# Barriers to Technology Transfer in the Low Carbon Energy Sector

## Executive Summary:

Technology transfer can be a useful way to aid developing countries and to "leapfrog" the most polluting phases of industrial and economic development. The most successful technology transfers result in the adopting country being able to accept the technology successfully, adapt it to local conditions, and eventually being to develop their own innovations from the knowledge and expertise gained during the process. There are various barriers to successful technology transfer. Intellectual Property Rights (IPR) are both an enabler and a barrier to successful transfer. Without these rights there is little motivation for companies to send expertise and knowledge to countries when they are unlikely to be able to realise a return on their development costs. However, these rights also restrict the extent to which developing countries can learn from and utilise the technologies.

The public sector can have a large role to play in determining how successful and extensive technology transfer can be. Most transferring bodies will be private enterprises. The public sector can both support individual transfers by various means; as well as providing a robust and encouraging framework for transfers to occur. They can develop in concert with the public bodies in adopting nations, a sensible and tailored suite of IPR legislation, as well as providing accessible knowledge to assist all stakeholders in selecting technologies for transfer. Finally they can enable technology transfer by developing collaborative projects where IPR are prearranged to be conducive to the transfer of the technologies developed to a wide range of countries.

## Introduction:

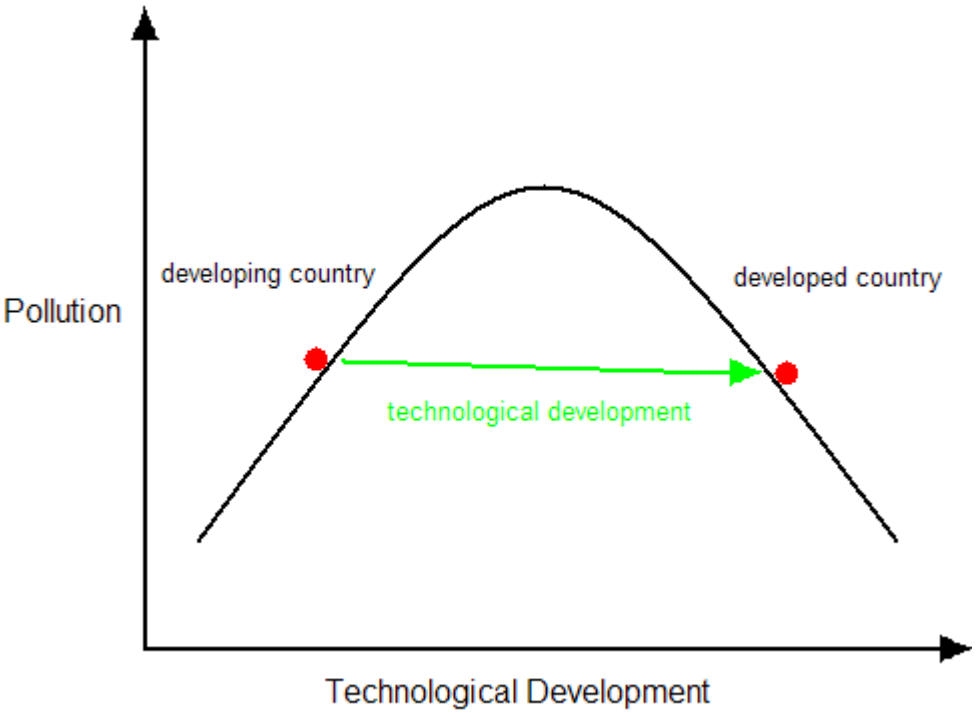
Many technologies relating to "green" energy have reached maturity or advanced stages of development and/or application in developed countries. Developments in renewable energy sources, energy efficiency improvements, and clean coal technologies have produced viable products which available for take up by end users.

Penetration of new advances and best available technology is restricted to some extent by Intellectual Property Rights (IPR) legislation. This presents distinct challenges in attempting to promote technology transfer to developing countries.

Technology transfer to developing countries is particularly attractive for agencies attempting to reduce global emissions of greenhouse gasses. The concept of "leapfrogging" suggests that developing countries can avoid following a development path similar to that already followed by developed countries. It may be possible for them to avoid, at least partially, the highly polluting phase of industrialisation and economic development preceding the take up of cleaner technologies. The concept of an Environmental Kuznet's curve illustrates this possibility, shown in figure 1 below. Rather than follow the black curve "leapfrogging" may shift the developing country across the emissions peak, preventing significant amounts of emissions.

There are several barriers to technology transfer into developing countries. In order to allow these technologies to penetrate as far as possible into developing countries these barriers must be overcome so far as is possible.

**Figure 1: Environmental Kuznet's Curve**




## Barriers to Technology Transfer

The first potential barrier suggested by the literature is the term itself. The term casts the receiver in a passive role, which may well impair the ability of a recipient country to assimilate the transferred technology [1]. It is extremely important to note the role of the receiver in making technology transfer successful. Various factors affect the ability of a recipient country to accept and assimilate a given technology. Some of these factors are presented below in the "Barriers" section. Together they present a compelling case that technology transfer will be most successful when done in a partnership, rather than with a donor/recipient mindset.

Several more barriers exist to the successful transfer of low carbon technologies to developing countries. These identified barriers are outlined below.

*Lack of technological infrastructure in the receiving country:*

> In order for a transfer to succeed, the country accepting the technology must have sufficient technological infrastructure in place to support the introduced technology. Without that infrastructure the country will lack the foundation on which to build an understanding of the specific technology being introduced.

*Skills and Resources:*

Transferring only the material parts of the technology will not succeed in the longer term. To promote a sustainable transfer it is vital that the skills and resources needed to transfer the complete system are provided. This will involve education about the technical aspects of the technology at levels appropriate for users, technicians and project implementers.

*Political Power Balance and Relationships*:

The potential differences in political power and motivation for technology transfer, can cause significant problems for technology transfer [2]. For a technology transfer project to be considered successful it must avoid potential pitfalls associated with an uneven power balance between the two partners. These include increasing dependency of recipient countries on donor countries, indebting the recipient country and destroying traditional practices.

*Public Capacity for Information Dissemination:*

Related to the above point is the lack of capacity in some developing countries to disseminate information about a technology and educate the potential end users on the advantages of such technologies [3]. Without this capacity in place the potential for successful technology transfer is low, due to the difficulties the stakeholders will have in effectively transmitting information and training relating to the technology.

*Power Balance between Stakeholders:*

There is often an imbalance of power between stakeholders within the transfer process. Government, outside financiers and commercial suppliers hold the majority of the power, and crucial decisions about which technologies to transfer have often been made by government bureaucrats in concert with overseas technology suppliers [1]. The technology transfer is often seen as an end in itself, rather than a means. (Compare “rural electrification” with “providing energy services” as ways to describe development).

*Local Cost Barriers:*

Uptake of a transferred technology may be poor, as rural areas lack sufficient funds to meet the initial investment cost of the technology. Technology transfer programs that do not take into account the economic potential for uptake of a technology when considering suitable technologies for transfer are likely to fail.

*Limited Investment Capital:*

In addition to these problems with uptake, limited capital availability will prevent uptake of energy efficiency technologies, as other investment priorities will compete for the available capital. In some countries the cost of capital can be as much as 30-40%, which becomes a significant barrier to investment [3]. Further, this lack of capital may result in the purchase of older, second hand industrial equipment with the associated high Carbon emissions.

*Difficulty of Foreign Technology Assessment by Local Investors.*

It can be more difficult for local investors to obtain accurate and useful information about technologies provided by foreign suppliers than to obtain

similar information about local investment opportunities. This again works to restrict the available investment capital for these technologies.

*Poor National Ability to Assess Technologies:*

In a number of cases poor ability to assess the needs of developing countries have resulted in technology transfer led by donor preference, rather than by demand from the developing country [6]. This increases the likelihood that an inappropriate technology will be chosen and makes it more likely that the above barriers will be substantial obstacles to successful transfer.

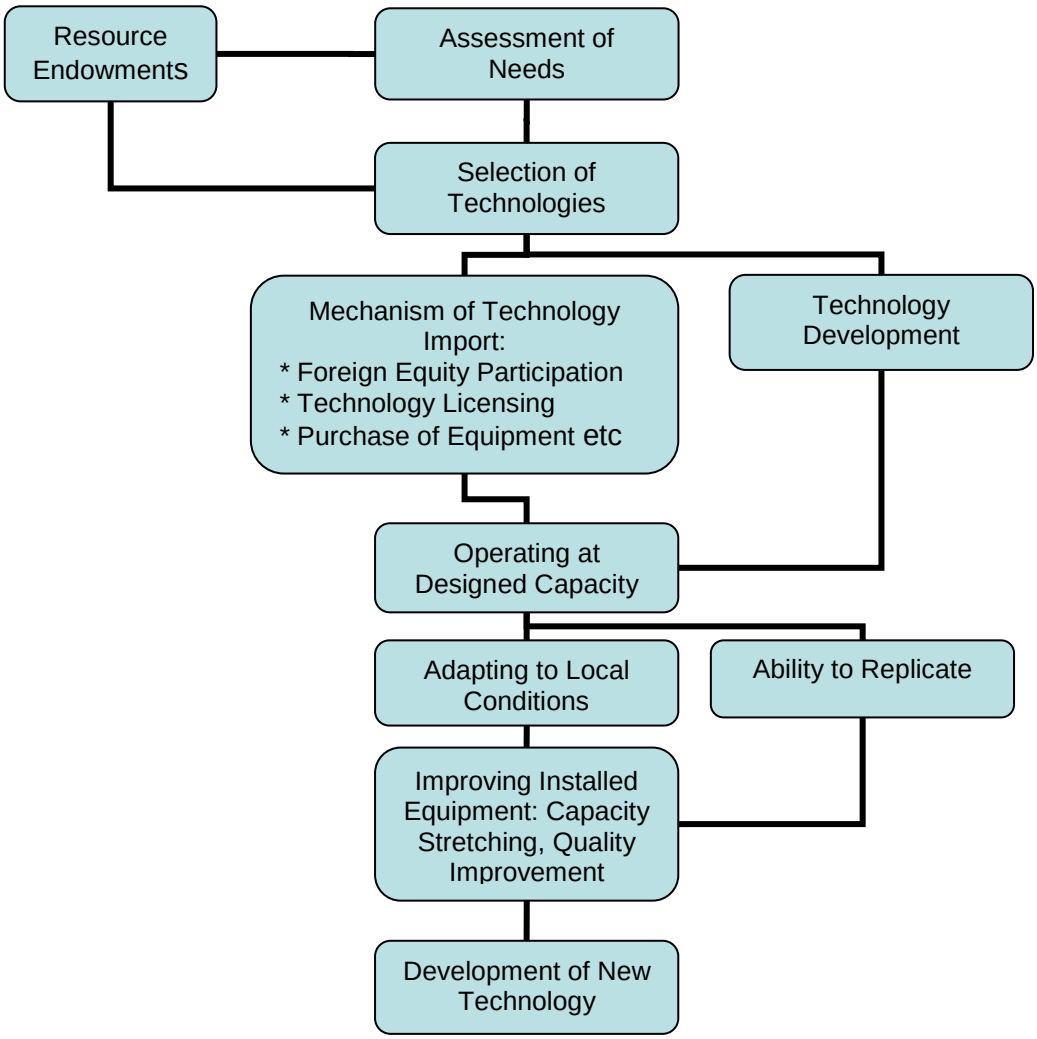
## Successful Technology Transfer:

Not withstanding the potential barriers listed above, it is apparent that technology transfer can work successfully. Most successful technology transfer projects will carefully select the appropriate technology to transfer; take into account the situation the technology will be transferred into; understand the needs and skills of the potential end users. The project will deliver not just the end product, but also the expertise to maintain and develop that product, and integrate it into the technological development of the accepting country.

A successful transfer will see the technology adopted widely in the recipient country, and being successfully implemented. It will also contribute to expanding the technological base of the country, developing their capacity to accept further technological developments. It should enhance their capabilities to "assess the need, select, import, assimilate, adapt and develop the appropriate technologies" [6]. Ideally, the development of expertise will enable the country to make advances in the technology, first adapting it to local conditions, and then developing it further, beyond the point at which it was transferred. Indeed, it has been found in some studies [4] that developing countries enjoy a business culture more conducive to continuous development than those in the OECD, and multinational companies have found such improvement easier at plants in the developing world than at those in the developed world.

Figure 2, overleaf, shows the various steps of technology transfer, from the initial assessment and selection of technologies through the actual transfer mechanism, out to the point where an adopter begins to develop their own technology.

**Figure 2: Steps to various levels of Technology Transfer [6]**




## The Role of IPR

Given that barriers to successful technology transfer exist, to what extent can IPR be used as a tool to avoid or reduce these barriers? To what extent does IPR legislation present barriers of it's own to successful technology transfer?

Developed countries believe in protecting the rights of the inventor to their innovation. They also see that in order to encourage further development the producers of ideas should be able to profit from those ideas.

Developing countries see the removal of IPR as necessary to bring their economy and social welfare up to the level of the industrialised world. They can also believe that the industrialised countries wish to maintain a monopoly over advanced technology by demanding that developing countries implement strong intellectual property rights [7].

Technology transfer can have significant impact on the wealth of supplier and recipient countries. The interests, political, and economic power of the agencies involved in the transfer process are like to have significant bearing on the barriers to and outcomes of technology transfer processes [5]. This may be of particular relevance in the low carbon technology sector, where a wide range of powerful interests may be affected.

The first notable impact of IPR on technology transfer is as an enabler. The potential for a company to retain intellectual rights over a technology it has developed, and make a profit from that technology, is vital in encouraging countries to deliver new technologies to various markets. Without this protection there is little incentive for companies to produce these technologies. If the protection only exists in the developed world, technology transfer to developing countries may be inhibited.

Conversely, strict IPR protection may present a barrier to technology transfer success. In order to adopt the technology fully and being to adapt it for local conditions, and then develop it further, the recipients must have access to intellectual property. This access must not just be the possession of the protected material itself, but also the capacity to understand the material, and to put it to use. Without this access, the utility of technology transfer is likely to be limited.

This is not always the case, however. In some cases transfer of the IPR surrounding the technology is not necessary for the technology transfer to be successful. Take the example of Hybrid drivetrains. When these are supplied to other countries, the manufacturing skill and expertise to develop the drivetrains themselves is not normally supplied. However, the supplier companies have, by necessity, had to train engineers and mechanics in fitting and maintaining these drivetrains. This implies development of technological background which provides the capabilities for further development, and may also filter through in the long term to the wider economy [5].

The role of IPR as a barrier to technology transfer also varies in importance. This depends on the stage of development reached in the receiving country, or the nature of the transferred technology. If a technology has been developed to a stage where the investment in R&D is particularly high, the company holding the IPR may expect to be proportionately rewarded for this development before releasing the IPR.

There is also a complex relationship between the nature of the IPR regime in the receiving country and the extent to which a particular technology is suitable for transfer [5].

## The role of the public sector in facilitating Technology Transfer in the green energy sector.

There are several angles from which the public sector can facilitate successful technology transfer from developed to developing countries. These range from actions to smooth or remove the barriers identified above, to developing new methods for technology development that encompass the desire to transfer the new technology efficiently and successfully to appropriate adopters.

Perhaps the simplest method to encourage adoption of new technologies is to provide foreign currency to aid in initial investment costs. As noted above, care must be taken to avoid wasting capital on schemes that are not suited to the area in which they are being introduced. Providing capital alone without ensuring that it is

appropriately invested into projects which will thrive in the region adopting the technology is almost certainly wasteful. This is compounded by the fact that failed attempts at technology transfer reinforces negative impressions that may hinder all future attempts at technology transfer [1].

Given the wide range of affected stakeholders the public sector can make a significant contribution by developing a clear framework as part of an industrial policy for technology transfer. This framework can include environmental, energy, trade, taxation and patent legislation. It should be designed to provide all stakeholders with the right signals, and reduce concerns, whether these are about the investment potential of the technology, or the risk to IPR of transferring a technology to another country.

A crucial part of developing this framework is the rationalisation of IPR agreements and legislation between the supplying and adopting countries. Where strong IPR protection might reassure the supplying companies that their intellectual property will not be at risk from taking part in technology transfer, it can also work to restrict the extent to which the technology benefits the adopting country. Suitable levels of IPR will vary between countries and technologies. Flexibility can be a significant means to enable technology transfer where sufficient motivation might not otherwise exist. An example from outside the field of clean energy is software development. Most profits for software development in the developed world occurs in a short period of time. This suggests that a short patent length of perhaps 5 years for transferred software might allow the companies to exploit their intellectual property enough to have an incentive to take part in the transfer, while still giving the developing country the prospect of accessing the code and building their own expertise [7].

In terms of preparing the ground for technology transfer most of the work seems to be needed in the adopting country, rather than the country of technology origin. Useful work could be done gathering and preparing information on the readiness of the adopting country to assimilate potential technologies, although this work is better suited to the specific agency intending to transfer the technology. This work would include assessments of the ability of the host country to disseminate information about the technology, of the technological background to support the technology, of the available investment capital to install the technology, and so forth.

Facilitating the transfer of specific technologies is likely to involve negotiating licenses, or financially supporting the specific technologies to reduce the initial costs. [7]. In the environmental sphere this has already been seen with the Montreal protocol dealing with ozone depletion.

Outside of any given project there appears to be value in furthering the ability of developing countries to assess technology in the area of clean energy and energy efficiency. Stakeholders in developing countries find it difficult to access technology information, and an international clearing house for information on these technologies might be expected to have wide ranging benefits [3].

Finally one large scale suggestion for public bodies to massively enable technology transfer in the clean energy and energy efficiency fields is the initiation of widespread international collaboration on R&D initiatives relating to technologies that are in a very early stage of development. These technologies could be collaboratively developed, and IPR rights structured to benefit the various partners while still promoting free or low cost transfer of the technology to a wide range of markets. This approach also involves the sharing of knowledge and expertise between collaborators, which can build the technological background of the developing

countries and hence further develop their capacity to absorb transferred technologies in the future.

*Response prepared for the TI-UP Resource Centre by T Brightman & P Sivell, TRL*

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