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Engaging other main actors: Engaging emerging economies Removing barriers for technology cooperation

Note

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Executive Summary

Climate technology development and deployment is a core element in order to achieve effective global climate change mitigation as well as adaptation in the context of international efforts under the UN Framework Convention on Climate Change (UNFCCC). For emerging economies technology transfer is crucial in order to ensure a steady energy supply for their rapid economic development. Energy demand in these countries is growing fast, particularly in India and China, and their infrastructure and generating capacity are struggling to keep pace. To ensure that the economic growth is not coupled with the high GHG emission growth, technology transfer of low-carbon technologies and technology avoiding negative impact on adaptation is essential.

However, under the UNFCCC negotiations, the incorporation of technology transfer for global concerted action (i.a. Marrakesh Framework) has proved difficult and slow and no explicit measures have been agreed on. In the last COP 13 in Bali, technology transfer has become more important and it will stay a crucial point for the success of future conferences (especially for emerging economies).

The first part of the briefing gives an **overview of key partnerships** in transferring technology for mitigation of and adaptation to climate change to emerging economies within the climate change regime and in further international technology cooperation. It presents key actors and their roles, highlights **success factors** and identifies potential for improvement. In the subsequent chapter, the **barriers** that technology transfer is facing and examples for appropriate **tools** that can help to overcome the remaining obstacles are pointed out.

Although the current climate change regime sees some development in technology needs assessment, identification of barriers and capacity building (e.g. TT:CLEAR), it has not succeeded in developing mechanisms to effectively enhance technology development and deployment. **GEF** funds are crucial for the promotion of technology transfer and climate change-related projects. Although developing countries usually complain that its evaluation criteria are not responsive enough to local development priorities, the environmental effectiveness – in regard to the size of investments – is to be assessed as good. In Bali it was agreed on that GEF will serve as secretariat to the **Adaptation fund**, which will be financed by a share of proceeds from CDM.

Although **CDM** does not have explicit technology transfer mandate, technology transfer is often mentioned as an ancillary benefit. However, the scale of technology transfer achieved by CDM is lower than expected (less than 50% of CDM projects). A high share of projects is located in emerging economies (75% of CERs in India, China and Brazil). The continuity of CDM in post-2012 is recommendable. Reasons for low involvement of technology transfer (and other teething problems) of current CDM should be analysed by UNFCCC and appropriate modifications to improve the greater involvement of technology transfer included.

Activities of **knowledge sharing and coordination** outside UNFCCC include exchange of information and possibly coordination and harmonization of research agenda and measurement standards (e.g. Asia Pacific Partnership on Clean Development and Climate).

Looking at **RD&D agreements**, like EU and China partnership on Climate Change or the IEA-IA, they have a high technological effectiveness, but uncertain results regarding environmental effectiveness. To increase the availability and transfer of low-cost technology options, these agreements offer a valuable instrument.

The **Multilateral Fund** of the Montreal Protocol, as example for financing and diffusion of technologies, has proved successful to facilitate the fade out of ozone depleting substances in developing countries. A technology transfer fund that attempted to cover the incremental costs of GHG reductions in developing countries would have to be orders of magnitude larger in scale and in reach than the Multilateral Fund.

Cooperation to set **international technology standards** and incentives (e.g. EU Renewables Directive) may have a high technological and environmental impact, i.e. diffusion effects for environmentally sound technology. The cost-effectiveness depends on the detailed provisions and domestic policies that are employed.

Adaptation, unlike mitigation, can mostly build on technologies that are already being applied and are also likely to be less capital intensive and more amenable to small-scale interventions. Technology **cooperation in adaptation** to climate change comprises a combination of ‘soft’ technologies (e.g. crop rotation patterns), and ‘hard’ technologies.

The switch to low- and no-carbon technologies will require high financial volumes and most important barrier to technology transfer is the **lack of financial resources**. In this regard, the public and private sector have differing and complementary roles at different stages of the technology development and diffusion process. To facilitate access to **private-sector funding** and promote Public Private Partnerships (PPPs), four main tools have been proven successful (capacity-building; market development instruments; rules and regulations; taxes and subsidies).

Barriers to technology transfer arise at each stage of the transfer process and depend on the context and regional circumstances. The same concerning the tools: no ‘one policy fits to all’ solution is possible. The interventions vary and depend on technology, stage of development and supplier as well as recipient countries. One key issue under discussion is the **protection of international property rights (IPRs)**. From the perspective of the industrialised countries, IPR are necessary to guarantee adequate returns to private R&D and commercial development of new technologies; from a developing country perspective, they act as a barrier to technology transfer (adoption). As the factors and barriers differ by technology, sector and country, a case-by-case approach to address the issue of IPRs is recommended. If cooperation in RD&D starts early, new technologies can become common goods, in particular mitigation and adaptation technologies. China proposed the establishment of a Multilateral Technology Acquisition Fund (MTAF) that could buy IPRs for low- and no-carbon technologies.

A crucial point for the success of technology transfer and the development of technological capacity in a recipient country is **capacity building and knowledge sharing**. Key elements for successful international cooperation on R&D are the co-ordination of R&D priorities and pooling of risk and reward for major investments. Especially for emerging economies cooperation in RD&D is recommendable e.g. for energy efficient production, technical improvement and market introduction of RES and CHP technologies.

1 Introduction

Climate technology development and deployment is a core element in order to achieve effective global climate change mitigation in the context of international efforts under the UN Framework Convention on Climate Change (UNFCCC). It represents an indispensable complement to internationally agreed reduction targets (see e.g. Schellnhuber *et al.* 2006; Stern 2006). Technology has also a vital role to play in adaptation. The development and diffusion of improved crop varieties, more efficient irrigation systems, and cultivation methods will reduce the costs of adapting to climate change in the agricultural sector. Improvements to design, materials and construction techniques can improve the resilience of infrastructure and urban development. Adaptations are typically not solely climate change related. However, some of these techniques are also relevant to mitigation – leading for example to lower emissions from rice cultivation, reduced energy use for space heating and cooling (Stern 2006, ch. 24). **Table 1** gives an overview of the sub-sectors in mitigation and adaptation.

Table 1: Overview of sub-sectors in Mitigation and Adaptation

Subsector	Mitigation	Adaptation
Energy	x	
Transport	x	
Waste management	x	
Industry	x	
Forestry	x	x
Agriculture	x	x
Capacity Building	x	x
Coastal Zone Management		x
River base management		x
Human Health		x
Natural Resources Management		x
Other Assessments		x

Source: IPCC Third Assessment Report, www.ipcc.ch

Technology transfer is crucial for emerging economies in order to ensure a steady energy supply for their rapid economic development. Energy demand in these countries is growing fast, particularly in India and China, and their infrastructure and generating capacity are struggling to keep pace. According to the World Bank, primary energy demand in non-OECD countries is expected to increase worldwide by 2.3-5.2 times between now and 2050 (World Bank, 2006).

However, the process of incorporating climate technology development and diffusion issues in UNFCCC negotiations for global concerted action has proved difficult and slow. Only at COP 13 in Bali technology transfer became unexpectedly a crucial point of the negotiations (Ott 2008). Over the past decade, a growing importance of public-private partnerships or other multilateral and bilateral initiatives specifically focused on climate technology cooperation and information dissemination can be observed. These initiatives have developed either in cooperation with UNFCCC or in parallel (Carlino *et al.* 2007).

There is little consensus on what technology transfer comprises. The literature shows a broad array of definitions (Wilkins, 2002; Kline *et al.*, 2003). In this briefing, we adopt the definition according to the IPCC (2000): "A broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, NGOs and research/education institutions."

The first part of the paper deals with key partnerships in transferring technology for mitigation of and adaptation to climate change to emerging economies within the climate change regime and in further international technology cooperation. It presents key actors and their roles, highlights success factors and identifies potential for improvement. In the subsequent chapter, the barriers that technology transfer is facing and examples for appropriate tools that can help to overcome the remaining obstacles are pointed out.

International technology cooperation can take many forms. According to De Coninck *et al.* 2007a, the following four broad types of technology cooperation can be suggested:

(1) knowledge sharing and coordination;

(2) research, development and demonstration (RD&D);

(3) technology transfer and financing

(4) technology deployment mandates, standards, incentives.

This typology is based on the innovation chain of technologies: R&D, market introduction and diffusion (see **Figure 1**). Corresponding each level of technology development, different forms of cooperation are needed and possible.

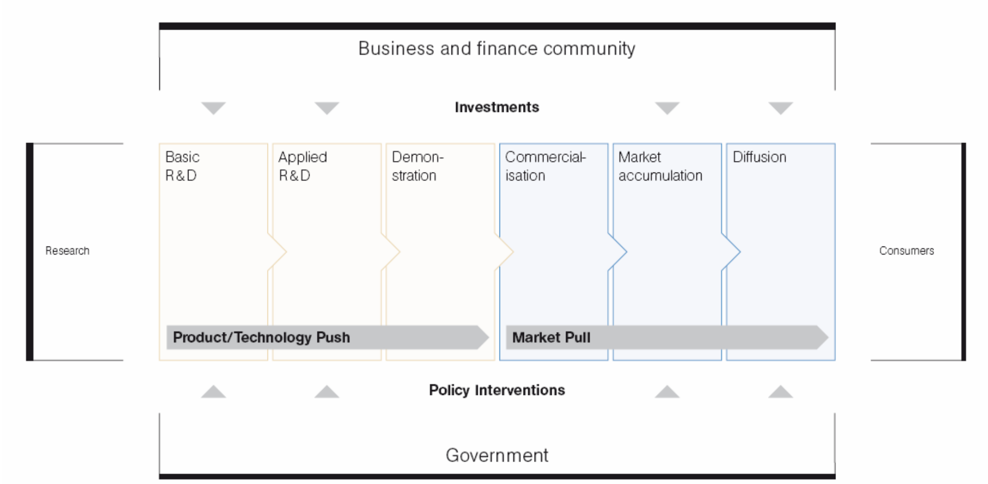

Figure 1: The innovation cycle

Source: Grubb, 2004

The technology initiatives are evaluated according to the following criteria proposed by De Coninck *et al.* (2007a): environmental effectiveness, technological effectiveness, cost-effectiveness, incentives for participation, and administrative feasibility.[1]

[1] A broader evaluation scheme is being developed, and referred to in Ott (2008). As amendment to De Coninck *et al.*, the criteria of the Wuppertal Institute include the potentials (on GHG reduction, social effectiveness), institutional structure (consequence of failure, not meeting targets, gender ratio etc.), embedding (national and international cooperation, connection with international processes) and risks of technology partnerships.

2 Overview and evaluation of existing technology partnerships and initiatives

2.1 Technology transfer in UNFCCC and Kyoto Protocol

The UNFCCC technology framework

Technology development and transfer is an important feature of the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol (Article 4.5 of the Convention, Article 10 c of the Protocol). However, no explicit measures with regard to technology cooperation have been agreed on.

In 2001, at the seventh Conference of the Parties (COP) in Marrakesh, Parties adopted decision 5/CP7 to guide the discussions regarding technology transfer and development. It provides a framework for actions to enhance the implementation of Article 4.5, covering five themes: technology needs assessments, technology information, enabling environments, capacity building, and mechanisms for technology transfer.

Based on this decision, the secretariat has developed the web-based technology information system TT:CLEAR that includes an inventory of environmentally friendly technologies and projects. The decision further established an Expert Group on Technology Transfer (EGTT). Its mandate has been renewed in 2007 at COP 13 in Bali. The EGTT facilitates and advances technology transfer activities and makes recommendations to the Subsidiary Body for Scientific and Technological Advice (SBSTA).

The implementation of the UNFCCC technology framework agreed upon in Marrakesh is slow. To a large extent, this can be explained by differing views of developing and industrialised countries (Carlino *et al.*, 2007):

(a) first contentious issue is the focus of technology transfer efforts (mitigation vs. adaptation);

(b) financial controversies include the role of the GEF;

(c) the intellectual property rights (IPR) debate basically opposes two views; from the perspective of the industrialised countries, IPR are necessary to guarantee adequate returns to private R&D and commercial development of new technologies; from a developing country perspective, they act as a barrier to technology transfer (adoption) when considering the costs of access to technologies.

The major milestones of transfer to technology of UNFCCC can be seen in an illustration of UNFCCC (2007b; see Annex, **Figure 5**). The Global Environment Facility (GEF) committed funding for conducting Technology Needs Assessments (TNAs) in 94 developing countries. Some 50 have been carried out either as stand-alone exercises or in the framework of the National Communications to the UNFCCC (SBSTA 2006c).

The available evaluations suggest that actions under the UNFCCC technology framework have successfully advanced in two respects: diffusion of information and evaluation of technology needs in developing countries (Carlino *et al.* 2007).

Global Environment Facility

Article 11 of the Convention defines a mechanism for the provision of financial resources to developing countries on a grant or concessional basis, including for the transfer of technology. The Global Environment Facility (GEF) is the operating entity of the financial mechanism.

The GEF aims to play a catalytic role in the development of markets related to climate change. Since 1991, approximately US$ 3,3 billion was provided in grants from the GEF to climate change activities[2]. An additional amount of more than US$ 14 billion has been leveraged through co-financing from bilateral agencies, recipient countries and the private sector, or USD 4,2 per dollar of GEF grant (UNFCCC 2007a).

Most of the funds are allocated to China, India and the Russian Federation, followed by Brazil, Mexico and South Africa. The largest share of the GEF resources has been assigned to long-term mitigation projects. To date, only one per cent of GEF resources have been assigned to adaptation activities.

Although many of the GEF projects and programmes are more of technical assistance nature, their catalytic impact is significant in creating bankable financing through competent development financiers in the development, adaptation and transfer of climate technologies. GEF funds are crucial for technology transfer in climate change-related projects, as they are designed to provide funding in cases where financing is most needed and difficult to get. This type of "soft" financing for the improvements in the policy environment and for technology combined with the provision of financial support to local agencies, entrepreneurs and investors. Especially new instruments under consideration, such as partial risk guarantee mechanisms would be one area where GEF could catalyse the transformation process together with financing institutions (Noro 2006). The World Bank estimated that the annual resources available to GEF should be made ten-fold to be able to provide it with a more forceful resource base (World Bank 2006).

All in all, developing countries usually complain that GEF criteria for the evaluation and the allocation of funding are not responsive enough to local development priorities and thus are not completely in line with UNFCCC principles (Carlino *et al.* 2007). The GEF is successful in its objective of transferring technologies to developing countries. Taking the size of the investments undertaken as a consequence of its funding as criteria, the environmental effectiveness is to be assessed as good. The organization of the GEF is relatively complex, with task distribution between UNDP, UNEP and the World Bank. Requirements for project design are substantial and for smaller projects relatively costly (De Conick *et al.* 2007a).

Special Climate Change Fund and Adaptation Fund

In 2001, the Conference of the Parties in Marrakech considered channels for the assistance to adaptation and established three new funds, two of which relevant to emerging economies[3]. The Special Climate Change Fund (SCCF) gives support to adaptation, transfer of technologies, activities in major GHG-emitting sectors, and economic diversification. The Kyoto-Protocol Adaptation Fund finances measures to adapt to climate change. The operation of the funds is guided by the COP to the Convention and operated by the Global Environment Facility (UNFCCC 2004).

As of June 2007, the original pledges to the SCCF totalled USD 67 million. Of this sum, USD 57 million was pledged for the SCCF Programme for Adaptation and USD 10 million for the SCCF Programme for Transfer of Technology (UNFCCC 2007a). The SCCF also considers appropriate technological options in addressing the impact of response measures, consistent with national priorities and indigenous resources.

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[2] The GEF also finances climate change activities in developing countries beyond the financial obligations under the UNFCCC of the Annex-I-countries.

[3] The third funding channel is the Least Developed Countries Fund (LDCF).

Technology Transfer for Adaptation will use the procedures and methodologies to assess technology needs for adaptation consistent with the approach adopted by the technology needs assessments under the national communications[4].

In 2007, the Parties to the UNFCCC agreed at COP13 in Bali that the GEF will serve as secretariat to the Adaptation Fund for the next 3 years. This decision has allowed the Adaptation Fund to become operational. The fund is to be financed with a share of proceeds from the Clean Development Mechanism (CDM) projects and other sources of funding. The share of proceeds amounts to 2 % of Certified Emission Reductions (CERs) issued for a CDM project activity. The level of funding for the Adaptation Fund depends on the quantity of CERs issued and the price of CERs. Assuming annual sales of 300-450 million CERs and a market price of EUR 17.50 (range of EUR 10-25) the Adaptation Fund would receive USD 80-300 million per year for 2008 to 2012 (UNFCCC 2007a). Funding for the Adaptation Fund for post-2012 depends on the continuation of the CDM and the level of demand in the carbon market.

An evaluation of technical adequacy of adaptation funding from a governance perspective as revealed by their responsiveness to the needs of developing countries concludes that the funds are not technically adequate for responding to developing countries' needs, owing both to the complex design of the funds and to poor implementation of the guidance (Möhner/ Klein 2007). The responsiveness of the funds could be enhanced by the following measures:

(a) The COP could provide more explicit guidance in terms of priority activities and eligibility.

(b) The GEF, which has been requested by COP (Conference of the Parties) to give due priority to adaptation activities (UNFCCC Decision 2/CP.12), could make operational all COP guidance on adaptation as part of its revised climate change strategy.

(c) Research could focus on the feasibility of a special adaptation programme, possibly subsuming the LDCF and the SCCF under the GEF Trust Fund.

(d) Similar to the current GEF Resource Allocation Framework for mitigation, adaptation funding could be based on specific country allocations that reflect countries' respective vulnerability and adaptive capacity (Möhner/ Klein 2007).

The Clean Development Mechanism

The CDM has been created as one of the flexible mechanisms of the Kyoto Protocol to reduce GHG emissions through investments in projects that reduce or avoid emissions in developing countries. The project developer is entitled to receive CERs. The demand for CERs comes from industrialized countries that can count these credits towards Kyoto compliance (see **Figure 2**). Although the CDM does not have an explicit technology transfer mandate, it may contribute to technology transfer by financing emission reduction projects using technologies currently not available in the host countries. While its primary goal is to save abatement costs, technology transfer is often mentioned as an ancillary benefit.

India, China and Brazil dominate the CDM pipeline, India in terms of number of projects (33.9 %), and China in terms of value. These three countries account for 75 % of CERs to be issued by 2012.

[4] www.gefweb.org

It was expected that the CDM would contribute substantially to investment in and transfer of climate technologies to developing countries. However, many analysts argue that the scale of technology transfer achieved by the CDM, in comparison to initial expectations, has been scarce due to, for example high transaction costs (see for example Bradley and Baumert, 2005). It has been shown that technology transfer takes place in less than half of the CDM projects (De Coninck *et al.* 2007b, Dechezleprêtre *et al.* 2007; Haites *et al.* 2006).

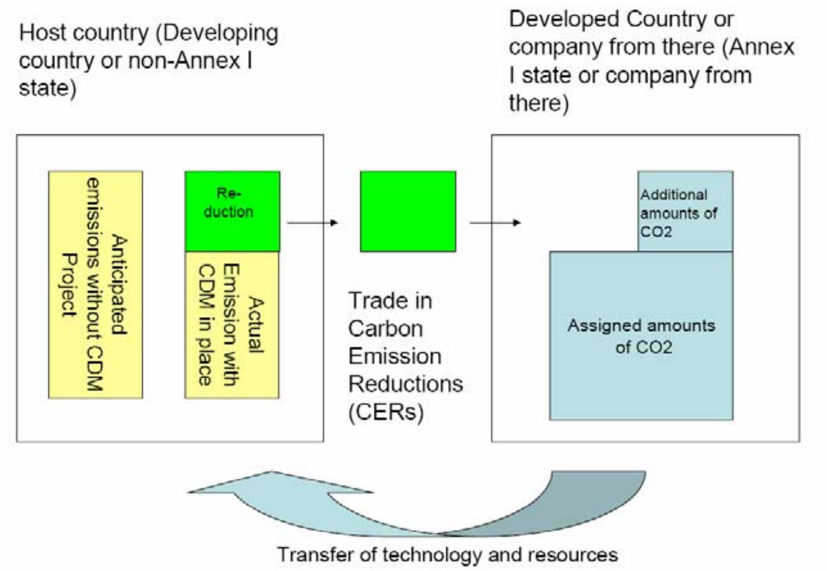

Figure 2: ***Chart X: How does the CDM work?***

Source: Benecke *et al.* 2007

Technologies used in non-CO_2-greenhouse gas and wind energy projects, and a substantial share of the hydropower projects, use technology from outside the host country, but biogas, agricultural and biomass projects mainly use local technology. The imported technologies originate mostly from the European Union (De Coninck *et al* 2007b). Transfer likeliness increases with the size of the projects, i.e. equipment transfer is more common for larger projects, while smaller projects involve transfers of both equipment and knowledge or of knowledge alone. Technology transfer does not appear to be closely related to country size or per-capita GDP, but a host country can influence the extent of technology transfer involved in its CDM projects (Haites *et al.* 2006). The transfer probability is 50 % higher in projects implemented in a subsidiary of Annex 1 companies while the presence of an official credit buyer has a lower, albeit positive, impact (Dechezleprêtre *et al.* 2007).

To sum up, although the current climate change regime sees some development in technology needs assessment, identification of barriers and capacity building, it has not succeeded in developing mechanisms to effectively enhance technology development, transfer and deployment (Höhne *et al.* 2007).

2.2 Technology cooperation for climate change mitigation: Other initiatives

2.2.1 Knowledge sharing and coordination

Activities undertaken under knowledge sharing and coordination agreements include meeting, planning, exchange of information, and possibly the coordination and harmonization of research agenda and measurement standards (De Coninck et al. 2007a).

Asia Pacific Partnership on Clean Development and Climate

The Asia Pacific Partnership (APP), formed by Australia, China, India, Japan, South Korea and the USA in 2005, takes a sectoral approach and focuses on the role of the private sector[5]. The partnership includes a small amount of seed funding, but focuses on understanding the main drivers for investment in new technologies. Strong involvement of leading technology providers and investors provides a forum to explore practical steps to remove barriers to commercial cooperation on low carbon technologies. Over 90 private companies and industry groups and 150 senior task forces contain public and private members as equal participants rather than stakeholders (Stern 2006, ch. 24).

International Partnership for the Hydrogen Economy

The International Partnership for the Hydrogen Economy (IPHE), launched by the US in 2003 is an international institution dedicated to accelerating the transition to the hydrogen economy. The IPHE provides a mechanism for partners to organize, co-ordinate and implement effective, efficient, and focused international research, development, demonstration and commercial utilization activities related to hydrogen and fuel cell technologies. It also provides a forum for advancing policies, and common technical codes and standards that can accelerate the cost-effective transition to a hydrogen economy[6]. It does not provide direct funding to research. However, it secures increased awareness and recognition of significant international collaborative research, development and demonstration projects. The strength of the IPHE is that is a top-level political initiative – launched by ministers – with high-level official representation in its steering committee (Stern 2006, ch. 24).

International Energy Agency Implementing Agreements

The Energy Technology Collaboration Programme of the International Energy Agency (IEA) includes more than 40 international collaborative energy research, development and demonstration projects known as Implementing Agreements (IEA-IA)[7]. These enable experts from different countries to work together and share results, which are usually published for a wider audience.

Generally speaking, environmental effectiveness of knowledge sharing and coordination agreements is rather limited (De Coninck *et al.* 2007). Partnerships for knowledge sharing and coordination are the least demanding and involve the lowest cost. However, they help raise awareness of opportunities for technology cooperation as well as of barriers for advancing technology development and diffusion.

2.2.2 R&D and demonstration

Research, Development and Demonstration (RD&D) agreements include jointly agreed RD&D activities and funding commitments or mutual agreements to expand or enhance domestic RD&D (De Coninck *et al.* 2007).

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[5] www.asiapacificpartnership.org

[6] www.iphe.net

[7] http://www.iea.org/Textbase/techno/index.asp

International Energy Agency Implementing Agreements

The joint demonstration projects of high-temperature, high-pressure filters necessary for pressurized, fluidised bed combustion and integrated gasification combined cycle plants were financed in cost-shared scheme. Participants including private companies, shared the cost (about US$ 15 million) and pooled technical knowledge (IEA 1996).

The IEA Energy Conservation in Buildings and Community Systems initiative is primarily focused on the R&D and construction/-deployment of buildings that have lower energy intensity - thus a lower environmental footprint – than buildings that have been constructed in the past. In terms of R&D, the initiative aims to identify the long-term energy, environmental, economic and technical issues associated with new building construction and will aim to ascertain new technologies and practices that could be developed to improve the energy efficiency o newly constructed buildings (APERC 2007).

The FutureGen Alliance

The FutureGen Alliance has been implemented as international energy initiative in 2005[8]. It is a public and private sector collaborative initiative that plans to build the pilot coal-fired near zero emissions electricity generation plant through a grant in excess of US$ 1 billion. The main objective of this initiative is to R&D technologies that allow the capture and permanent storage of GHG emissions, while producing hydrogen and other by-products that can be used in other industrial processes. – Thus all waste streams from the plant are minimised as much as possible. One of the major challenges that this initiative faces is the protection of intellectual property rights in relation to the development and deployment of a legal framework that specifically targets how intellectual property rights will be governed within the initiative (APERC 2007), see also 3.1.1.

The focus of the Partnership is concrete action: the development and deployment of clean energy technology. It demonstrates the EU’s determination to tackle climate change at the highest level and in concrete ways, as announced at the G8 Summit in Gleneagles. It underlines the commitment to the implementation of the UN Framework Convention on Climate Change and its Kyoto Protocol. It also helps to strengthen the momentum for discussions of a multilateral climate change regime ‘post 2012’.

EU and China Partnership on Climate Change

The Partnership contains two concrete co-operation goals, to be achieved by 2020:

- The first is to develop and demonstrate, in China and the EU, advanced “zero-emissions” coal technology (EU 2005). This technology will allow for the capture of CO_2 emissions from coal-fired power plants and its subsequent storage underground.
- The second cooperation goal is to significantly reduce the cost of key energy technologies and promote their deployment and dissemination.

The Partnership will also support EU and Chinese efforts to reduce the energy intensity of their economies. China has set the goal of halving the energy intensity of the Chinese economy by 2020. In the recently adopted Green Paper on energy efficiency, the Commission has proposed to reduce the EU’s energy consumption by 20% over the same period by increasing energy efficiency. These efforts will be strengthened through the involvement of the private sector, bilateral and multilateral financing instruments and export credit agencies, and the promotion of joint ventures and public-private partnerships.

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[8] www.futuregenalliance.org

The Partnership will also reinforce EU-China cooperation on the Kyoto Protocol's CDM. It foresees a dialogue on the further development of this mechanism 'post 2012' in combination with an exchange of information and experience on the use of market-based mechanisms such as the EU emissions trading scheme.

R&D and demonstration agreements have a high technological effectiveness (in advancing technologies or in achieving a high market penetration), but highly uncertain results regarding environmental effectiveness. As regards economic efficiency (e.g. resulting in an efficient distribution of abatement burdens on those technologies with lower mitigation cost) or cost-effectiveness (achieving lowest cost technology development and diffusion means), it is important to add dynamic considerations. From this point of view, increasing the availability of low-cost technology options is key in order to achieve high emissions reductions over time, and R&D and demonstration agreements offer a valuable instrument (De Coninck *et al.* 2007).

2.2.3 Financing and diffusion of technologies

Technology transfer agreements include commitments for technology and project financing, particularly flowing from developed to developing countries, as well as potentially facilitating international licensing and patent protection (De Coninck *et al.* 2007).

Multilateral Fund for Implementation of the Montreal Protocol

The Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol) was agreed in 1987. In order to provide incentives for developing countries to join the Montreal Protocol, the Multilateral Fund was set up. The Montreal Protocol turned out to be a success story as it resulted in very substantial reductions in chlorofluorocarbons CFCs and effectively involved developing countries that were at first unwilling to commit to reductions.

As regards the contribution to facilitating mitigation of the environmental problem at hand in developing countries, the Multilateral Fund has proved successful. This is due to the fact that a range of technologies to limit ozone layer depletion was available and identified by the time the Multilateral Fund was created. A technology transfer fund that attempted to cover the incremental costs of GHG reductions in developing countries would have to be orders of magnitude larger in scale and in reach than the Multilateral Fund (De Coninck *et al.* 2007).

Technology transfer agreements can help to increase incentives for participation of developing countries, while advancing overall technological and environmental effectiveness. The environmental effectiveness of technology transfer can be high, provided sufficient funding is available (De Coninck *et al.* 2007).

2.2.4 Technology mandates and incentives

This type of technology initiatives is comprised of international agreements encouraging technology deployment by establishing deployment mandates for a specific technology or group of technologies (e.g. renewable portfolio standards), international technology performance standards (e.g. automobile fuel economy or appliance efficiency), or technology deployment incentives (e.g. renewable subsidies).

The 1 Watt Initiative

Appliances and energy using consumer products are a major cause of growth in energy demand. The IEA launched the '1 Watt initiative' on the basis that more widespread use of existing management technology could reduce total standby energy consumption by as much as 75 % in some appliances and could form an important, cost-effective component of an overall global strategy to reduce greenhouse gas emissions[9].

International Convention for the Prevention of the Pollution from Ships

The International Convention for the Prevention of Pollution from Ships (MARPOL) Treaty was agreed in 1973 to halt marine oil pollution from oil tankers. MARPOL was agreed after unilateral threats from the United States to impose stringent domestic technology standards. After entry into force of the MARPOL treaty, international shipping had difficulties escaping the standards because all major ports required that ships meet MARPOL standards.

Cooperation to set international technology standards may have a high technological and environmental impact, i.e. diffusion effects for environmentally sound technology. Cost-effectiveness depends on the detailed provisions and domestic policies that are employed (De Coninck *et al.* 2007).

2.3 Technology cooperation in adaptation to climate change

Technology cooperation in adaptation to climate change comprises a combination of 'soft' technologies, such as crop rotation patterns, and 'hard' technologies, such as sea-walls or new irrigation systems.

Global Index Insurance Facility

One approach to providing international support is through Public-Private Partnerships (PPP), which unite public institutions, private companies, and NGOs in an attempt to meet public goals by harnessing private efficiency and resources. A new example of such PPPs in the area of insurance is the Global Index Insurance Facility (GIIF), now being set up by the World Bank and the EU. This will help countries to access insurance markets for weather and natural disasters. The GIIF will combine private and donor capital to support index-based insurance schemes (like water derivatives) in developing countries. The GIIF would lower the entry barrier to international insurance markets by pooling smaller transactions, thereby scaling up the transfer of risk from developing countries to those better able to carry these risks (Stern 2006, ch. 24).

Lessons from R&D co-operation from CGIAR

A strong precedent exists for international collaboration on research and development in Agriculture. The Consultative Group on International Agricultural Research (CGIAR), established in 1971, is a strategic partnership of countries, international and regional organizations and private foundations supporting the work of 15 international Centres. In collaboration with national agricultural research systems, civil society and the private sector, the CGIAR fosters sustainable agricultural growth through high-quality science aimed at benefiting the poor through stronger food security, better human nutrition and health, higher incomes and improved management of natural resources[10].

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[9] http://www.iea.org/textbase/papers/2005/standby_fact.pdf

[10] www.cgiar.org

Several lessons from the experience of agriculture are relevant for an international programme in the development and use of low carbon technologies and adaptation practices. In the case of agriculture there was a shared commitment among the sponsors. The programme evolved from an already extensive network of national research centres and supplemented and enhanced national efforts. It was based on real demonstration and R&D projects, and was not simply a 'talking shop. The efforts were not centred on one institution in one country, but divided across a set of institutions in several countries specializing on particular crops (rice, wheat, maize, agroforestry and so forth) and livestock farming. There were good working links between the programme and the users (extension services and farmers), so that technology and knowledge could be rapidly diffused to those who use it (Stern 2006, ch. 24).

Transfer of technologies for mitigation of climate change has typically involved transferring equipment or know-how from developed to developing countries. There may thus be a temptation to envisage transfers of technologies for adaptation following the same pattern. However, technologies for adaptation differ from those for mitigation in a number of important respects. First, unlike mitigation, which is a relatively new task, adaptation builds on efforts to reduce vulnerability to current climate variability, for which many technologies are already being applied. Second, adaptation technologies, with some exceptions, are also likely to be less capital intensive and more amenable to small-scale interventions (UNFCCC 2006).

2.4 Roles of public and private sector in technology cooperation

Generally speaking, the private sector is the major driver of innovation and diffusion of technologies around the world. But governments can help to promote international collaboration to overcome barriers to technology development.

Public and private sector have differing and complementary roles at different stages of the technology development and diffusion process. During the first stage of basic technology development, the public sector may play an important role in providing adequate funding (since market failures may imply private underprovision of R&D efforts). At the demonstration stage, both sources of funding may be combined to provide for adequate funding, since some commercial potential may be detected but uncertainty may lead to underinvestment by private actors. Finally, at the diffusion stage (technologies are commercially available) the role of the private sector is key as compared to the public sector. If market returns are normal and no further barriers exist, the public sector role could be limited to providing the adequate signals for "technology push" (Carlino *et al.* 2007).

In this last regard, it may be added that the stability of GHG permit markets and project mechanism is also key, and crucially depends on achieving long-term commitments under the UNFCC.

To date, most Public Private Partnerships (PPP) efforts have been limited to mitigation activities to reduce GHGs. Adaptation activities should not be neglected: a key area in which to explore PPP would be the development of climate-resilient crops. Experience from previous publicly supported crop research demonstrates the efficacy of this public-private approach (Stern 2006, ch. 24).

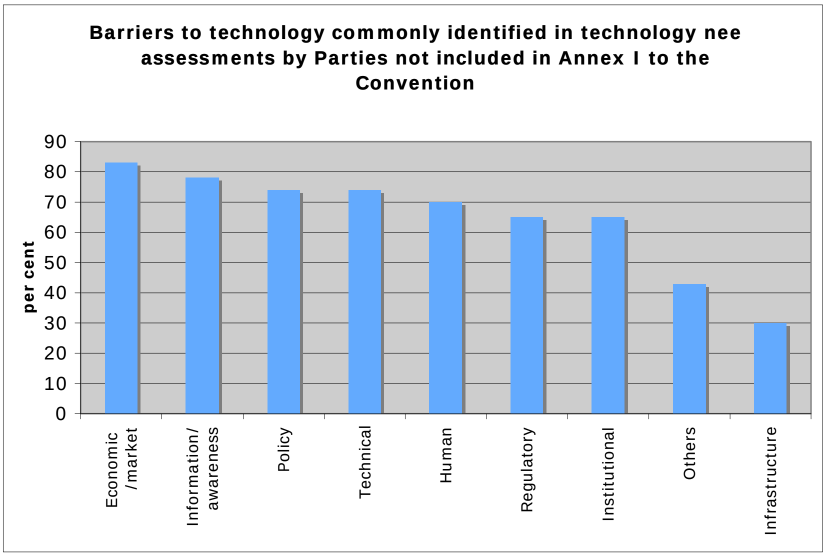
3 Analysis of remaining barriers and tools to technology co-operation

In the beginning of the 1990s the lack of technological capabilities, infrastructure and institutions had been identified by the United Nations as key barriers to technology transfer. It also had been recognized that the barriers are not only technical, but rather linked to "social, economic, political, and cultural milieus in which technologies are developed, diffused, and used" (Heaton *et al.* In: IPCC 2000, chapter 4.2).

Due to the IPCC special report on methodological and technological issues in technology transfer, barriers to technology transfer arise at each stage of the process and depend on the context and regional circumstances. The variety of barriers to technology cooperation cannot entirely be presented in the scope of this briefing; however, some examples of the currently discussed barriers and tools are highlighted.

3.1 Barriers to technology co-operation – general overview

One of the latest overviews on existing barriers to technology transfer can be found in the UNFCCC Synthesis report on technology needs of Non-Annex I countries. The findings from the Technology Needs Assessments (TNAs)[11] state that most important barriers to technology transfer are economic and market ones, followed by insufficient information and awareness, barriers in the policy, lack of human and technical capacity as well as regulatory and institutional barriers (UNFCCC 2006a, see **Figure 3**). **Table 2** lists the barriers stated by the parties.



Source: UNFCCC (2006a, page 25)

Figure 3: Barriers to technology commonly identified in technology needs assessments by Parties not included in Annex I to the Convention

Most often mentioned under the economic and market barriers, was the lack of financial resources. High investment costs, incompatible subsidies and tariffs, lack of incentives were also considered important economic/market barriers (UNFCCC 2006).

[11] By then only a minor part of the non-Annex I countries had provided technology needs assessments, more precisely 23 (around 15% of all Non-Annex I countries), whereof only three are counted among emerging economies (namely Chile, China and Indonesia). Currently more than 100 TNAs are funded by GEF.

According to the TNAs the existing in-country capacity was insufficient to address the transfer of Environmental Sound Technologies (ESTs) and the need for capacity-building was stressed as important issue. A common set of barriers that is only associated with emerging economies cannot be found in the literature. Looking at the three TNAs of the participating emerging economies, Chile identified a need for human capacity-building and sees economical and technical barriers to technology transfer. Indonesia stresses its needs for capacity-building in information/awareness and institutional/ organizational issues, especially for the implementation of CDM projects. It also lists all types of barriers as relevant for Indonesia. The Republic of China did not identify the need for capacity building in her TNA, but barriers to technology in almost all sectors (except infrastructure) (UNFCCC 2006a).

Table 2: Barriers to technology commonly identified in TNAs by Parties included in Annex I to the Convention

Financial • Lack of financial resources • High level of debt • Incompatible price, subsidies, tariffs • Lack of incentives • Lack of access to credit • High up-front costs • Low economic productivity	**Informational** • Lack of access to information • Lack of access to relevant technical data • Lack of awareness about climate change related issues, options for mitigation and adaptation, and advanced technologies • Lack of information about potential donors and project developers
Market • Unstable market situation (the case in many countries) which hinders the procurement of international technological investment from donors • Low income among consumers	**Human resources** • Lack of skill/expertise in dealing with the various aspects of climate change related projects, i.e. greenhouse gas inventory, assessment of mitigation and adaptation options and their implementation • Lack of skilled personnel for the installation and operation of environmentally sound technologies
Organizational and institutional • Lack of a compatible or adequate organizational and institutional framework • Lack of coordination between the activities of the existing organizations and institutions that presently target climate change related concerns could also prove to be a barrier in the effective implementation of climate change related mitigation/adaptation projects	**Social and cultural** • Social practices, beliefs and norms that prevent acceptance of climate change mitigation/adaptation options
Regulatory and policy • Existing laws and policies that may not be compatible with climate change mitigation and adaptation related measures • Lack of necessary policies, regulations, standards and codes	

Source: UNFCCC (2006, page 38)

Other issues that should be mentioned under barriers to technology cooperation are the drawbacks and concerns, that e.g. Justus and Philibert (2005, page 8) brought up in their synthesis report. Especially from the viewpoint of developed countries and industry, the following examples are critical issues that can play a decisive role in technology cooperation:

- Concerns about intellectual property rights protection (see also 2.1).
- Possible loss of existing competitive advantages.

- Time and resources needed to build an agreement among numerous parties could distract from more productive activities.
- Players with vested interest in one technology may deliberately slow progress of new technologies.
- Collaboration on a particular technology might prematurely foreclose potentially significant technology pathways.

(Justus & Philibert 2005, p.8)

3.1.1 Examples of key barriers to technology transfer: Trade barriers and Intellectual property rights (IPR)

Trade barriers

Next to high specific upfront costs for a lot of mitigation technologies, taxes and custom duties remain a barrier that hinders the successful implementation and technology transfer (BMU 2007; UNFCCC 2006a). In combination with national subsidies for fossil fuels and lacking internalization of external costs, no level playing field is possible. Options to overcome these obstacles can be seen in the reduction of taxes and customs duties for environmental sound technologies on a bilateral or even multilateral level.

In the context of the market liberalisation and climate change issues, Philibert (2004) emphasises both sides of the coin. Lowering trade barriers and opening markets might boost not only economic growth, but as well GHG emissions. On the other hand innovation and diffusion of mitigation or low emission technologies are promoted. So he stresses to see globalisation *"more as chance than as risk, even for climate mitigation."* And states that "*Reinforcing and 'greening' the framework for trade and investment can play a key role in enhancing technology cooperation for mitigating climate change*" (Philibert 2004, page 25).

Intellectual Property Rights

The issue of Intellectual Property Rights (IPR) is controversially discussed and remains one of the biggest challenges to technology transfer from developed to developing economies (APERC 2007). The protection of IPRs is important to set incentives for innovators of new products who can obtain a return on the use of the patent or by charging monopoly price on the product (Philibert 2004, p. 28). On the other hand it might be a barrier to efficient diffusion and further development of technological capacity, tacit knowledge and absorptive capacity within recipient countries. As the majority of patents belong to companies of industrialized countries, the latter argument is the concern of emerging economies. Although joint venture partnerships could serve as tool for successful technology transfer, competition issues and concerns relating to IPRs may lead companies to offer older technologies.

Stern (2006, ch. 23) is of the opinion that in many cases, intellectual property rights are not key barrier to transfer of technology. He stresses that for mitigation technologies (e.g. electricity generation), the costs related to IPR are much smaller than the capital investments and running costs. Due to IPCC, many of the technologies for addressing climate change may not be protected anyway (IPCC 2000).

To balance the two effects of IPR protection, different aspects are under discussion.

- Cooperation in RD&D activities shall start at an early stage in the development of a technology because at a later stage the issue of IPRs often prevents common approaches (see FutureGen Initiative, p.9). If cooperation starts early, new technologies can become common goods. In particular, new technologies with global interest (e.g. adaptation technologies) could be favourable for public IPR (IGES, 2006).

Efforts in this regard could be part of the larger technology deal between Annex I and non-Annex I countries (Ecofys/WI 2008; Ockwell *et al.* 2006; Stern 2006).

- One option to handle the conflict of interest is seen in the limitation of the duration of the patent to an appropriate time, not too short to block cost-intensive and risky innovation and not too long to hinder the diffusion (Philibert 2004).
- The differentiation between the licensing of inventions for the use in the host country and on reasonable terms and conditions in other countries is also under discussion.
- As the factors and barriers differ by technology, sector and country, a case-by-case approach to address the issue of IPRs is highly recommended by Ockwell *et al.* (2006). This study highlights the high potential in bilateral and multilateral collaboration on R&D for low-carbon technologies.
- China has shown immense interest in joint activities regarding RD&D. It proposed the establishment of a Multilateral Technology Acquisition Fund (MTAF) that could buy IPRs for low- and no-carbon technologies (Ecofys/WI 2008).
- According to The German Advisory Council on Global Change (WBGU 2007), a mix of different instruments can help to avoid problems relating to the protection of intellectual property rights, including on the one hand public subsidies and compensation, and on the other hand commitments to technology transfer under legally regulated conditions.

3.2 Options/Tools to technology cooperation

The main options and policy tools that can address the existing barriers for technology transfer have been presented in the IPCC Special Report (2000), following ten dimensions of enabling environments:

(1) National systems of innovation;

(2) Social infrastructure and participatory approaches;

(3) Human and institutional capacities;

(4) Macroeconomic policy frameworks;

(5) Sustainable markets;

(6) National legal institutions;

(7) Codes, standards and certification;

(8) Equity considerations;

(9) Rights to productive resources and

(10) Research and technology development.

The list with the mainly recommended policy tools, barriers and relevant sector can be found in the Annex (**Table 3**).

A key message in a UK-India study on barriers to the transfer of low carbon energy technology was, that *"There's no 'one policy fits to all' solution to facilitating low carbon technology transfer. Relevant policy interventions vary according to the nature of the technology its stage of commercial development and the political and economic characteristics of both supplier and recipient countries."* (Ockwell *et al.* 2006, p. 2)

3.2.1 Options to improve access to financing for climate-change-related technology transfer

The switch to low- and no-carbon technologies will require high financial volumes estimated to range from Euro 20-30 billion as stated in the Stern Review (Stern 2006) to US$ 200-210 billion in 2030 according to the UNFCCC (2007a). As the lack of funding is the most important barrier to technology transfer, innovative options for the development and transfer of technologies need to be found. A technical paper on the analysis of these options has been published by the UNFCCC (2006c).

Some key conclusions highlighted in the report:

- Good quality of the projects and business plans is essential (including risk management).
- Added value, benefits and revenues for particular stakeholders need to be shown, especially for Public-Private-Partnerships quantifying the benefits is an important issue.
- Link of climate change-theme to other themes to improve the economic or financial sustainability of a project (in public-sector projects e.g. with poverty alleviation).
- The different instruments of public and private financing offer the possibility for a combination or sequencing of funding. The cooperation at an early stage between the stakeholders is recommendable to find the optimal financing mix.
- Multilateral programmes and institutions are essential for financing technology transfer of low-carbon technologies; they offer long-term commitments and operate via networks to a wide group of stakeholders that are crucial for the success.

(UNFCCC 2006c, p. 43-45)

In the private sector the potential for investments in low-carbon technologies is much higher than within governments and multilateral programmes (Stern 2006). Fast-growing economies are already starting to attract international funding, in spite of policy and structural weaknesses. This starting financial flow needs to be sustained, with market-based policies to increase these markets' attractiveness and security. Investors currently complain about a lack of bankable projects in developing countries, rather than a finance gap (Hohler *et al.* 2007).

The following tools have been proven successful to **facilitate access to private-sector funding** from financing or industrial corporations[12]:

- Capacity-Building: Informing financial institutions/industrial corporations on opportunities and robustness of mitigation technologies to initiate a dialogue; e.g. SEFI (Sustainable Energy Finance Initiative) brings together financiers and convinces them to get involved in the public-private alliances on sustainable energy projects; Training in project development and the management and operation of climate technologies.
- Market development instruments: Public/multilateral risk mitigation instruments can decrease the initial investment risk for financiers; provision of public financial services for climate change technology transfer community; one positive example are the credit enhancement programmes for small-scale renewable energy projects by UNEP[13].
- Rules and regulations: Public rules e.g. on specific standards for emissions and emissions reductions to be met and benchmarks for technologies can promote investments in efficient and low-carbon technologies; e.g. EU Renewables Directive.
- Taxes, levies and subsidies: Taxes and levies can be applied for polluting technologies or practices that contribute to climate change or go against adaptation measures; subsidies or tax allowances can be provided for low-carbon or efficient technologies.

To address the first issue, in 2006 the UNFCCC published a "Guidebook on preparing technology transfer projects for financing" to assist project developers from developing countries and emerging economies to transform their ideas into sound financing project proposals to meet the standards of international finance providers (UNFCCC 2006b).

As outcome of the G8 Gleneagles summit in 2005, the financial world, namely World Bank and Regional Development Banks, was asked to develop a Clean Energy Investment Framework (EIF**)**. The three pillars of the World Bank approach include energy for development and access for the poor, transition to a low-carbon economy and adaptation. It will also combine financial and technical assistance to developing countries to promote policy reforms, sectoral initiatives etc. (Stern 2006, ch.23) Other initiatives are the ones of the European Bank for Reconstruction and Development (EBRD) and of the Asian Development Bank.

Already existing international financing programmes for (co-)financing of sustainable energy technologies are the GEF and CDM (see chapter 2.1). Looking at the share of CDM projects by regions, around 70% of the CERs from renewable energy projects expected by 2012 are located in the emerging economies India, Brazil or China (BMU 2007). On the other hand the number of projects that include technology transfer differ extremely within the emerging economies (e.g. only low share in India compared to others like China) (Ockwell *et al.* 2006). The reasons for these differences still need to be identified.

3.2.2 Option: Support for capacity building

Capacity-building at all levels is a key element in the discussions on barriers of technology transfer and tools to overcome the remaining obstacles. Failures of technology transfer often result from an absence of human and institutional capacity (IPCC 2000). According to the literature screened in the UK-India study (Ockwell *et al.* 2006), three flows are important for international technology transfer (see **Figure 4**).

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[12] Those tools were published in technical paper on the analysis of these options (UNFCCC 2006c, p.22).

[13] The partnership with UNEP e.g. supports Indian banks to develop new loan products in a growing clean energy sector. An interest subsidy helps them to build solar financing portfolios without distorting the credit risk - or the existing cash market for solar home systems. Other programmes are implemented in China, Tunisia, Morocco, Indonesia and Egypt (UNFCCC 2006c, p.22)

If not only new production capacity shall be achieved, but also technological capacity in the recipient country, knowledge sharing is essential.

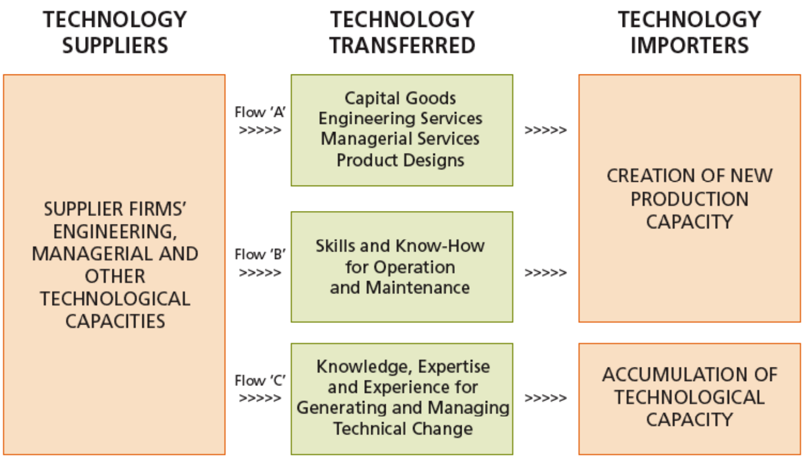

Figure 4: The three flows of international technology transfer (Ockwell *et al.* 2006)

The need for capacity building in emerging economies in different sectors is high, as already noted in 3.1, but varies greatly from country to country, so that case studies and other types of analyses should assess the needs of particular countries (IPCC 2000).

In the case of India e.g. the lack of absorptive capacity – the ability to absorb new technology - is a crucial point that hinders the manufacturing of Light Emitting Diodes (LEDs) or the broad dissemination of briquette production (due to insufficient ability to maintenance) (Ockwell *et al.* 2006, p.6).

Governments have a clear responsibility to support and encourage R&D initiatives, promote facilities and networks (e.g. via building public research laboratories, providing targeted research grants, and strengthening technical education system).

Exchange of knowledge and cooperation in research and development are potentially effective instruments of introducing and disseminating new technologies and political instruments (de Coninck *et al.* 2007). International cooperation on R&D can focus on

(a) **Sharing knowledge and information**, including between developed and developing countries

(b) **Co-ordinating R&D priorities** in different national programmes and

(c) **Pooling risk and reward** for major investments in R&D, including demonstration projects

(Taken from Stern 2006, ch. 24 and Ockwell *et al.* 2006)

In regard to mitigation and adaptation technologies, the study of WBGU (2007) stresses that cooperation arrangements with newly industrialized countries in the fields of business and research should be encouraged via the establishment of reliable legal frameworks and government support. In addition, the development of national roadmaps in developing countries and emerging economies (e.g. decarbonisation partnerships) shall be supported by developed countries.

Next to the improvement of scientific and technical skills other issues like knowledge on management, financing, maintenance, selecting of technologies, information dissemination as well as on infrastructural and issues and policy development can be essential for a successful implementation of low-carbon technologies (IPCC 2000).

For an improved knowledge exchange, UNFCCC provides a web-based technology information system (TT:CLEAR) that includes an inventory of environmentally friendly technologies and projects, and its technology web page. But the success of this instrument depends on the submission of information and TNAs to fill the database (Ockwell *et al.* 2006; see 2.1).

The 7th EU Framework Programme will invest 5 billion Euro on energy and environment issues, intending to include developing countries and emerging economies in its R&D programme.

For six mayor emitting emerging economies (Brazil, China, India, Mexico, South Africa and South Korea), a cooperation in RD&D schemes are recommendable for the accelerated development, technical improvement and market introduction of Renewable Energy Systems (RES) and Combined Heat and Power (CHP) technologies for electricity, heat and cold efficient conventional power plants. And in particular schemes and the methods for energy efficient production could be promising joint activities (Ecofys/Wuppertal Institute 2008).

4 Conclusions and Recommendations

International technology cooperation is a key element for broad dissemination and development of mitigation as well as adaptation technologies. For successful abatement of GHG emission increase and long-term environmental sustainable economic / energy growth in emerging economies technology transfer of low-carbon technologies as well as knowledge capability is essential.

The following recommendations are a non-exhaustive summary of issues brought up in the regarded studies and papers.

UNFCCC technology framework

- Development of an appropriate framework to address the barriers identified in the TNAs - including intellectual property rights issues - and creation of a flow of sufficient finance for R&D.
- The continuity of CDM in post-2012 is recommendable. Reasons for low involvement of technology transfer (and other teething problems) of current CDM shall be analysed and appropriate modifications to improve the greater involvement of technology transfer included. Through incentives, like additional credits or simplified administrative procedures more companies might be attracted (Dechezleprêtre 2007).
- An integrated technology cooperation (for Post 2012) might combine the interest of the EU in integrating the larger economies of the non-Annex I countries in the context of a control regime with the interest of the emerging economies in new and cleaner technologies. Such an approach could comprise cooperation in the research, development and deployment (RD&D) of low- and no-carbon technologies, the elaboration of common standards and a substantial commitment for financing the switch to low- and no-carbon technologies (Ott 2008; Ecofys/WI 2008).

International Technology Agreements

- The different types of international technology oriented agreements have different advantages. Although R&D and knowledge partnerships have uncertain results on environmental effectiveness, the technology effectiveness is high. In contrast, technology standards cooperation have high environmental impact, the cost-effectiveness depends on domestic conditions. For incentives or technology mandates, it is important to add dynamic considerations (Coninck *et al.* 2007).

EU bilateral cooperation

- In the partnerships of the EU on climate change and clean energy (e.g. with China and India) and through holding regular summits (e.g. with Latin America) greater business involvement could provide an important channel for focusing on opportunities for profitable cooperation and priorities for policy interventions (Stern 2006, ch. 23).

Intellectual Property Rights

- One possibility for future technology development and IPRs can be seen in the early involvement of the relevant parties in RD&D activities to help newly developed low-carbon technologies become common goods.
- As the factors and barriers differ by technology, sector and country, a case-by-case approach to address the issue of IPRs is highly recommended to find proper solutions.

Financial cooperation

- To facilitate access to private-sector funding and promote PPPs, four main issues/tools have been proven successful and should be considered as general recommendations (Capacity-Building; Market development instruments; Rules and regulations; Taxes and subsidies).
- A technology transfer fund that attempted to cover the incremental costs of GHG reductions in developing countries could be successful (like the Multilateral Fund of Montreal protocol), but would have to be orders of magnitude larger in scale and in reach.

Capacity building

- For emerging economies capacity building is one of the most important issues in regard to effective technology transfer.
- Especially international R&D cooperation and joint activities in RD&D schemes are recommendable for the accelerated development, technical improvement and market introduction of RES; CHP technologies; efficient conventional power plants and energy efficient production.

In general it can be stated that the approach of "technology push" needs to be combined with efforts to promote "market pull" to achieve significant and successful technology transfer. The requirements for an effective policy framework for a proper enabling environment, pronounced by van Aalst (2004) in 2004, are still appropriate, it *"shall be {…}* ***loud*** *(adequate framework communicated properly),* ***long*** *(stable and sustainable to reflect financing horizons) and* ***legal*** *(legal establishment with binding targets)"*.

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List of abbreviations

APERC	Asia Pacific Research Centre
APP	Asia-Pacific Partnership
BMU	*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit*- German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CHP	Combined Heat and Power
CFC	Chlorofluorocarbons
CGIAR	The Consultative Group on International Agricultural Research
COP	Conference of Parties of United Nations Conventions
EBRD	European Bank for Reconstruction and Development
EIF	Energy Investment Framework
EGTT	Expert Group on Technology Transfer
EU	European Union
EST	Environmental Sound Technology
G8	Group of the Eight
GDP	Gross domestic product
GEF	The Global Environment Facility
GHG	Greenhouse Gas Emissions
GIIF	Global Index Insurance Facility
IEA/IA	International Energy Agency Implementing Agreements
IGES	Institute for Global Environmental Strategies
IPCC	Intergovernmental Panel on Climate Change
IPHE	International Partnership for the Hydrogen Economy
IPR	Intellectual Property Rights
LDCF	Least Developed Countries Fund
LED	Light Emitting Diodes
MARPOL	International Convention for the Prevention of the Pollution from Ships
MTAF	Multilateral Technology Acquisition Fund
OECD	Organisation for Economic Co-operation and Development
PPP	Public-Private Partnerships
RES	Renewable Energy Systems
R&D	Research and Development
RD&D	Research, Development and Demonstration
SCCF	The Special Climate Change Fund
SBSTA	Subsidiary Body for Scientific and Technological Advice
SEFI	Sustainable Energy Finance Initiative
TT: CLEAR	Technology Transfer Clearing House
TNA	Technology Needs Assessments
TOA	Technology Oriented Agreement
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework on Climate Change
WBGU	*Wissenschaflicher Beirat der Bundesregierung Globale Unweltveränderungen* - German Advisory Council on Global Change

Annex

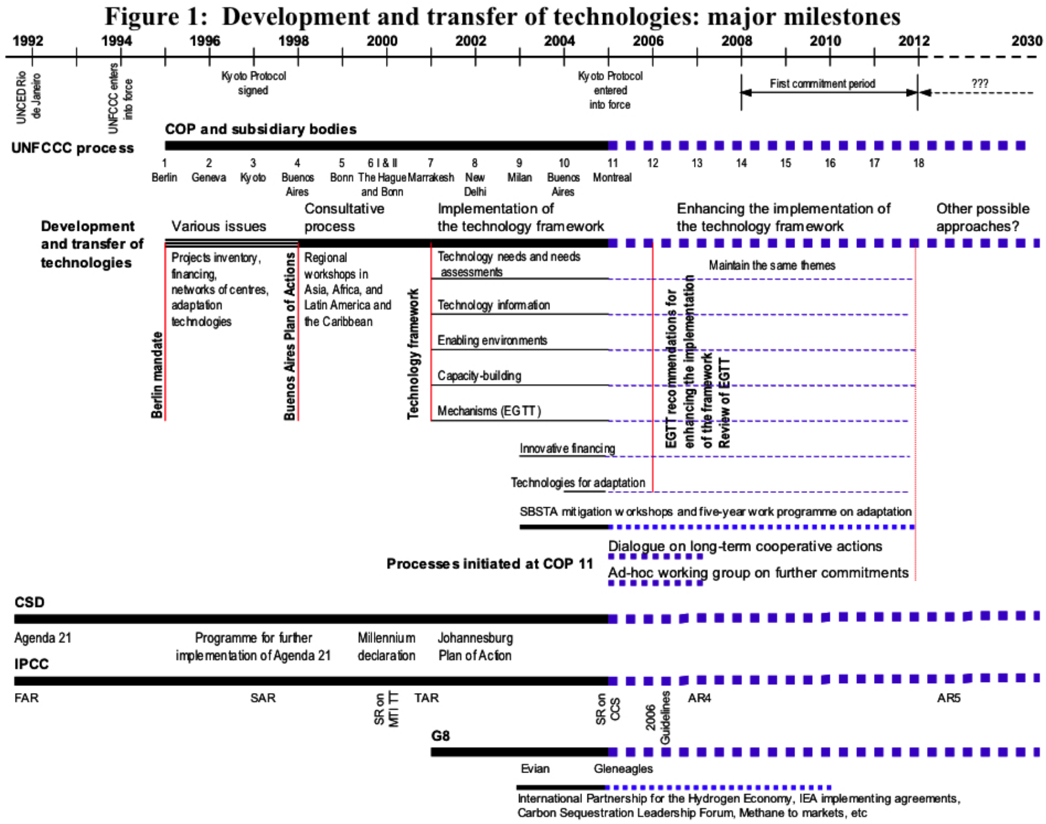

Figure 5: Development of transfer to technologies: major milestones (UNFCCC 2007b)

Table 3: Policy Tools for Creating an Enabling Environment for Technology Transfer

Policy Tools for Creating an Enabling Environment for Technology Transfer		
POLICY TOOL	BARRIERS ADDRESSED	RELEVANCE
NATIONAL SYSTEMS OF INNOVATION AND TECHNOLOGY INFRASTRUCTURE		
• Build firms' capabilities for innovation • Develop scientific and technical educational institutions • Facilitate technological innovation by modifying the form or operation of technology networks, including finance, marketing, organisation, training, and relationships between customers and suppliers	• Lack of technology development and adaptation centres • Lack of educational and skills development institutions • Lack of science, engineering and technical knowledge available to private industry • Lack of research and test facilities • Lack of information relevant for strategic planning and market development • Lack of forums for joint industry-government planning and collaboration	• Primarily private-sector-driven pathways • Primarily buildings, energy, and industrial sectors • All stages
SOCIAL INFRASTRUCTURE AND RECOGNITION THROUGH PARTICIPATORY APPROACHES		
• Increase the capacity of social organisations and NGOs to facilitate appropriate technology selection • Create new private-sector-focused social organisations and NGOs with the technical skills to support replication of technology transfers • Devise mechanisms and adopt processes to harness the networks, skills and knowledge of NGO movements	• Technology selection inappropriate to development priorities • Historical legacy of technology transfer in development • Problems of scaling cultural and language gaps and fostering long-term relationships	• All pathways • Particularly adaptation technologies, but applies to all sectors • Particularly assessment, evaluation and replication stages, although NGOs are more and more participating in implementation stages
HUMAN AND INSTITUTIONAL CAPACITIES		
• Build capacities of firms, non-governmental organisations, regulatory agencies, financial institutions, and consumers	• Inability to assess, select, import, develop and adapt appropriate technologies • Lack of information • Lack of management experience • Problems of scaling cultural and language gaps and fostering long-term relationships • Limited impact of technology because no long term capacity built to maintain innovation • Lack of joint venture capabilities for learning and integrating	• All pathways • All sectors • Particularly assessment and implementation stages

MACROECONOMIC POLICY FRAMEWORKS		
• Provide direct financial support like grants, subsidies, provision of equipment or services, loans and loan guarantees. • Provide indirect financial support, like investment tax credits • Raise energy tariffs to cover full long-run economic costs • Alter trade and foreign investment policies like trade agreements, tariffs, currency regulations, and joint venture regulations • Alter financial sector regulation (See also Chapter 5 for further discussion of policy tools for financing technology transfer)	• Lack of access to capital· Lack of available long-term capital • Subsidised or average-cost (rather than marginal-cost) prices for energy • High import duties • High or uncertain inflation or interest rates • Uncertain stability of tax and tariff policies • Investment risk • Excessive banking regulation or inadequate banking supervision • Incentives for banks that are distorted against risk taking • Banks that are poorly capitalised • Risk of expropriation	• Particularly private-sector-driven pathway, but relevant to all pathways • Trade and foreign investment policies particularly relevant to private-sector-driven pathways • Particularly assessment and repetition stages • All sectors; energy tariffs relevant to buildings, industry, and energy sectors
SUSTAINABLE MARKETS FOR ENVIRONMENTALLY SOUND TECHNOLOGIES		
• Conduct market transformation programmes that focus on both technology supply and demand simultaneous. • Develop capacity for technology adaptation by small- and medium-scale enterprises (SMEs) • Conduct consumer education and outreach campaigns • Targeted purchasing and demonstrations by public sector	• High transaction costs • Inadequate strength of smaller firms • Uncertainty of markets for technologies prevents manufacturers from producing them • Lack of consumer awareness and acceptance of technologies • Lack of confidence in the economic, commercial, or technical viability of a technology	• Private-sector-driven pathways • Buildings, industry, and energy sectors • All stages
NATIONAL LEGAL INSTITUTIONS		
• Strengthen national frameworks for intellectual property protection • Strengthen administrative and law processes to assure transparency, participation in regulatory policy-making, and independent review • Strengthen legal institutions to reduce risks	• Lack of intellectual property protection • Contract risk, property risk, and regulatory risk • Corruption	• All pathways • All sectors • Particularly agreement stage

CODES, STANDARDS, AND CERTIFICATION		
• Develop codes and standards and the institutional framework to enforce them. • Develop certification procedures, and institutions, including test and measurement facilities.	• High user discount rates do not necessarily result in most efficient technologies • Lack of information about technology or producer quality and characteristics • Lack of government agency capability to regulate or promote technologies • Lack of technical standards and institutions for supporting the standards	• All pathways • Buildings, transport, industry, and energy sectors • Assessment stage
EQUITY CONSIDERATIONS		
• Devise analytical tools and provide training for social impact assessment. • Require social impact assessments before technology is selected • Create compensatory mechanisms for 'losers'	• Social impacts not adequately considered • Some stakeholders may be made worse off by technology transfer	• All pathways • All sectors • Assessment stage
RIGHTS TO PRODUCTIVE RESOURCES		
• Investigate impacts of technology on property rights, test through participatory approaches, devise compensatory mechanisms for losers.	• Inadequately protected resource rights	• All pathways • Most sectors where land use is involved
RESEARCH AND TECHNOLOGY DEVELOPMENT		
• Develop science and educational infrastructure by building public research laboratories, providing targeted research grants, and strengthening technical education system • Directly invest in research and development	• Insufficient investment in R&D • Inadequate science and educational infrastructure	• Government-driven and community-driven pathways • Assessment and replication stages • Buildings, industry, energy, waste management and treatment sectors

Source: IPCC (2000, ch. 4.2)