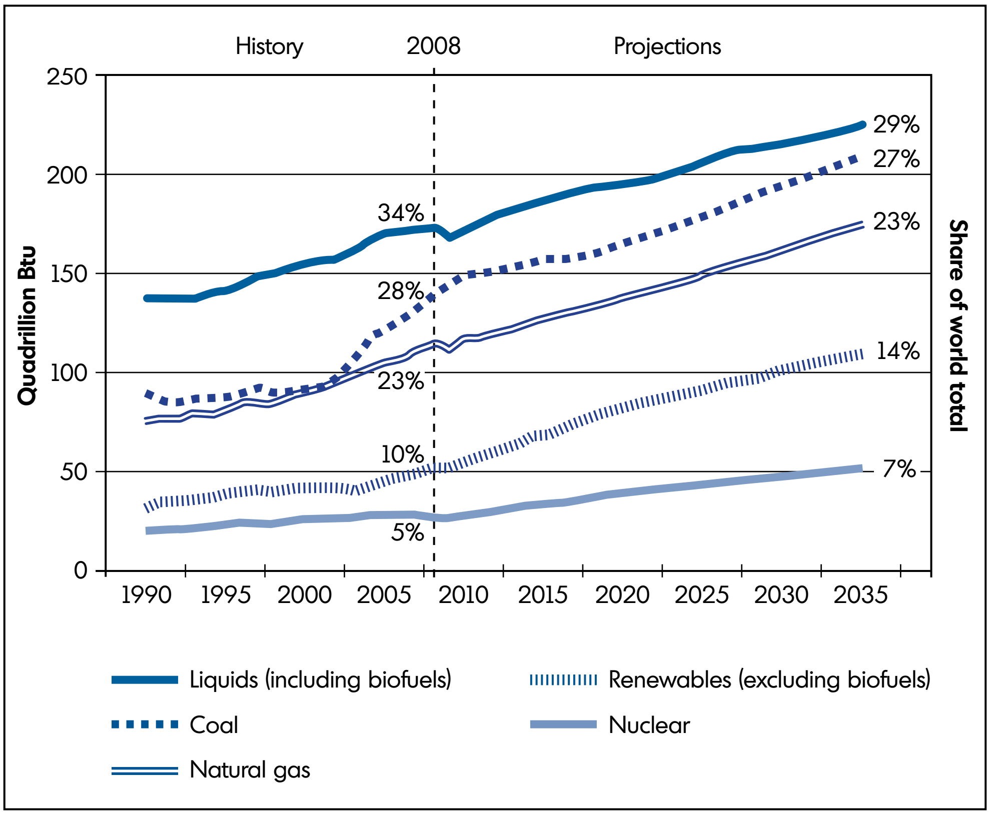
To address the joint challenges of climate change and energy, a total investment of over $750 billion a year between 2010 and 2030 and over $1.6 trillion a year between 2030 and 2050 will be required.[12] Helping developing countries adapt to climate change will cost between $28 billion and $67 billion, with Africa having to spend approximately $560 billion by 2030 for additional, largely clean, energy generation.[13]

Until recently three regional groups have dominated global R&D spending on climate-friendly technologies – the US with 34% of spending, Europe spending 23% of global spend and Japan at 12% of the global total.[14] Leading the developing countries, China, India and Brazil have, in the past few years, sharpened their focus on R&D on renewable energies.

Private companies account for two-thirds of total R&D spending by countries in the Organisation for Economic Co-operation and Development (OECD) and for 72% of R&D

in China.[15] In 2009 of the almost $25 billion spent globally on clean technology R&D, 60% was financed through private investment, including $7 billion in venture capital and private-equity financing.[16] In Europe, the largest investor in clean energy technology R&D – the private sector – contributed $8 billion of the $12 billion spent.

Figure 1: World energy consumption by fuel, 1990–2035



Source: EIA (Energy Information Administration), *International Energy Outlook 2011*, http://i.bnet.com/blogs/eia-renewableschart.bmp?tag=content;siu-container, accessed 17 March 2013.

IPRs AND TECHNOLOGY

The private sector is clearly a source of innovation and sustainable, market-based investment for clean energy. One way to motivate the private sector is through IPRs, which protect the economic interests of investors in a manner that promotes the sharing of information and technology. The intellectual property rights[17] relevant to climate-friendly technology are:

- **Patents:** Are an exclusive right granted for an invention, which is a product or a process that provides a new way of doing something, or offers a new technical solution to a problem. A patent provides protection for the invention to the owner of the patent for a limited period, generally 20 years.
- **Utility model (UM):** Similar to patents, UMs are a series of rights granted for an

invention for a limited period (usually seven to 10 years) and without substantive examination. During this time, UM holders can commercially exploit their inventions on an exclusive basis. The terms and conditions for granting UMs are different from those for 'traditional' patents.

- **Copyright:** Is a legal term describing rights given to creators for their literary and artistic works (including computer software) against illegal copying for a period of 50 years (70 years in the US and EU). Related rights are granted to performing artists, producers of sound recordings and broadcasting organisations in their radio and television programmes.
- **Trade secrets:** Are elements of protected information not generally known among, nor accessible to, individuals who normally deal with the kind of information in question. This information has commercial value because it is secret, and has been subject to reasonable steps to keep it secret by the person lawfully in control of the information.
- **Licensing agreement:** Is a partnership between an intellectual property rights owner (licensor) and another who is authorised to use such rights (licensee) in exchange for an agreed payment (fee or royalty). A variety of such licensing agreements is available, which may be broadly categorised as a technology license agreement; trademark licensing and franchising agreement; or a copyright license agreement.

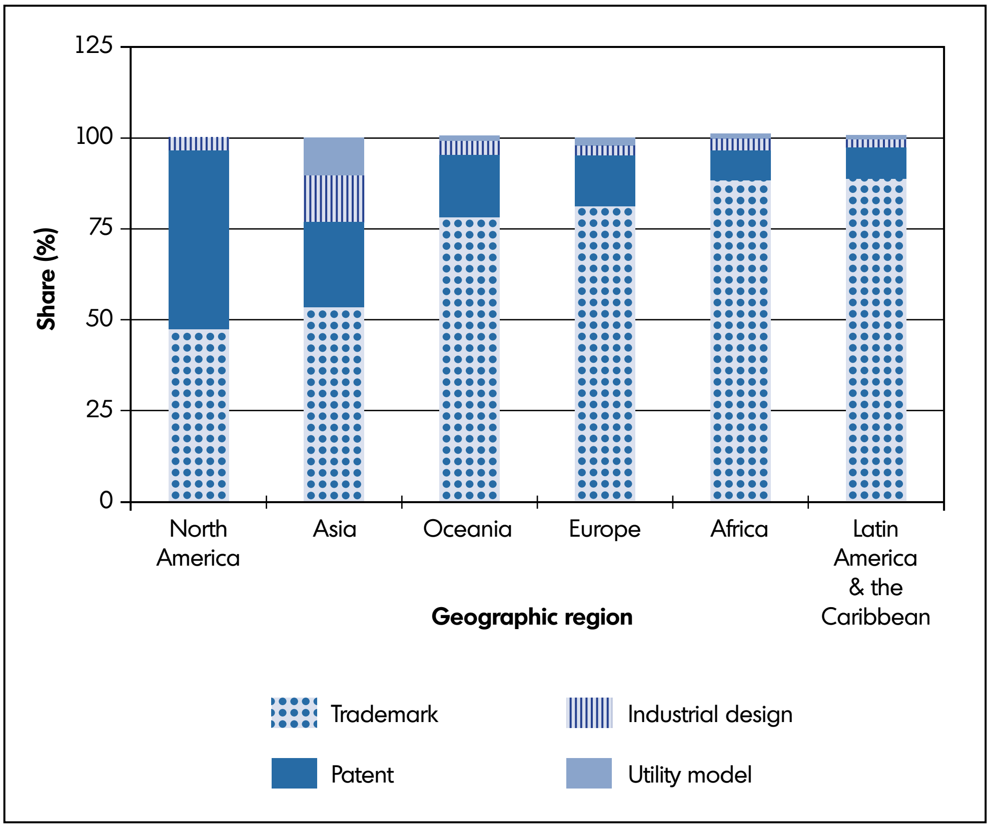
Two of these rights can be suspended under the WTO's Trade-Related Investment Measures (TRIMs) Agreement:

- Copyright can be exempted for 'fair use' in sectors or by persons designated by the relevant authority responsible for enforcing the copyright restriction.
- Authorities can allow for the 'forced licensing' of a patent for products manufactured in-country and deemed of strategic and humanitarian importance; for example, the patents of anti-retroviral drugs for treating HIV/Aids.

IPRs can play various roles, including incentivising businesses to invest in risky projects, providing certainty that allows technological transfers to take place, and preventing others from blocking the use of a technology by derivative initiatives.[18] Harvey argues that IPRs formalise a commodity, providing either a choice 'to give, transfer, sell or license so that others can invest in its further development' or to own an IPR. Holding or transferring the IPR is 'separate from the decision of how much, or whether, to charge for them'. To be effective, IPRs also need to be supported by appropriate infrastructure, governance and competition systems.[19]

Under certain circumstances, IPRs are not incentives for technology transfer at all.[20] For LDCs in particular, IP protection may in fact hinder or prevent transfer of technologies.[21] Existing technologies are absorbed and adapted to local conditions primarily through informal mechanisms such as imitation. In most cases, strong protection prevents the sort of 'reverse engineering' required for these mechanisms. Furthermore, in developing countries, the role of IPRs in promoting more formal means of technology transfer (trade, foreign investment and licensing) is negligible compared with other constraints such as limited market size, weak regulation and low technological capability of local firms.[22] However, what also needs to be considered is whether technology dissemination is likely to occur without the patent system.

Figure 2: Type of IP application across geographical regions

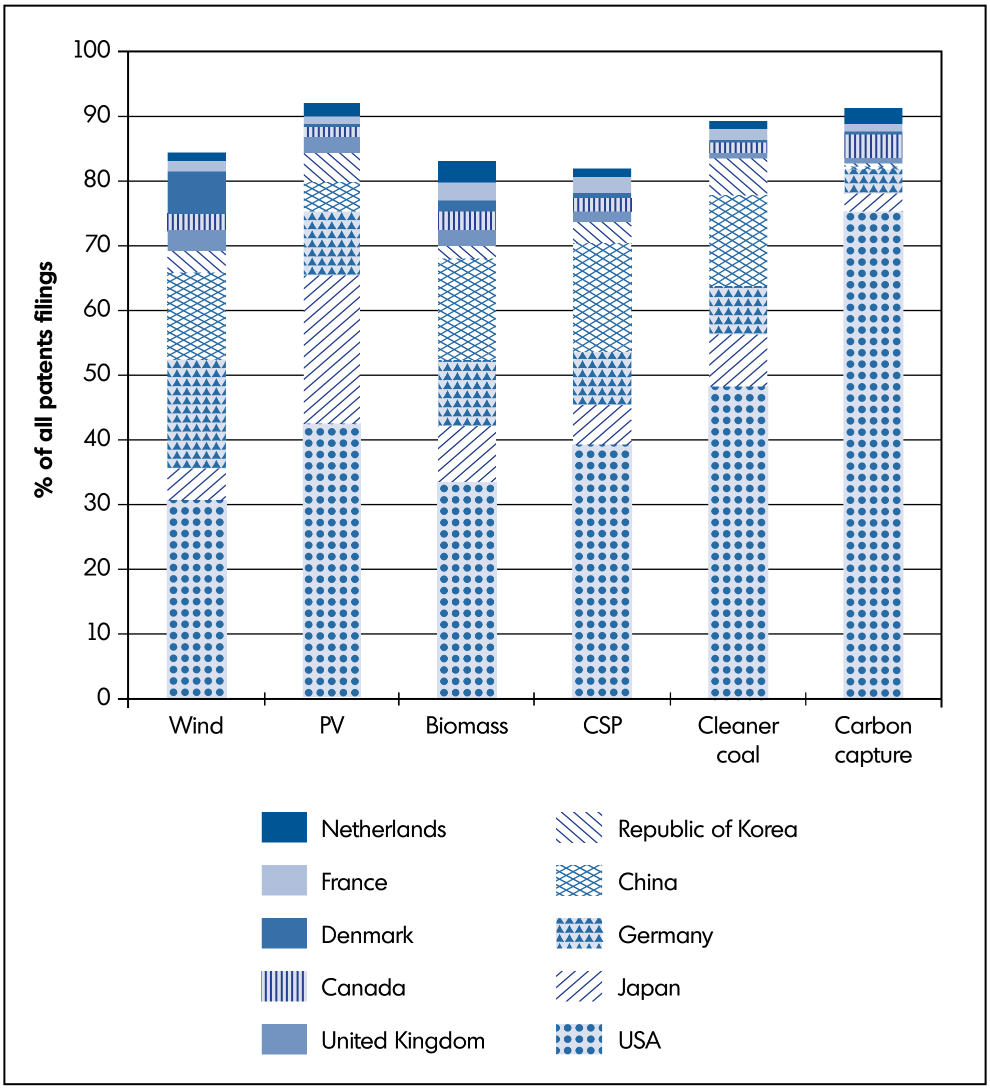


Source: WIPO (World Intellectual Property Organization), *2012 WIPO IP Facts and Figures*, http://www.wipo.int/freepublications/en/statistics/943/wipo_pub_943_2012.pdf, accessed 18 March 2013.

PATENTS OF CLIMATE TECHNOLOGY COMPANIES

Reflecting the global R&D expenditure up to 2009, patent ownership has been concentrated in the US, Japan and Germany, according to a study of over 50 000 patents for six clean energy technologies: solar PV (15 989), wind (12 264), carbon capture (9 160), concentrating solar power (CSP)[23] (7 193), cleaner coal (7 059) and biomass (5 305).[24]

Figure 3: Share of patents by geographical origin – top 10 countries

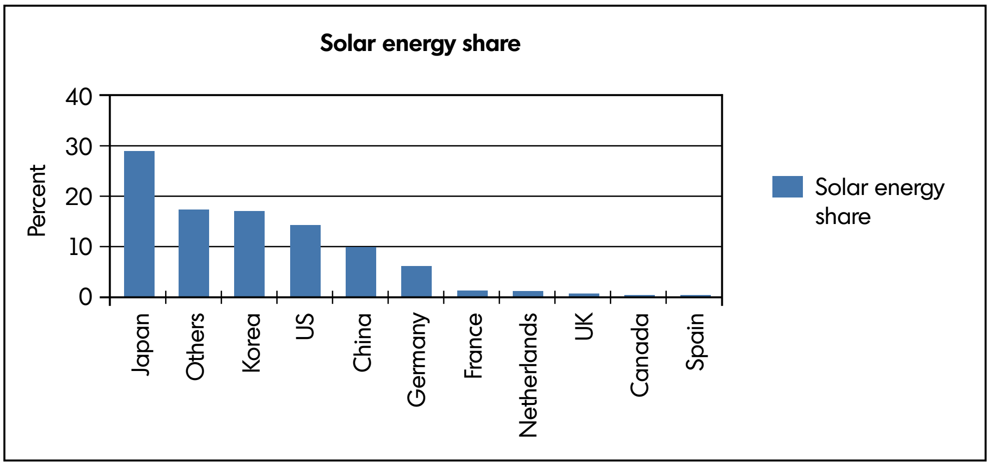


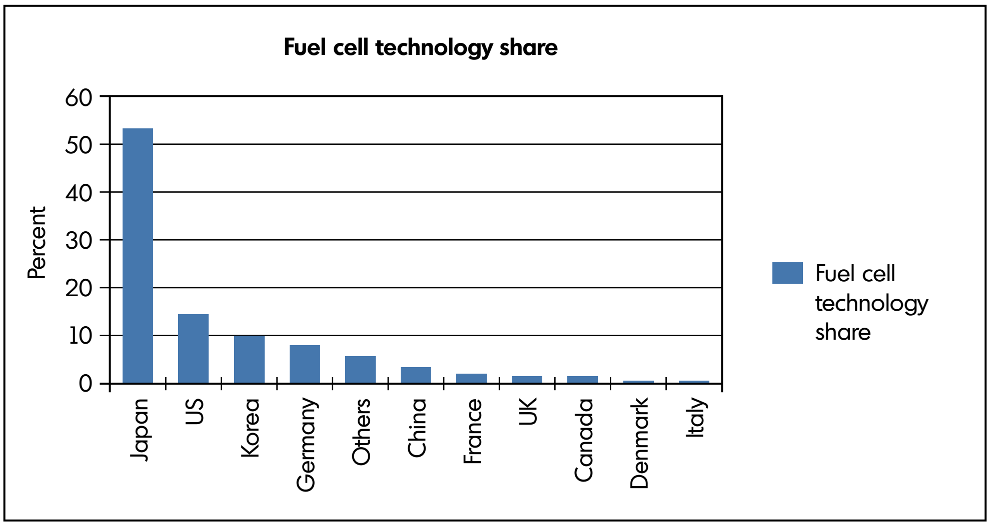
Source: Lee B, Iliev I & F Preston, *Who Owns Our Low Carbon Future?*, Chatham House, 2009,http://www.chathamhouse.org/sites/default/files/public/Research/Energy,%20Environment%20and%20Development/r0909_lowcarbonfuture.pdf.

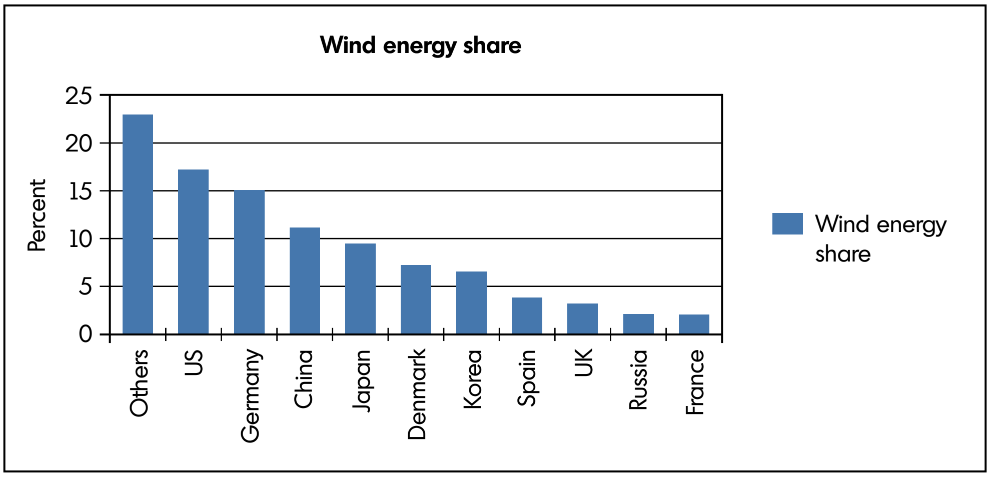
Since 2010 China has shown the highest rate of growth in patent applications and is also rated as the world's leading market for (and exporter of) a variety of clean technologies. These include solar water heaters, PV, wind turbines and batteries. China is also rated number one for investment attractiveness for energy renewables.[25]

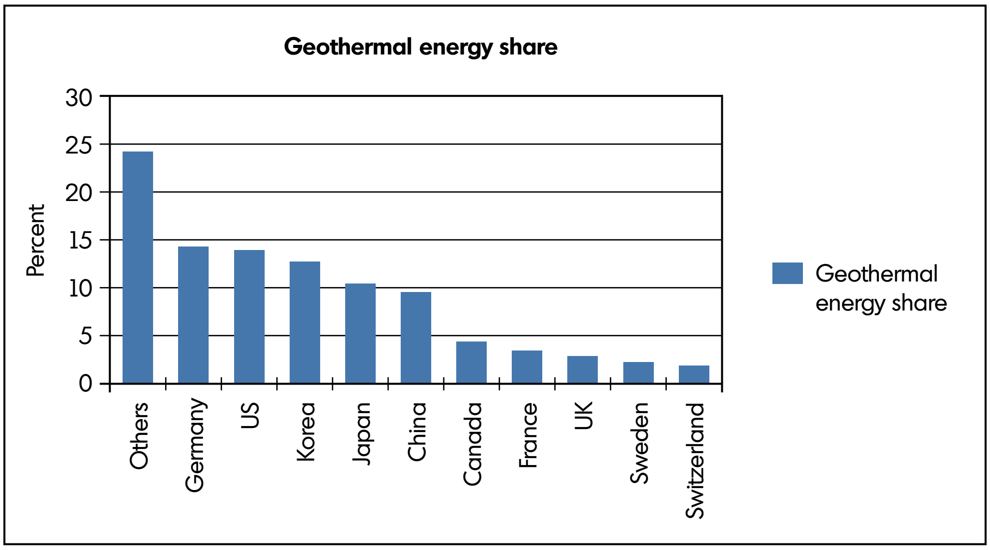
As could be expected, these patents are concentrated in the hands of multinational and national companies. The top 20 companies hold around 30% of patents, with the notable exceptions of, at the one extreme, cleaner coal (over 40%) and, at the other, CSP (10%). The graphs below show the top players in the global share of the renewable energy market by country.

Figure 4: Share of patent applications in energy-related technologies for the top origins, 2006–10









Source: WIPO, 'World intellectual property indicators – Tables and figures', http://www.wipo.int/ipstats/en/wipi/figures.html#overview.

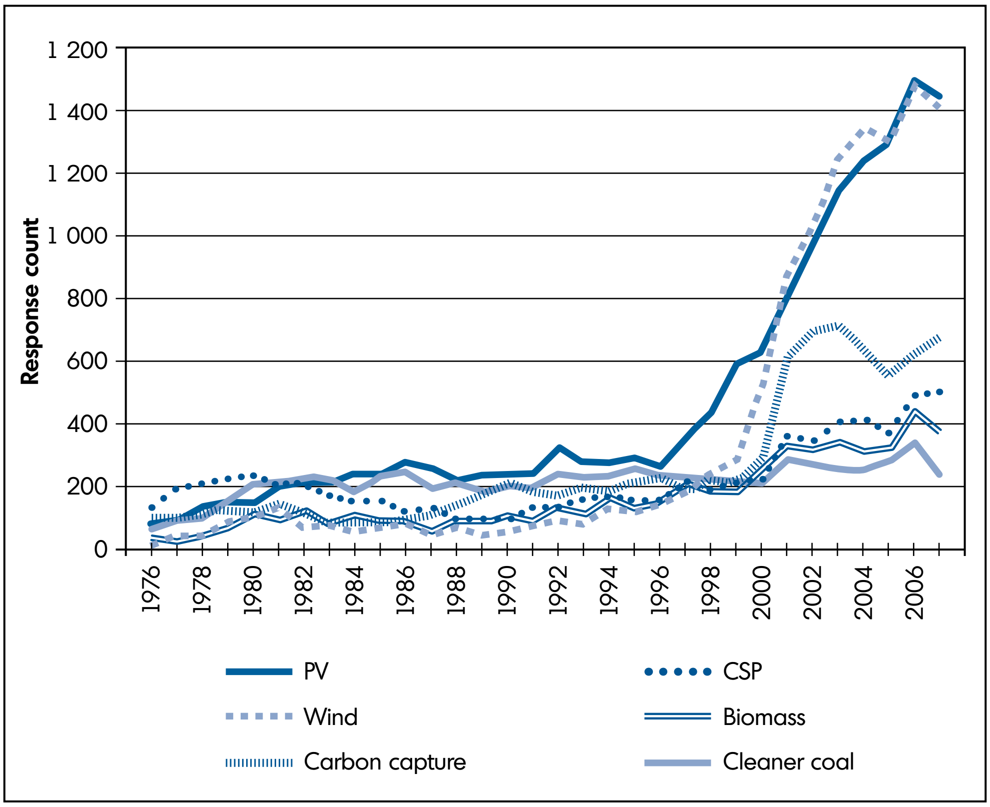
Three of the technologies considered critical to the sector – PV, biofuel and wind – have patents that cover specific improvements or new features, rather than basic technologies.[26] This implies that the markets are competitive enough for developing countries to be able to avoid high IP costs.

- In the PV sector, developing nations face a loose oligopoly with many entrants. Companies such as Tata BP Solar in India and Suntech in China have shown that developing countries can participate in the market. By 2011 this is a moot point, as China dominates both PV demand and supply.
- For biofuel technologies, IP appears not to be a barrier to developing countries accessing current-generation technologies, as demonstrated by Brazil, South Africa and Malaysia. The study found that more significant obstacles were trade barriers and distortions, which are related to trade, not IPRs.
- The wind sector is relatively concentrated but still competitive enough for developing countries. The greater challenge lies in breaking into the global wind turbine supply chain, which China and India have both succeeded in doing over the last decade.

THE PACE OF TECHNOLOGY DIFFUSION

Patenting has been a leading indicator for innovation and investment, with a time lag of around seven years. To illustrate, patenting for renewable energy technologies in particular started to accelerate in 1997, while investment started a strong pattern of growth in 2004.

Figure 5: Patenting trends for six clean energy sectors, 1976–2007



Source: Lee B, Iliev I & F Preston, *Who Owns Our Low Carbon Future?*, Chatham House, 2009, http://www.chathamhouse.org/sites/default/files/public/Research/Energy,%20Environment%20and%20Development/r0909_lowcarbonfuture.pdf.

Despite this upsurge in patenting and investment, a study by Lee, Iliev and Preston[27] found that in order to have a realistic chance to meet climate action goals, the time needed for diffusion of clean technologies would need to be halved by 2025. This means that continuing business-as-usual practice will not bring new technologies to market fast enough. The analysis by Lee, Iliev and Preston established that new energy inventions generally take two to three decades to reach the market. A similar time lag is found for any patented technology to become widely adopted in subsequent inventions.

THE COST OF IPRs

Despite the centrality of the additional cost of IPRs to the debate around technology transfer, information on actual IPR costs is scarce. According to the World Business Council for Sustainable Development (WBCSD), the royalty cost for energy patents represents a small share of the total investment cost.[28] Like the Stern Review,[29] the WBCSD argues that the cost of bringing a new technology to market is dominated by 'soft' elements such as operation and maintenance practices, training and organisational procedures – things that are not patentable. This view holds that the real issue for developing countries is not the accessibility of technologies or the price of the patents, but the lack of capital and management.

This cost is higher when it comes to accessing technology for the purposes of manufacturing a product. However, this part of the value chain is of less significance to developing countries, as manufacturing provides a relatively small share of the overall employment benefit of renewable energy roll-out.[30]

Lee, Iliev and Preston argue that patents offer influential financial and strategic incentives to the private sector and are important in attracting venture capital. Patents can be seen as currency in strategic alliances; they protect against litigation; and provide opportunities for mergers and acquisitions. The authors point out that the interaction between obtaining financing and access to patents is a critical issue for new market entrants – in both developed and developing nations. However, they also note that IP may be an incentive for investing in R&D but is not sufficient for diffusing technologies. It is noted that weak IP protection certainly slows diffusion efforts in some developing countries.[31]

Leading firms cite weak IP protection in host countries as reasons for withholding their latest technologies from certain markets. Companies may be willing to license for production or sale if they are confident that they will not lose control. These decisions depend both on the strength of the host countries' IP systems and on the IPR management norms, which differ from one industry to another.[32]

THE SOLUTION: PROTECTING IPRs

Solving the global climate challenge must include the protection of IPRs, in order to speed up the diffusion of innovation and technology. Property rights are a fundamental component of the dominant economic paradigm of capital, and countries with high levels of income have significant knowledge and services economies that are underpinned by strong recognition and protection of intellectual property. However, technology transfer cannot be achieved by decree or agreement among governments.

The innovation 'chasm' has been widely described[33] and adopted[34] as an organising principle for technology policy in developing countries. A number of factors may explain the failure of technology diffusion to progress from research to demonstration and development. However, the main challenge for developing countries is to participate as suppliers (not exclusively as buyers) in the climate technology markets. This implies the ability to transfer IP into products through access to the required means of appropriate government policy and planning, new production models, as well as access to skills, materials, production capacity and finance.

Therefore, international efforts towards improving global access to climate-friendly (and resource-efficient) technology should:

- Recognise that technology is not something exchanged by governments (ie the institutions represented at international talks) but is disseminated through a variety of mechanisms (trade, investment, hco-operation) between largely private actors (eg companies or individuals who travel between countries). To reflect this reality, the language needs to move from technology *transfer* to technology *diffusion*.

- Reach an agreement on the protection of IPRs, complemented by a Climate Technology Centre (for disseminating non-proprietary climate-related technology) and a special finance mechanism for first-of-its-kind demonstration projects in aid of technology diffusion.
- Promote effective competition, which helps limit the cost of IPRs. None of the key renewable energy sectors is dominated by monopolies, although oligopolies are not uncommon (in, for example, wind or PV).
- Improve research and absorptive capacity in developing nations. A global fund for climate action (such as the Green Climate Fund) could include a window for research and capacity building in developing nations, in the form of grant funding for 'salary support' for in-country experts and scientists, enabling public sponsorship for developing and maintaining essential skills in green technologies to compete with the demand for these skills in the private sector.
- Close the innovation (or commercialisation) gap from research to production. A global climate fund could support the additional cost of demonstration projects that would be clearly defined. For example: a first-of-its-kind project within a radius of 2 000 km within a specific technology class (from a set of classes in a prescribed list) and within the best 20% of global resource endowment. Demonstration projects could be supported through the use of public finance mechanisms as described by the UN Environment Programme Finance Initiative,[35] which share investment risks for the private sector, by the public sector. Developing countries could be supported by Annex 1 countries assuming some of the finance risk (through innovative guarantee mechanisms) or providing low-cost finance, particularly for projects at the demonstration stage, where the value of the technology risk is likely to be highest.

THE ROLE OF GOVERNMENTS

As a guiding principle, general early-stage research is best supported publicly, but in later stages the private sector is a more efficient delivery mechanism for diffusing technology because of the link to commercialisation.

Harvey[36] states that '[g]overnments are best placed to fund basic research, spreading their funding quite widely, whereas the development of new marketable technologies and products is most likely to succeed quickly in the private sector'. Abbott also maintains that:[37]

> proposals for transfer of technology to address climate change should seek to take advantage of private incentive mechanisms. Business joint ventures that combine OECD working capital and technology with developing country local resources and capacity, and which provide a good rates of return on investment, are needed.

Beyond the demonstration stage, the diffusion and commercialisation of technology depend mostly on an enabling domestic policy and regulatory environment to drive the uptake of, and investment in, climate-resilient technology.

Concentrating solar power (CSP) South Africa

CSP plants use mirrors or lenses, known as heliostats, to focus a large amount of sunlight onto a heat-absorbing receiver. A South African invention in the field of CSP provides an example of how IP can act as an enabler for developing new technologies and (thereby) reducing costs over time.

Unlike the more widely used solar energy technology of PV (or solar panels), CSP collects solar heat in a small area and uses it to drive a steam cycle in a manner similar to other thermal power stations that use fuels such as coal, oil or uranium. CSP can achieve near-baseload (continuous) operation using thermal storage (eg molten salt) technology or hybridisation (with, for example, gas). PV or wind energy may generate at a cheaper price, but for these technologies to provide baseload or 'dispatchable mid-merit' power would require much more expensive electrical storage in the form of batteries or fuel cells.

The CSP market is relatively small and immature compared with the wind and PV markets, but is potentially significant for South Africa. Not only is South Africa rich in solar energy, but the country also has long-standing familiarity with thermal generation technology, building and maintaining some of the world's largest thermal power stations. An analysis by the South African Renewables Initiative estimates that 49% of the value of a CSP plant could be supplied locally. The Independent Power Producer Procurement Programme has invited bids for 200 MW of CSP and requires 35% of the project's value to be made up of local content.

CSP is clearly an attractive option for South Africa but needs to improve its generation cost in order to be competitive with other renewable energy technologies such as wind. This can be done through energy storage (which means the plant generates more of the time, thereby paying for itself at a lower hourly rate), improved scale and innovation.

Heliostats make up roughly 50% of the cost of a CSP plant,[38] with the drive that positions the mirror accounting for about 20% of the cost (approximately \$27 per m^2). Therefore, halving the cost of the drive could lead to a 5% reduction in the overall cost of a CSP plant.

A good drive needs to aim a large mirror at a small target area up to 1 000 metres away, to support a high gear ratio and not be prone to backlash (or shifting position unintentionally).

One particular example of cost-saving South African innovation can be found in the Kimberley Mechanism, a low-cost drive for positioning CSP heliostats (or tracking PV systems). The invention of South African engineer, Joseph Steele, the Kimberley Mechanism uses a unique planetary gear mechanism to provide an ultra-high gear ratio in limited space. It also has few moving parts and can be used in a modular configuration to provide both the azimuth (east to west) and elevation (up and down) drives of a solar tracking platform (for CSP towers or tracking PV) using two of the same components. Effectively made from profiled plate, it is cheap to manufacture using technology already available in South Africa. The high gear ratio and low friction also allows for the use of simple motors. Although mass production costs have not yet been established, this platform could potentially represent a significant competitive advantage for tracking solar technologies like CSP, particularly of the tower/central receiver kind where every heliostat requires two drives.

The inventor developed the mechanism using his own funds and a small contribution from the Eskom/WFF Renewable Energy Research Fund. He is seeking IP protection through patenting his design to ensure that its development can be financed (using the IP as equity).

New CSP projects

Two CSP stations are currently under construction by Spanish developer Abengoa, in partnership with the Industrial Development Corporation (IDC) and the community trusts at the two locales – Upington and Pofadder, both in the Northern Cape. In each project, the community trust holds a 20% stake in the CSP project in its area. Abengoa owns 51% of the projects and the IDC has a 29% stake as part of its mandate to support development of the green economy.

The IDC has offered funding on favourable terms to the community trusts, which will use the dividends to fund social and economic development projects. In addition, the community trusts also own 8% of the engineering, procurement and construction company.

ENDNOTES

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