Sussex Energy Group
Policybriefing
Number 9 November 10

Low Carbon Technology Transfer: Lessons from India and China

Jim Watson, Rob Byrne, David Ockwell and **Michele Stua,** Sussex Energy Group and Tyndall Centre for Climate Change Research SPRU, University of Sussex, UK

Alex Mallett, Carleton University, Ottawa, Canada

Introduction

Low carbon technology transfer to developing countries has a central role to play in mitigating carbon emissions. It is a key issue for the international negotiations under the United Nations Framework Convention on Climate Change (UNFCCC). The promise of access to low carbon technologies was an important incentive for developing nations to support the UNFCCC in 1992. Although the Convention was intended to facilitate low carbon technology transfer, its success in achieving this has been limited, Many developing nations have expressed frustration that their expectations have not been met.

Key messages

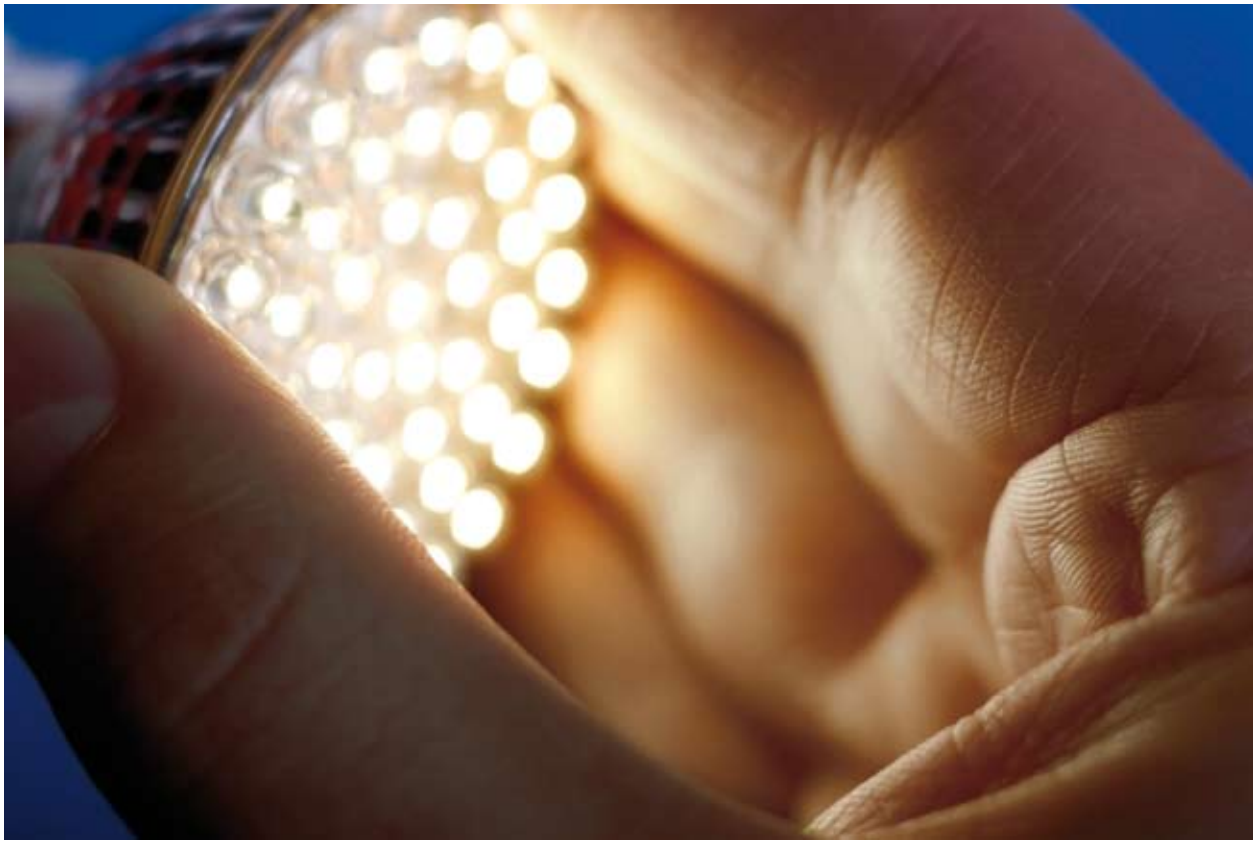
- Low carbon technology transfer is an essential component of the UNFCCC negotiations. However, it should be analysed and supported as a component of wider processes of low carbon innovation in developing countries.
- Supporting low carbon innovation capabilities in developing countries is crucial. Such capabilities mean that firms and other organisations are better placed to operate and maintain low carbon technologies, to innovate through 'learning by doing', and to adapt technologies for local circumstances and markets.
- A 'one size fits all' approach to low carbon innovation in developing countries would not be supported by the evidence. There are huge differences between different low carbon technologies and different developing countries which support a more tailored approach.
- Developing country policies and incentives are needed to complement stronger international action on finance and technological innovation – e.g. to support the development of national innovation systems and to create local markets.

University of Sussex
SPRU – Science & Technology Policy Research

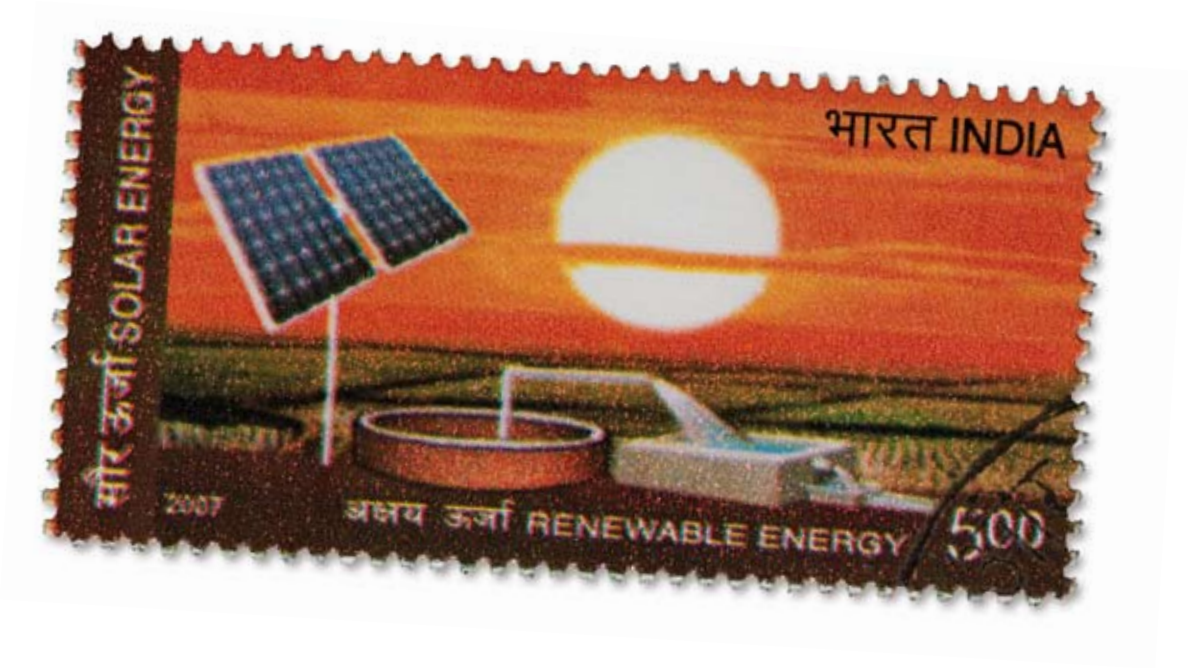
Tyndall Centre for Climate Change Research

Despite the high profile of technology transfer within the UNFCCC negotiations, there is relatively little empirical evidence upon which to base policy. Low carbon technologies are diverse – in their stages of development, their target markets and their scale. They include early stage capital intensive energy supply technologies (such as carbon capture and storage), mass produced consumer goods (such as energy efficient light bulbs) and can be facilitated by new network infrastructures (such as smart grids). This diversity introduces new and unique barriers, opportunities and policy challenges which are not yet properly understood. Global policy solutions from other domains such as health and agriculture have only limited applicability. Furthermore, there is a need for urgent action if dangerous climate change is to be avoided.

This briefing note discusses these challenges, based on empirical research on India and China led by the Sussex Energy Group over the past five years[1]. The research is based on low carbon technology case studies including LED lighting, solar PV and more efficient coal-fired power plants. The research on India, undertaken with The Energy and Resources Institute (TERI), was carried out between 2006 and 2009. The insights from a follow-on study on China with Tsinghua University, are tentative since full results will not be available until early 2011.



[1] For more details, see: **http://www.sussex.ac.uk/sussexenergygroup/1-2-22.html**



Definitions and rationales for technology transfer

The term 'technology transfer' is often misunderstood in climate change debates, and has a range of meanings and interpretations. For some, it is simply the transfer of low carbon technological hardware from one location (e.g. a developed country) to another (e.g. a developing country). We take a wider view. Technology transfer also includes the knowledge and skills necessary for the recipient firm or organisation to operate, maintain and develop the transferred technology. We also analyse it in the context of wider processes of low carbon innovation within developing countries.

Additional capabilities are required for a number of reasons. First, they strengthen the ability of developing country firms and organisations to operate and maintain technologies effectively – and to undertake processes of 'learning by doing' that improve technologies in the field. Second, they are often necessary since low carbon technologies need to be adapted to a particular developing country context (as in the case of coal gasification for India). Third, the transfer of knowledge as well as hardware can contribute to the process of 'catching up' by developing country firms, as a key component of industrial development policies.

It is this third rationale that often makes technology transfer discussions contentious. Some developing country policy makers emphasise the need for knowledge as well as hardware to improve the capabilities of their firms and industries. This framing can be seen as problematic by some developed country policy makers and firms, since it implies a pathway that could lead to the erosion of the current sources of their competitive advantage.

A range of policy challenges flow from this. There is a need to acknowledge the central role of firms as owners of low carbon technologies[2], rather than discussing such technologies as if they can be transferred at will by governments. Governments do not only need to identify strategies to manage the tensions over what constitutes technology transfer. They also need to implement frameworks and incentives that take into account the reasons why firms already make technologies available in developing countries – and to steer such processes in a more low carbon direction.

There is a need to acknowledge the central role of firms as owners of low carbon technologies, rather than discussing such technologies as if they can be transferred at will by governments

[2] B Lee, I Iliev and F Preston (2009) Who Owns Our Low Carbon Future? Intellectual Property and Energy Technologies. London: Chatham House.

Climate Change Conference, Copenhagen 2009

Building indigenous technological capabilities

Our research supports a key finding from the economic development literature – that indigenous efforts within developing countries play an important, complementary role to the acquisition of technologies from international sources.

With respect to wind power in China, the national government's 863 R&D programme has been an important source of capability building for leading Chinese firms. This has placed these firms in a better position to absorb foreign technologies – for example via licensing and joint ventures. It has complemented other strategies such as selective takeovers and joint ventures which have improved access to 'tacit' knowledge embodied in skilled personnel. In the Chinese cement industry, technologies to improve efficiency (and hence, to lower emissions) are now bought from the domestic market. Our interviewees emphasised indigenous innovation as being much more important than international technology transfer in recent years.

In most of our Indian case studies, indigenous technological developments have also been crucial. The National Hybrid Propulsion Program (NHPP) has brought together the public and private sector to indigenise this technology – most recently through a concept car at the Delhi Commonwealth Games in October 2010. In the case of energy efficient technologies for small and medium enterprises in India, indigenous technologies have evolved over time. A step-wise, incremental approach to cooperating with others to make firms more energy efficient was

Indigenous efforts within developing countries play an important, complementary role to the acquisition of technologies from international sources

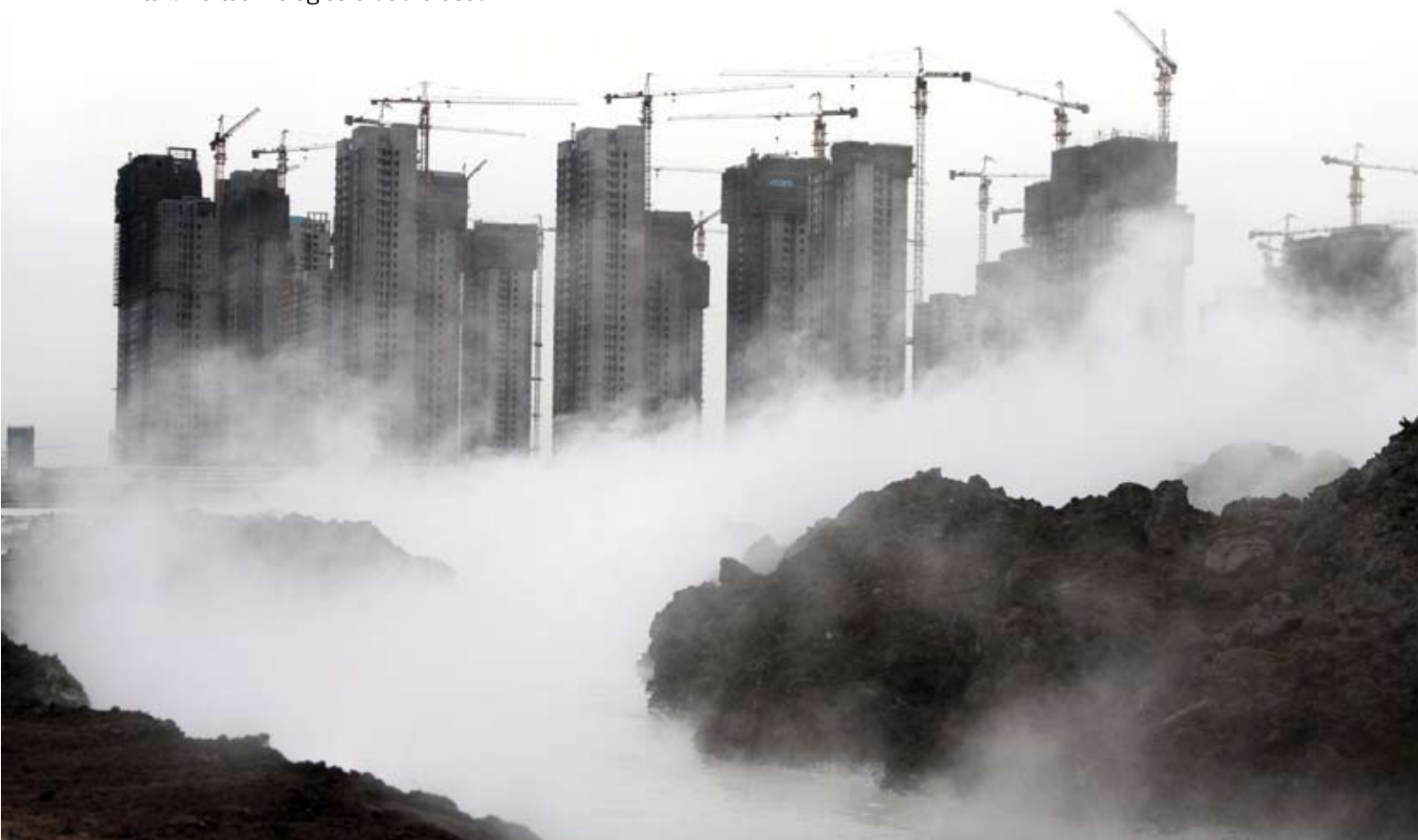
followed. This incremental approach also led to a growing confidence among entrepreneurs to experiment with, develop, and adopt their own cost-effective technological solutions.

Limitations to developing country access to intellectual property rights (IPRs) is often cited as a barrier to the development of low carbon capabilities. But the empirical evidence is mixed. In some cases access to IPRs is necessary but not sufficient for the development and deployment of low carbon technologies. IPRs for low carbon technologies are rarely codified in a single patent. Multiple patents usually exist, and significant 'tacit' knowledge that is not codified is required to make use of them.

For some technologies the acquisition of IPRs is possible, at a reasonable cost. For example, Indian and Chinese firms have been able to access wind and PV technologies from international suppliers through licensing, joint ventures and even some takeovers.

However, there are important caveats to this. First, it does not apply to all low carbon technologies, some of which have much higher barriers to entry than wind or solar PV. Gas turbine technologies that are used in some advanced 'cleaner coal' power plants are concentrated in very few international firms, which makes it much harder for developing country firms to master core technologies. Second, while IPR barriers may not prevent companies acquiring a particular low carbon technology in principle, they can slow the rate at which they can acquire variants at the cutting edge (e.g. thin film solar PV). Third, some technologies need extensive adaptation to suit local conditions. For example. coal gasification technology developed for the US market requires adaptation to handle high ash Indian coal.

Despite significant evidence of indigenous support for low carbon innovation in India and China, problems remain in both counties. In China, there are sometimes weak links between firms and research institutes, which mean that the full benefits of the Chinese 'national innovation system' have yet to be realised. Firms lack engineering and design capabilities (cited, for example, in the case of electric vehicles), and often focus mainly on incremental innovation.



The windmills from the Royal Cenotaphs at Jaisalmer, Rajasthan

Similarly for Indian PV developments, our research highlighted a disconnect between the research base and the needs of firms. Firms recognized that some of the Indian technical institutes are actively engaged in research, and that some of this research is excellent. But firms also argued that it was difficult to find a bridge between this research and the development of better commercial products.

Domestic finance and policy in China and India

To successfully build low carbon innovation capabilities, policy frameworks have a key role to play. In China and India, we have already argued that significant government support through research programmes has been important.

In both India and China, incentives for the deployment of wind power have been crucial in supporting domestic firms such as Goldwind, Sinovel and Suzlon. In China, this deployment support has been complemented by government funding for technology development. Controversially, there have also been local content rules and restrictions on the ability of international firms to sell products within the Chinese market. With respect to the nascent area of offshore wind, initial Chinese projects have to be majority-owned by domestic firms. Whilst some of these rules have been criticised by international players, the selective use of such measures to protect new industries is a frequent feature of catching up strategies (for example in the South Korean vehicle industry).

With respect to the Chinese cement industry, the key challenge is not the acquisition of international technologies. In the past, collaborative programmes have helped introduce such technologies to China, for example from Japan. Research by our Chinese partners suggests that incentives are needed for the deployment of indigenous energy efficiency technologies. These tend to be cheaper, but policy incentives are still required to facilitate their adoption.

To successfully build low carbon innovation capabilities, policy frameworks have a key role to play

Chinese government tax breaks, grants and energy intensity targets have all helped to do this. So has the Clean Development Mechanism (CDM). Efficiency within the sector has also been boosted by the closure of smaller, less efficient plants. Nevertheless a significant efficiency gap remains between plants in China and those in OECD countries.

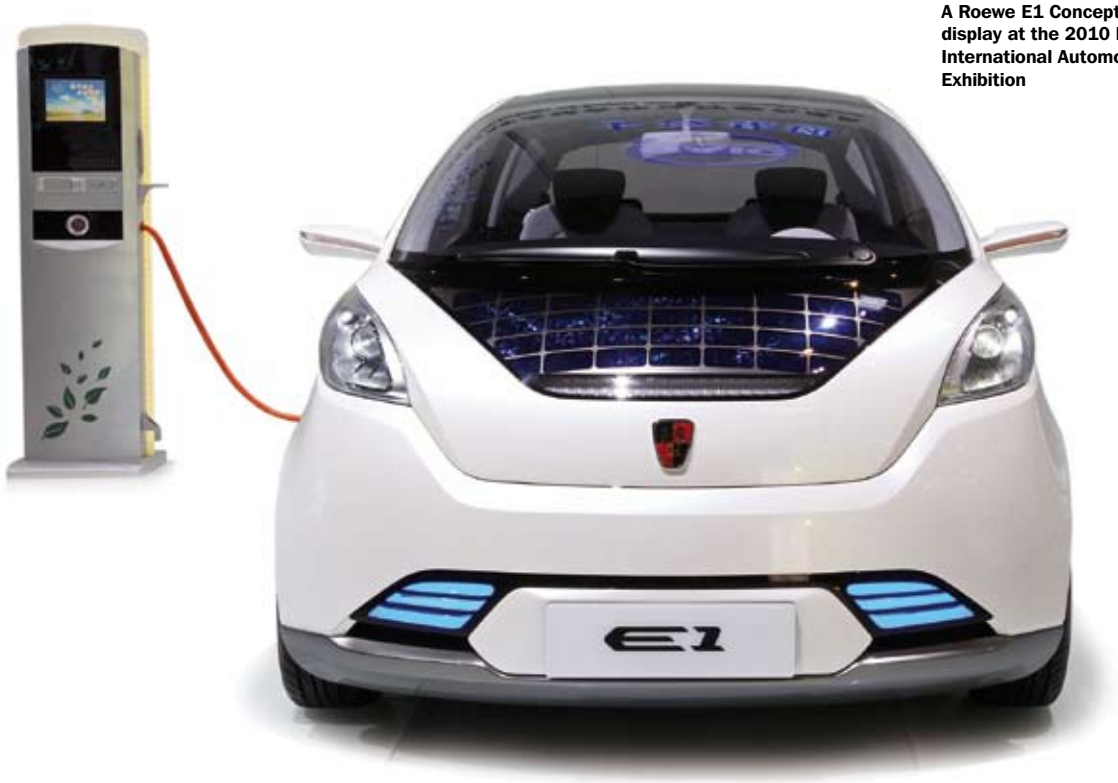
Some of our cases revealed a more mixed picture, however. An important brake on the progress of hybrid vehicle technologies in India has been the lack of incentives for consumer adoption. Tax breaks have not been sufficient to overcome cost barriers. It may be the case that overcoming such barriers is too costly at this stage for public policy to overcome. In China, such incentives are currently being implemented, including a target that 5% of new car sales should be 'new energy' models (including electric vehicles) by 2011 and trials in several major cities. However, Chinese firms still see many challenges apart from the general early stage of development of electric vehicles world-wide. These include product quality issues and significant dependence on foreign technology[3].

International finance and policy

Returning to the international policy realm, there is clearly large scope for action on a bilateral and multilateral basis. We found evidence of significant impacts from one of the UNFCCC's key financing mechanisms – the CDM. As has been widely reported, the CDM has been particularly beneficial for China, though it has also been a focus for controversy. Some developing country governments have argued that it has not delivered on expectations of technology transfer. However, the CDM has been a source of additional finance – including for the Chinese cement industry, and in the early growth of China's onshore wind power programme.

Outside the UNFCCC, our case studies also found examples of bilateral o-operation programmes that are helping to improve capabilities in developing countries. In China, there are several bilateral programmes on electric vehicles, including a US-China programme announced by their respective Presidents in 2009. Collaboration with Germany

There is clearly large scope for action on a bilateral and multilateral basis



A Roewe E1 Concept is on display at the 2010 Beijing International Automotive Exhibition

[3] M Levi et al (2010) Energy Innovation: Driving technology competition and cooperation among the U.S., China, India, and Brazil. Washington, DC: Council on Foreign Relations.

and Denmark played a significant role in the development of the Chinese wind power industry. Whilst the policy and research focus of these initiatives is welcome, it is also important to foster collaboration between firms. As we concluded from our studies with Indian colleagues, international collaboration in R&D, demonstration and deployment can help to overcome some intellectual property barriers. For example, low carbon technologies that are specifically designed for developing country markets could be developed in this way.

Whilst they have not focused primarily on China and India, the World Bank's Climate Investment Funds may hold useful lessons for future UNFCCC finance and technology mechanisms. A key feature of the largest of these funds – the Clean Technology Fund – is its 'transformational' ambitions[4]. The fund does not only help finance low carbon technology demonstration and deployment, but also encourages improvements in policy frameworks and capabilities to create additional demand for these technologies. Whilst they are time limited, these funds could in future provide an important source of learning about whether transformational change can be achieved – including technology deployment and improved innovation capabilities.

Implications for Climate Policy

First, contexts are important. There is no 'one size fits all' approach to low carbon technology transfer. There are key differences between countries (including between China and India), technologies and markets. Lessons drawn from China and India have limited applicability to less developed countries which have fewer resources and different needs.

Second, technology transfer is only part of the process of low carbon innovation in developing countries. It cannot be analysed or supported in isolation from indigenous innovation. In many cases, technology transfer and indigenous innovation play complementary roles.

Third, intellectual property barriers to low carbon innovation do not apply equally to all low carbon technologies. Our research found that in many cases, IPR barriers have not prevented Indian and Chinese firms from producing these technologies. However, these barriers can slow the rate at which firms can commercially produce low carbon technologies, particularly if they wish to innovate at the cutting edge.

Fourth, there is a need for international climate policy to build innovation capabilities and deploy low carbon technologies in developing countries. Implementation projects (such as those co-financed by the CDM and the Clean Technology Fund) play a key role – but are not enough. Other activities are required to build innovation systems in developing countries, including underpinning investment in R&D, policies to create markets, and new institutions such as climate technology centres[5].

Fifth, international policy action and finance needs to be complemented by domestic policy incentives in developing countries. Many low carbon technologies are simply too expensive, and have significant incremental costs and risks when compared to higher carbon alternatives.

[4] See: **http://www.climateinvestmentfunds.org/cif/**

[5] UNEP (2010) An exploration of options and functions of climate technology centres and networks. UNEP Discussion Paper.

Acknowledgements

The research underpinning this briefing was funded by the UK government Departments of Energy and Climate Change, and Environment Food and Rural Affairs. The authors would like to thank research teams in TERI (led by Prosanto Pal) and Tsinghua University (led by Zhang Xiliang) who have made major contributions to this research.

University of Sussex
SPRU – Science & Technology Policy Research

Tyndall Centre for Climate Change Research