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Intensifying and reorienting transfer of low carbon technologies for climate change prevention

The transfer of "low carbon" technologies is crucial in order to moderate greenhouse gas (GHG) emissions by developing countries, which are set to rise significantly. Their implementation will determine the success of a global agreement on climate change in 2015, and this is the task of the Technology Mechanism, created in 2010. This policy brief sets out the principal results of a study commissioned from the MINES ParisTech Industrial Economics Centre (CERNA). The study shows that, unlike China, Mexico, South Africa and, to a lesser extent, Brazil, India is currently left out of international flows of low carbon technologies transfer – it is therefore a top priority, as is the rest of developing Asia, Africa and Eastern Europe.

To intensify these transfers, ambitious greenhouse gas emissions reduction policies need to be implemented and absorptive capacities need to be created in countries that receive such technologies. In emerging countries, which possess a genuine capacity for innovation, and which are involved in international trade, the strengthening of intellectual property rights and the lowering of barriers to trade and investment are to be recommended. However, in the least developed countries, emphasis must be placed on technology absorptive capacities and in particular on the development of a qualified labour force. ■

KEY MESSAGES

1 ■ Only some emerging countries (China, Mexico and South Africa) are already recipients of technology transfer from developed countries. However, India, the other developing Asian countries and Africa receive insufficient technology transfer in view of their potential to reduce GHG emissions. The least developed countries, in particular, are practically left out of such trade.

2 ■ In developing countries, implementation of ambitious climate policies and the creation of absorptive capacities are vital in order to encourage technology transfer in these countries.

3 ■ In emerging countries, the strengthening of intellectual property rights is likely to promote technology transfer. In the least developed countries, the focus must be on building and consolidating absorptive capacities.

BACKGROUND

International transfers of low carbon technologies[1], which now essentially occur between developed countries, must also be directed towards developing countries (DCs) to stop the rise in the average global temperature and reduce the likelihood of irreversible catastrophe. International dialogue on this issue has been hampered by disagreement in the area of intellectual property rights. However, the recent implementation of the Technology Mechanism, created in 2010 during the Conference of the Parties in Cancún, should make it possible to organise international cooperation and move negotiations forward on the future global agreement planned for 2015. The French Policy Planning Commission (CGSP) has commissioned a report from CERNA, the objective of which is to propose recommendations on the directions that low carbon technologies transfers should take and the means by which these may be intensified[2]. In order to make progress in this field, current low carbon technologies transfer needs to be mapped through an analysis of the main technology transfer channels: flows of international patents, Foreign Direct Investment (FDI) and international trade in capital goods. The aim of such analysis is to determine priority countries and technologies for transfer. It will also identify the public policy instruments that may be availed of in order to encourage such transfers.

WHY TRANSFER LOW CARBON TECHNOLOGIES?

Transfers are needed for climate change prevention

International commitments

Low carbon technologies enable greenhouse gas emissions to be reduced or controlled[3]: they are particularly present in the sectors of energy (renewable energies, biofuels, energy storage), transportation (hybrid and electric vehicles), construction (heating, insulation) and industry (electric arc furnaces).

Their diffusion, intended to make the most effective technologies available as rapidly as possible to all countries as soon as they become available, is a key element for success in climate change prevention[4]. Technology transfer to developing countries, whose currently modest emissions are set to increase, are vital to success in climate change stabilisation: indeed, the International Energy Agency (IAE) estimates that 75% of increases in CO_2 emissions between now and 2050 will come from developing countries, with India and China alone accounting for almost 50%[5] of this increase. Such transfers must be stepped up immediately to prevent the increase in global average temperatures compared with pre-industrial levels. The IAE estimates that this increase could reach between 3.6°C and 5.3°C, which is well over the 2°C threshold that nations have undertaken to comply with in order to reduce the prospect of irreversible catastrophe[6]. For example, refurbishment of existing coal-fired power stations, worldwide, using the best technologies available, would reduce CO_2 emissions by more than a gigatonne per year, or 3% of global emissions from the burning of fossil fuels in 2012[7].

1. In its special report entitled "*Methodological and Technological Issues in Technology Transfer*" (2000), the IPCC defines technology transfer as "a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders [...]".
2. This policy brief also makes use of the results of a comparative study commissioned from the French Directorate of the Treasury, "International Low Carbon Technology Transfers, a Comparative Analysis in 14 Countries".
3. See annex 1 for the list of technologies covered by the study.
4. It should be noted that the dissemination of technologies is also necessary to enable vulnerable countries to adapt to the effects of climate change. This issue, which is also included in international climate negotiations and agreements, is not dealt with in this policy brief.
5. IEA (2012), *Energy Technology Perspectives*.
6. IEA (2013), *Redrawing the Energy-Climate Map*, June.
7. Centre d'analyse stratégique (2008), *Energy outlook for France 2020-2050*, and IEA (2013), *op. cit*.

The United Nations Framework Convention on Climate Change (UNFCCC), adopted at the Rio de Janeiro Earth Summit in 1992, sets out an obligation for developing countries to "promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing countries Parties [...]. In this process, the developed countries Parties [...] shall support the development and enhancement of endogenous capacities and technologies of developing country Parties" (article 4.5). In 2007, the Bali Action Plan had set in place north/south transfers as one of the pillars of the framework for global action.

International negotiations on this issue have for a long time been held back by disagreements between developing and developed countries over the issue of intellectual property rights. It was only in 2010 that the creation of the Technology Mechanism (Box 1) was able to set out how global cooperation was to be organised.

BOX 1: THE UNFCCC TECHNOLOGY MECHANISM

The idea of implementing a Technology Mechanism designed to accelerate the development and transfer of technologies was incorporated into the final decision of the Copenhagen International Summit in 2009. Since this text was not endorsed by the UNFCCC, it wasn't until the following year that the Cancún Conference made official the creation of the Mechanism.

It is structured around a Technology Executive Committee (TEC), made up of twenty experts elected by the Conference of the Parties to the Convention, and a Climate Technology Centre (CTC), bringing together technical experts and associated with an international network.

The TEC sets out the Mechanism's strategic action priorities, which it reports on to the Conference of the Parties. Its mandate encompasses the preparation of country reports in the field of technology transfer and development and on obstacles encountered by countries in this regard; drafting of recommendations; development of collaboration between governments, businesses, non-governmental organisations (NGOs) and research centres, and driving the development of international, regional and national action plans.

The CTC is tasked with implementation of concrete actions, namely those having to do with capacity-building needed for technological development in developing countries, at their request. It informs the Conference of the Parties of its actions, through its consultative committee. The Centre is hosted for the next five years by a consortium of bodies directed by the United Nations Environment Programme (UNEP).

In 2009, the Convention[8] estimated that public and private investment in the diffusion of low carbon technologies, although insufficient, would reach 31 to 49 billion dollars per year, just over one-third of which would involve developing countries. In 2010, developed countries pledged to raise 100 billion dollars per year by 2020 to help developing countries reduce their greenhouse gas emissions and adapt to the effects of climate change. A portion of these funds, of public and private origin, is to enable the acceleration of low carbon technologies development and transfer.

Competitiveness issues and sources of mutual benefits

Despite the global benefits that these represent as "accelerators" for climate change prevention, the transfer of low carbon technologies raises obvious competitiveness concerns for the states providing them.

The CERNA study addresses this dilemma facing developed countries and finds that benefits exist for both recipients and providers of the technologies.

The transfer of technologies could, therefore, benefit those countries providing technologies (local job creation, increased exports) provided that adequate public policies guarantee the diffusion of expertise and know-how. Accordingly, strict policies for protecting intellectual property rights would limit "leakage" of expertise or counterfeiting by local competitors and would provide an incentive for developed countries to effect such transfers. Furthermore, measures for promoting trade and foreign direct investment would enable businesses owning technologies to access local markets more easily, which would provide an incentive for these to engage in technology transfer. Finally, technology transfers in economies open to global trade would help increase international competition on the product markets concerned and reduce prices. This development would therefore be beneficial for industries using low carbon technologies as well as for the end consumer.

8. See UNFCCC (2009), *Recommendations on Future Financing Options for Enhancing the Development, Deployment, Diffusion and Transfer of Technologies under the Convention*, Report by the Chair of the Expert Group on Technology Transfer, Document FCCC/SB/2009/2, and UNFCCC (2009), *Second Synthesis Report on Technology Needs Identified by Parties not Included in Annex I to the Convention*. Note by the secretariat, Document FCCC/SBSTA/2009/INF.1.

Misunderstandings regarding the very concept of technology transfer

The highly controversial nature of the debate on the international transfer of low carbon technologies arises partly from misconceptions about what technology transfer actually is.

At first sight, at least for the host country, transfer may seem synonymous with unlimited access to the technology that is exempt from all intellectual property rights. However, this is not generally the case. In fact, the issue is that these technologies are partly intangible assets. Since the underlying technological know-how is the result of costly research and development (R & D) efforts, which are to varying degrees paid for by the taxpayers of a given country and by private companies, it does not fully belong to the public domain. Usually, through means including patent rights and trade secrets, it is protected by its holders, to prevent any third parties from unduly appropriating it, the effect of which would be to remove the incentive for any subsequent R & D work. For reasons such as these, it is difficult to assess empirically the extent to which such technological know-how crosses borders, especially since these may or may not be combined with tangible assets such as machines and devices.

Transmission channels: scope and limitation

The methodology proposed by CERNA constitutes a diagnostic tool which enables priority destinations and technologies to be defined for technology transfer. It provides a useful addition to the Technology Needs Assessment (TNA) already implemented by countries and mobilised by the Technology Mechanism (Box 2).

Taking into account the available data comparable at the international level[9], the technology transfers covered in the CERNA study are identified using three types of indicators:

- the first is the number of patents registered, at a sufficiently detailed level to identify most of the technologies developed to combat climate change (Patstat database maintained by the European Patent Office). Also, in its definition of the concept of technology transfer, the study limited itself to "international patents", meaning those patents registered in a country for which rights are subsequently extended to one or more countries. Of course, this type of approach runs into a number of the usual limitations: not all inventions are patented, the number of patents does not provide any clue as to their economic value, or as to their actual use in a given country, etc. Nevertheless, extending protection through a patent to foreign countries is a costly operation and is therefore a fairly reliable indicator that the technology has a certain economic potential that may be transferred abroad by the holder;

- the second statistical source is the commercial value of the capital goods incorporating greenhouse gas reduction technologies (Comtrade database maintained by the United Nations);

- the third indicator is foreign direct investment, based on Orbis financial data provided by Bureau Van Dijk. In order to limit the field under examination, the study cross-references these data with the previously mentioned Patstat data; this allows to focus exclusively on multinational companies, each holding at least one patent for low carbon technologies, and which will therefore potentially make international transfers available. For this reason, the sector breakdown for FDI is identical to that used for patents. In view of the limited data available, the level of FDI between the companies of any two given countries is assessed in terms of the number of financial ties existing between them, rather than in terms of investment values.

9. It should be noted that there are lacunae in the available data for certain sectors (agriculture and forestry), certain technologies (energy efficiency in industry) and certain countries (patents in India and other South-East Asian countries).

BOX 2: TECHNOLOGY NEEDS ASSESSMENTS: A BOTTOM-UP EVALUATION OF NATIONAL TECHNOLOGY REQUIREMENTS

Contrary to the method developed by CERNA, the Technology Needs Assessment method provided for by the Climate Convention[10] is based on an assessment by the developing countries themselves of their priorities as regards access to low carbon technologies[11]. The aim of the process is also to develop a national technology action plan setting out the regulatory, financial and technological obstacles to the transfer and diffusion of technologies, and making provision for adequate, pragmatic sector-based response measures.

Drafting is entrusted to a national team, which receives contributions from a network of stakeholders: government representatives, national and international financial agencies, members of the private sector, NGOs, academic experts, international experts, developers of technologies, etc.). Following on from the setting of national priorities in terms of economic development, which is an essential prerequisite for the exercise, is the definition of priority sectors and technologies for climate change prevention; finally, if possible, the team prepares an action plan.

The analysis of 70 TNA[12] by the Secretariat of the Convention in 2009 showed that in most cases, countries list the following as priority technologies: renewable energies (particularly photovoltaic solar, biomass and hydraulic energy), forestry and agricultural management, energy efficient lighting, heating of buildings and water pumping, and also treatment of waste.

The report also highlights the highly diverse range of methods used by countries, irrespective of the guidance principles and technical assistance provided by international institutions such as the Global Environment Fund, UNEP, the group of experts on technology transfer created by the Convention, the United Nations Development Programme [UNDP] and the International Energy Agency's Climate Technology Initiative)[13]. TNAs therefore vary in quality: in 2009, the Secretariat of the Convention identified only nine "complete" documents. Prioritising of technologies was therefore left out by some, despite having been provided with a multi-criteria analysis tool (TNAssess) by the Secretariat of the Convention and the UNDP, which takes into account the energy, economic, social and environmental characteristics of each country. Moreover, the selection criteria for sectors and key technologies were not consistently made clear.

Stakeholders' involvement took a number of forms (participation in a workshop at the outset of the process, ongoing consultation or responding to a survey). Most of these experts are consulted when key technologies are selected: organising the process in this way risks having ruled out certain technologies from the range of options, if these are not known by stakeholders.

One of the drawbacks of the exercise, lasting from eight months to two years, is its cost: countries received financial support from the Global Environment Fund and the United Nations Environment Programme, and conducting a TNA every year is out of the question.

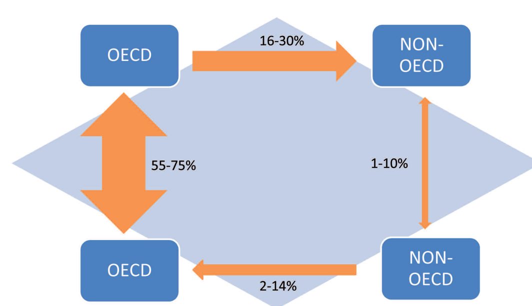
The CERNA and TNA methods complement one another: the first has the advantage of providing a complete, overall vision of priorities, particularly in terms of the geographical destinations for transfers, through the use of the most recent data, whilst the second gives a variety of different results but brings new elements to the fore. TNAs include, in particular, an analysis of the agricultural and forestry sectors, which is vital for countries in which land management has major potential for reducing emissions. Finally, TNAs are indispensable for raising awareness within governments regarding the actions to be undertaken.

TO WHICH COUNTRIES SHOULD TECHNOLOGIES BE TRANSFERRED?

Highly unequal distribution of low carbon technologies among developing countries

The vast majority of international low carbon technologies transfers currently take place between northern countries (figure 1): in fact, whatever the transmission channel in question is (international patents, capital goods or FDI), over 50% of international low carbon technologies trade occurs between OECD countries.

FIGURE 1: GEOGRAPHICAL BREAKDOWN OF LOW CARBON TECHNOLOGIES TRANSFER



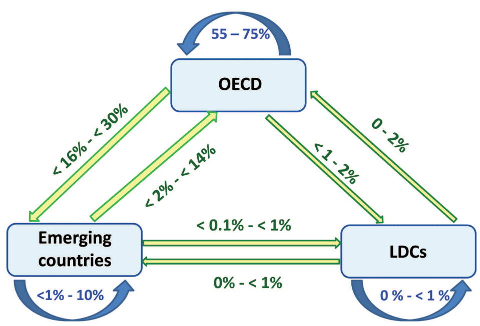
Source: CERNA, based on PATSTAT, COMTRADE and ORBIS data.

10. Article 4.5, UNFCCC.
11. It should be noted that TNAs also encompass climate change adaptation technologies.
12. 15 Latin American countries, 14 Asia-Pacific countries, 30 African countries, 11 European countries.
13. See *Handbook on Conducting Technology Needs Assessment for Climate Change*, November 2010.

The transfer of low carbon technologies to developing countries[14], although still small-scale, is nevertheless non-negligible and has increased considerably since the 1990s. This is attested to by the sixfold increase, between 1990 and 2007, in international patent registrations, in at least one developing country. Moreover, it appears that technology transfer to developing countries is greater for low carbon technologies than for other technologies.

However, the situation varies substantially depending on whether countries are emerging countries or least developed countries (LDCs). These latter barely import or export any low carbon technologies and are accordingly almost absent from the trade map.

FIGURE 2: FLOWS OF LOW CARBON TECHNOLOGIES TRANSFER BY GEOGRAPHICAL AREA



Source: CERNA, based on PATSTAT, COMTRADE and ORBIS data.

However, the contribution of emerging countries[15] to global technologies trade is considerable. They are responsible for almost 25% of global trade in capital goods and, moreover, benefit appreciably from technology transfer: the share of international transfers originating in OECD countries and going to emerging countries is 30% for FDI, 19% for capital goods and 16% for international patents.

This privileged position of emerging countries applies especially to China and South Africa, whose involvement in global low carbon technologies exchange is on a par with their share in the global economy (in GDP terms). Mexico, an emerging country within the OECD, is also relatively well integrated into global low carbon technologies trade. To a lesser extent, this is also the case for Brazil, which is relatively well connected to global exchanges through FDI. Conversely, Russia and India occupy an almost insignificant place in proportion to their contribution to the global economy.

The preferred channels for technology transfer vary from one country to another. Although China and South Africa tend to make use of international patents, global low carbon technologies transfers to Mexico, Brazil and Russia are based more on FDI, which is a good thing insofar as it induces greater transfer of knowledge than is the case for patents.

FIGURE 3: THREE CHANNELS FOR TRANSFER OF LOW CARBON TECHNOLOGIES IN SOME EMERGING COUNTRIES: GLOBAL SHARE OF FLOWS OF INCOMING PATENTS, EQUIPMENT GOODS IMPORTATION, AND INCOMING FOREIGN DIRECT INVESTMENT

Country	Patent inward flows	Imports of equipment goods	Inward FDI	Share of global economy (GDP)
China	15.5%	8.3%	7.1%	11.1%
Mexico	2.2%	1.7%	2.5%	2.2%
Russia	1.3%	1.4%	2.2%	3.3%
South Africa	1.2%	0.4%	0.9%	0.7%
India	n.a.	1.5%	1.6%	4.9%
Brazil	0.7%	0.7%	2.5%	2.9%

Source: CERNA, based on PATSTAT, COMTRADE and ORBIS data.

Transfers to be accelerated in India and in other Asian developing countries (excluding China)

KEY MESSAGE ■ 1

Only certain emerging countries (China, Mexico and South Africa) already benefit considerably from technologies from developed countries. However, India, the other developing Asian countries and Africa receive insufficient technology transfer in view of their potential to reduce GHG emissions. LDCs, in particular, are almost absent from such trade.

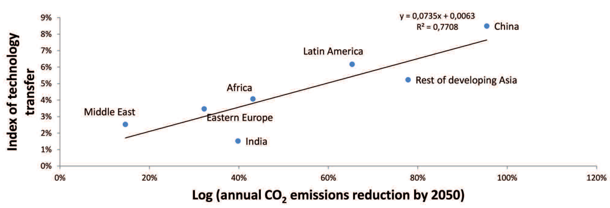
14. Developing countries include countries that are not part of the OECD. These are broken down into least developed countries and emerging countries. List of LDCs as defined by the UN: Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Democratic Republic of Congo, Djibouti, Equatorial Guinea, Eritrea, Gambia, Guinea, Guinea-Bissau, Haiti, Kiribati, Laos, Lesotho, Liberia, Madagascar, Malawi, Maldives, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Samoa, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Somalia, Sudan, Timor-Leste, Togo , Tuvalu, Uganda, Tanzania, Vanuatu, Yemen, Zambia. From among the criteria, countries are included whose per capita GDP is less than USD 800-900.

15. Excluding Mexico.

Countries or geographical areas are considered to be priorities for technology transfer if they meet the following two conditions:

- they offer significant potential for greenhouse gas emissions reduction at reasonable cost; in the CERNA study this potential was calculated based on data from the study published in 2010 by McKinsey – *Impact of the financial crisis on carbon economics*;
- the technology transfer that they currently receive is relatively limited. The indicator used to measure the current level of low carbon technologies transfer is the average of imports by two transmission channels under consideration: trade in capital goods and FDI. Patent data from Patstat were not included in the index as they are not available for India and other Asian countries (Indonesia, Philippines, Vietnam, Pakistan, Thailand, Bangladesh).

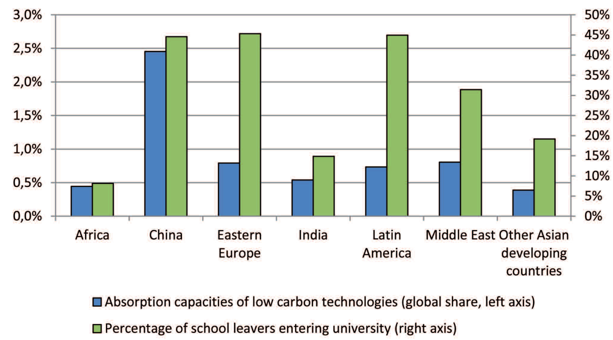
FIGURE 4: CO_2 EMISSIONS REDUCTION AND LOW CARBON TECHNOLOGIES TRANSFER BY REGION (2007-2009)



Source: CERNA.

Two regions stand out as being a priority: India and the other Asian developing countries[16], apart from China. Africa and Eastern Europe also emerge as regions not benefiting very much from technology transfer. In order for efforts to promote low carbon technologies transfer in these regions to yield results, they must be accompanied by policies to consolidate their capacities to absorb the technologies. Such capacities depend upon factors such as the stock of human capital, the quality of infrastructure and institutions and the stability of the macro-economic environment, which are vital for technology transfer to have a positive impact on the local production base. In the study, these were measured using two indicators: the current stock of patents registered by local inventors for a given technology and the percentage of school-leavers going on to university.

FIGURE 5: EVALUATION OF ABSORPTIVE CAPACITIES IN LDCS



Source: CERNA, based on PATSTAT and World Bank data.

The study therefore concludes that capacities must be improved in each region, particularly in Africa, in India and the other Asian developing countries (excluding China). This analysis needs to be substantiated by other indicators taking into account absorptive capacities, a factor that is difficult to evaluate accurately. However, it does indicate that in the countries concerned, the consolidation of technology absorptive capacities involves the development of international cooperation in the R&D field and demonstration programmes. The objective is to improve the training of technical personnel and to disseminate information on existing technologies across a broad range of scientific disciplines: in fact, it is characteristic of low carbon technologies that they mobilise numerous scientific specialisations (chemistry, environmental sciences, energy sciences, biology, agronomy, geology, etc.)[17]. The example of development of the Chinese photovoltaic sector is enlightening in this regard, since it benefited in large measure from technology transfers occurring in an industry that is apparently totally unconnected with green technologies, the semi-conductor industry.

16. Bangladesh, Bhutan, Brunei, Cambodia, North Korea, Indonesia, Laos, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, Timor-Leste, Vietnam.

17. See *Measuring Innovation: A New Perspective*, OECD (2010).

WHICH TECHNOLOGIES SHOULD BE TRANSFERRED?

International transfers of low carbon technologies are already taking place on a large scale

International transfers of low carbon technologies are already taking place on a large scale on the international stage. Although only a partial indicator, trends in intellectual patent protection show that climate-linked technologies are increasingly patented at the international level (patent registered in at least two countries) and comparatively more than other technologies. Therefore, **30% of climate-change-linked technologies are protected by international patents, compared with 20% of non-climate-related technologies.**

International trade in low carbon capital goods, which have registered an average annual increase of 18% since 1990, confirms the success of these export technologies: trade in other goods rose by only 13% over the same period.

The study underlines the fact that the dynamic dissemination of low carbon technologies partly compensates for the fact that innovation in this field is particularly highly concentrated (the United States, Germany and Japan account for 60% of all patented inventions).

Different transfers according to the maturity of technologies

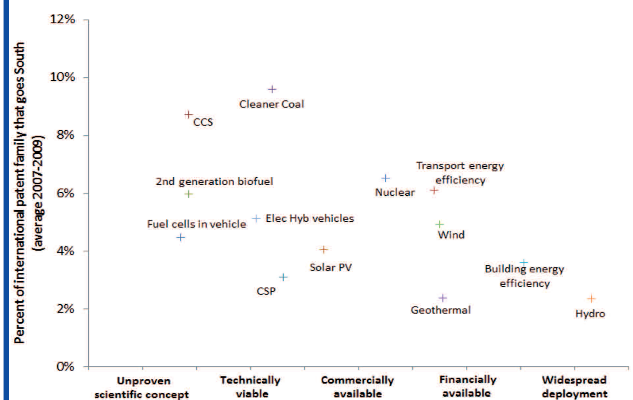
According to international patent registrations, the low carbon technologies transferred to LDCs are essentially those associated with CO_2 capture and storage (CCS) and "clean coal". In addition to CCS, this notion covers other technologies that are able to reduce pollution associated with the industrial use of coal, among these:

- reduction of emissions of acid gas (SO_2), nitrogen oxydes (NO_x) and dust (using well-known technologies not specific to coal);
- improving the efficiency of power stations.

For the most part, these are technologies under development; conversely, more mature technologies such as those dealing with thermal insulation, geothermal energy and hydroelectricity are three times less patented in these countries.

The study suggests that this negative correlation between diffusion and level of maturity of technologies in LDCs could be linked to the lack of any ambitious domestic policies for GHG emissions reduction and the weakness of legislation protecting intellectual property rights in many LDCs: as a result, the holders of mature technologies are reluctant to engage in technology transfers that their local competitors could easily bring to market.

FIGURE 6: INTERNATIONAL PATENTS REGISTERED IN LDCS, BY LEVEL OF TECHNOLOGICAL MATURITY



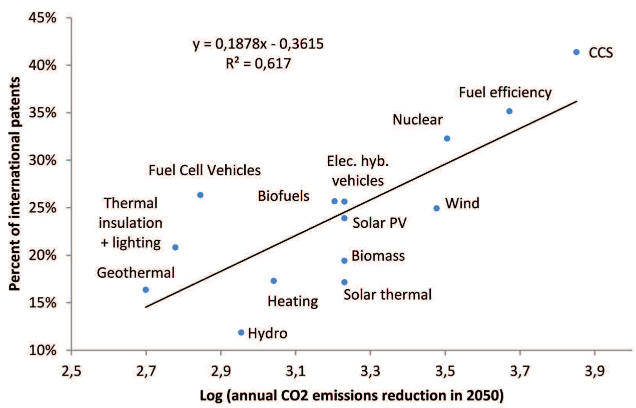
Source: CERNA, based on PATSTAT and World Bank data (*World Development Report*, 2011).

The preference currently given to technologies under development could provide competitive advantages for LDCs in the medium-to-long-term if the technologies transferred were found to be profitable and efficient, although the advantages and draw-backs of such a scenario would need to be assessed on a case-by-case basis.

Which technologies for which countries?

The study identifies the kinds of technology transfers to be prioritised, based on the volume of existing transfers measured using international patent data and the abatement potential for each of the various technologies. It therefore leaves out other criteria linked to the impact of the various technologies on the economic and social development of the LDCs, or the effects of transfers on international competitiveness. The methodology employed differs markedly in this regard from that of the Technology Needs Assessments which, through a bottom-up type consultative approach, identifies priority technologies in a given country. The analysis conducted reveals that technologies linked to hydroelectricity, heating, biomass, wind and solar thermal are among those offering both high abatement potential and comparatively insufficient volumes of transfers.

FIGURE 7: POTENTIAL FOR GHG EMISSIONS REDUCTION AND INTERNATIONAL PATENT TRANSFERS BY TECHNOLOGY TYPE (2007-2009)

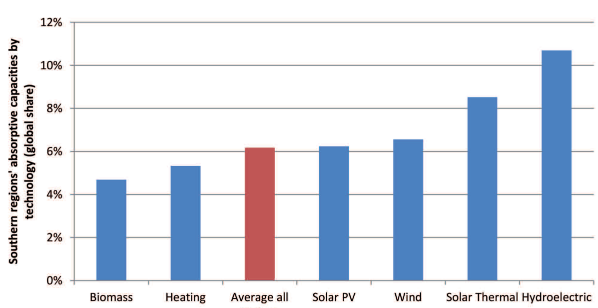


*: Fuel cells.

Source: CERNA, based on PATSTAT and IEA data (*Energy Technology Perspectives*, 2012).

An analysis of absorptive capacities in LDCs (measured by the number of patents registered by inventors in these countries) for technologies identified as priority technologies reveals that more effort needs to be made as regards biomass and heating equipment.

FIGURE 8: ABSORPTIVE CAPACITIES IN LDCS FOR THE 6 PRIORITY TECHNOLOGIES



Source: CERNA, based on PATSTAT data.

The analysis conducted by the study could be pursued in more depth in order to identify which technologies should be transferred as a priority for each individual country: the methodology developed by the study could be used profitably, provided that sufficiently accurate data were compiled.

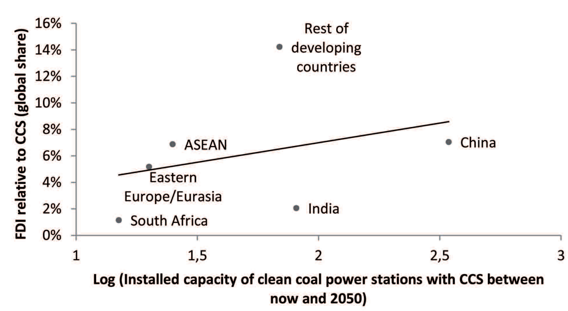
BOX 3: CASE STUDY: WHERE SHOULD IMPROVED TECHNOLOGIES FOR COAL-BASED ELECTRICITY PRODUCTION BE TRANSFERRED?

The more in-depth analysis carried out by the CERNA team serves to identify the geographical orientation of transfers to be carried out as a priority for a given sector: coal-fired power stations.

The IEA estimates that 20% of global GHG emissions reduction will need to be made in this sector to stabilise the global average temperature increase at 2°C (termed the "2DS" scenario). This reduction effort presupposes the development of CO_2 capture and storage and of technologies directly reducing emissions from the burning of coal (coal gasification, improved burning, fluidised bed combustion, improved steam generators, high-yield power stations).

A comparison of the current level of diffusion of these technologies in developing countries (measured by the proportion of FDI globally in the countries in question, the only available indicator covering all of the regions and technologies studied) with the capacities that the 2DS scenario would require to have installed for these same technologies – for the most part after 2030 – reveals that India, Africa and China will need to be supplied as a priority. These countries, in which the energy mix leans substantially towards coal, ought therefore to receive greater transfer of technologies in the fields of carbon storage and capture and cleaner coal technologies.

FIGURE 9: LEVEL OF TECHNOLOGY TRANSFERS (CLEANER COAL AND CCS) AND CAPACITIES INSTALLED IN THE 2DS SCENARIO IN LDCS



Source: CERNA.

WHICH PUBLIC POLICY INSTRUMENTS SHOULD BE MOBILISED?

Various studies have identified the most effective public policy instruments for promoting the international transfer of low carbon technologies: these could be either generic measures targeting all types of technologies, whether low carbon or not, or specific mechanisms.

KEY MESSAGE ■ 2

In developing countries, the implementation of ambitious climate policies and the creation of absorptive capacities are indispensable in order to promote technology transfer.

Regarding transversal measures, it is first and foremost necessary to set in place ambitious GHG emissions reduction strategies in the recipient countries, particularly through a demand-stimulating regulatory framework: emissions standards, feed-in tariffs for electricity produced from renewable resources, economic tools (carbon tax, emissions permit markets), etc. Within the countries, such measures have the effect not only of incentivising technology transfer from abroad but also of disseminating these technologies, and of stimulating the development of innovation on a local and endogenous basis.

In order to pursue these various initiatives and ultimately make best use of the knowledge transferred, it is indispensable that recipient countries assemble a qualified workforce of sufficient size, provided with a diverse range of training programmes.

Finally, it is important to set in place a system of intellectual property rights (IPR) providing an adequate level of protection and incentivisation. From the point of view of foreign innovators, as much for low carbon as for any other technologies, there is a risk involved not only in innovating but also in conducting transfers to foreign countries, particularly taking into account the likelihood that imitators will appropriate the benefits without shouldering any of the costs. Indeed, a number of countries such as India challenge the IPR global regulatory framework, which they consider to be unfair and disadvantageous to developing countries. Actually, striking a balance is key and numerous empirical studies available arrive at a differentiated assessment, depending on the level of development reached by the various countries and also depending on the technological fields in question.

Furthermore, the capacity of recipient countries to benefit from the transfer of foreign technologies is also positively linked to the degree of openness to external trade. Conversely, measures to restrict imports or foreign direct investment tend to reduce such transfers. That said, certain non-tariff barriers such as the application of local content clauses (minimum percentage to be manufactured in situ), or measures that require investors to form joint-ventures with local businesses, can have positive effects. In fact, although such barriers do somewhat limit technology transfer, on the other hand they stimulate their diffusion within the recipient country, as has been demonstrated in many countries, including China, Brazil, India and Mexico (Box 4).

Evaluation of Clean Development Mechanisms in technology transfers

Project mechanisms implemented by the Kyoto protocol to provide incentives to the operators of developed countries to finance GHG emissions reduction projects in developing countries have assisted in the transfer of technologies. Indeed, projects can lead to the establishment of a new technology in the recipient country, or accelerate the diffusion of a technology through the technical (plant and know-how) and financial support that they provide.

Even where transfer is not the primary objective of Clean Development Mechanisms (CDMs)(18), one CERNA study nevertheless estimates that on average 44% of projects have resulted in a transfer(19).

18. The Clean Development Mechanism (article 12 of Kyoto Protocol) rewards, through the issuance of carbon credits, the creation of a project for GHG emissions reduction in a developing country, through the payment of an amount equal to the value of the emissions reductions achieved. Since the provider of the project is classified as a developed country stakeholder, these carbon credits offset emissions from these countries, to which the Kyoto protocol assigns emissions reduction requirements. However, the opening of a second period of the protocol in 2012 saw few developed countries taking on emissions reduction commitments.

19. 2007 Data. Source: Dechezleprêtre et al. (2009), "Technology transfer by CDM projects: a comparison of Brazil, China, India and Mexico", *Energy Policy*, 37(2), p. 703-711.

However, not all recipient countries have benefited equally from technology transfer. China is substantially above the global average: in 2013, it had received 45% of the projects operated, and 59% of these resulted in technology transfer. India, which has received a quarter of all projects globally, only received a transfer of technology in 12% of cases, whereas although Mexico and Brazil received less than 5% of projects, in the former, 40% and in the latter 60% of these resulted in transfers.

Although the absorptive capacity of the various countries accounts for much of these variations, policies adopted by certain countries have also played a role in setting in place the necessary conditions for technology transfer.

In China, laws promoting energy saving, the decrease in carbon intensity of production (CO_2/GDP unit), renewable energy sources development and foreign investments accordingly provide a series of incentives to invest in these sectors[20].

The "Measures for Implementation and Management of CDM in China" (2005) also influence project-associated technology transfer. CDM projects and the corresponding carbon projects are akin to a national resource: to ensure a minimum income to the providers of Chinese projects, the government has set a lower limit on the prices of carbon credits. These price guarantees, now heavily criticised by buyers since they are out of step with the very low prices of the global market, also provide guaranteed income for projects and weigh in favour of investment decisions in technology transfer.

FIGURE 10: GEOGRAPHICAL BREAKDOWN OF CDM PROJECTS

	Number of projects	As a % of world total
Latin America	1,216	13.5%
of which Brazil	*427*	4.8%
of which Mexico	*216*	2.4%
Asia-Pacific	7,299	81.2%
of which China	*4,012*	44.6%
of which India	*2,173*	24.2%
Europe and Central Asia	102	1.1%
Africa	268	3.0%
Middle East	103	1.1%

Source: UNEP Risø Centre, May 2013.

These Measures designate technology transfer as one of the objectives of CDM projects (art. 10)[21]. Such transfers must promote the development of technologies and know-how in Chinese companies. The participation of foreign partners in a CDM project is therefore limited to 49% of the capital, the rest being owned by the Chinese partners (art. 11 of the Measures). Foreign partners cannot, therefore, operate alone and must form joint ventures with local companies. Furthermore, the local content requirement also encourages the emergence of local technologies through trade with foreign partners, particularly in the wind sector, where the local content requirement is set at 70% of the turbines installed. These requirements could have acted as disincentives for foreign companies: however they did encourage them to locate their plants in China, develop partnerships with local stakeholders and trade their licences.

20. The twelfth five-year plan (2011-2015) seeks in particular to achieve a 16% reduction in energy consumption per GDP unit between now and 2015 compared with 2005, a 17% reduction in CO_2 emissions per GDP unit, and an increase in the share of non-fossil fuels in primary energy consumption of up to around 15% by 2020.

21. Art. 10 of the Measures: " CDM project activities should promote the transfer of environmentally sound technologies to China".

Finally, CDM projects benefit from favourable taxation in the fields of energy improvement and efficiency, renewables development and methane recovery, which are designated priorities (art. 4 of the Measures): income from carbon credits for these projects is taxed at 2%, as opposed to 30% for projects linked to N_2O emissions and 65% for hydrofluorocarbons (HFC).

In Mexico, the development of CDM projects is promoted by the Mexican Carbon Fund (FOMECAR), which provides financial and technical support for these. Partnerships have also been concluded with various governments and institutions to accelerate cooperation and information exchange in the climate field, particularly as regards CDMs.

However, technology transfers brought about by CDMs are still limited by the system's architecture. A number of factors may in fact discourage such transfers: on the one hand the cost of administrative and auditing procedures; on the other hand, the failure to adapt this framework to complex projects, which have a certain scope (therefore appropriate for facilitating the dissemination of technology), or which are particularly risky (especially demonstration programs), as the return on investment depends on the carbon price, which has been subject to significant variations in recent years(22). Current thinking underway within the context of international climate negotiations, envisaging a programme or sector-based CDM could partially overcome such obstacles, were this to materialise(23). The Durban platform, which sets out the conditions for developing the new climate regulatory framework set to be the subject of an agreement in 2015, includes plans for a "New Project Mechanism", the rules of which remain to be defined.

Priorities vary from country to country, from LDCs to emerging countries

KEY MESSAGE ■ 3

In emerging countries, the supporting of intellectual property rights is likely to promote technology transfers. In the least developed countries, emphasis must be placed on the building and consolidation of absorptive capacities.

As regards IPR, ideally there would be different levels of protection according to the various requirements that exist and particularly that take into account the stage of development reached in the countries concerned. On the one hand, relatively strict IPRs tend to favour emerging the countries, particularly where these genuinely possess the capacity for innovation and are involved in international trade. On the other hand, IPRs that are too restrictive can be harmful to the least developed countries, where local businesses generally do not hold any patents and are hardly in a position to rival major multinational groups. In addressing this and in adapting to the specific case of environmental technologies, it is undoubtedly neither realistic nor necessary to envisage any serious challenge to the global IPR regulatory framework, which – as it relates to global trade – is managed by the WTO, which already views environmental concerns as potential grounds for exemption. Undoubtedly, it is more realistic to take a more modest, and targeted approach to adaptation of IPR, through flexible measures tailored to the specific requirements of a given environmental factor. For example, *patent pools* can be set in place – on a concerted and voluntary basis – by patent holders (universities, companies, etc.) and offered on preferential terms to developing countries.

Various combinations of industrial and trade policy can enable southern countries to derive maximum benefit from technologies initially designed abroad. Particularly through local content clauses or targeted financial incentive mechanisms, policies in place in countries such as India (in the case of photovoltaic) and Mexico enable them to derive maximum benefit from foreign technologies. Drawn by the prospect of local outlets, the foreign companies thereby contribute sustainably to a learning process and to technological development which proves mutually beneficial for both foreign investors and the recipient company (Box 4).

22. Except for those projects carried out in China, see above.

23. In addition to CDM administrative and structural constraints, the fall in the value of one tonne of CO2 on the European market also has an immediate disincentivising effect for CDM project providers.

BOX 4: POLICY TO ATTRACT AND DISSEMINATE LOW CARBON TECHNOLOGIES: THE EXAMPLES OF INDIA AND MEXICO

To date, **India** has not set in place any policies to attract or receive low carbon technologies transfer from abroad. As can be seen in the renewables sector, New Delhi instead prioritises national subsidiaries, primarily through the setting of local content rules for projects. That said, the Indian government does allow FDI of up to 100% in the renewables sector, in order to promote development in this sector, partly through the transfer of foreign technologies. **Mexico**, for its part, is more systematic in its endeavours to attract low carbon technologies through a policy of targeted attraction carried out by the ProMexico institution. This latter offers financial assistance to foreign companies that not only transfer technologies locally but also set up *in situ* research units. In this way, foreign companies are given financial incentives to engage in a process of *in situ* technological co-design, in partnership with the companies in the receiving country. Also, a law requires all Mexican companies acquiring foreign technology to comply with a local content clause which increases the possibility of shared learning between the providers of foreign technologies and the local business base.

Source: General Directorate of the Treasury (2012), *International transfers of low carbon technologies, comparative analysis in 14 countries*, October.

CONCLUSION

At the present time, relatively high levels of international transfers of low carbon technologies are taking place, but it is important for these to be reoriented. Even though some emerging countries such as China, South Africa or Mexico are already integrated into global technologies trading, this is not the case for regions with high emissions reduction potential: India, other Asian developing countries, Africa and Eastern Europe. In these regions, transfers may be intensified by adopting strategies for climate change prevention and developing absorptive capacities – particularly in the field of training. Policies concerning openness to trade and the protection of intellectual property rights also have a role to play: their orientations need to take into account national characteristics. It would also be preferable to adopt strict IPR regulations in emerging countries, and a more relaxed framework in LDCs. The CERNA study addressed in this policy brief makes use of currently available information to identify priority regions and technologies: in the future, it will be important to fill in the gaps in the existing data and apply this methodology in order to determine precisely which technologies are to be transferred, on a country-specific basis. Use of the methodology by the Technology Mechanism will make the databases used more complete, thereby yielding results that can be more directly applied at the operational level.

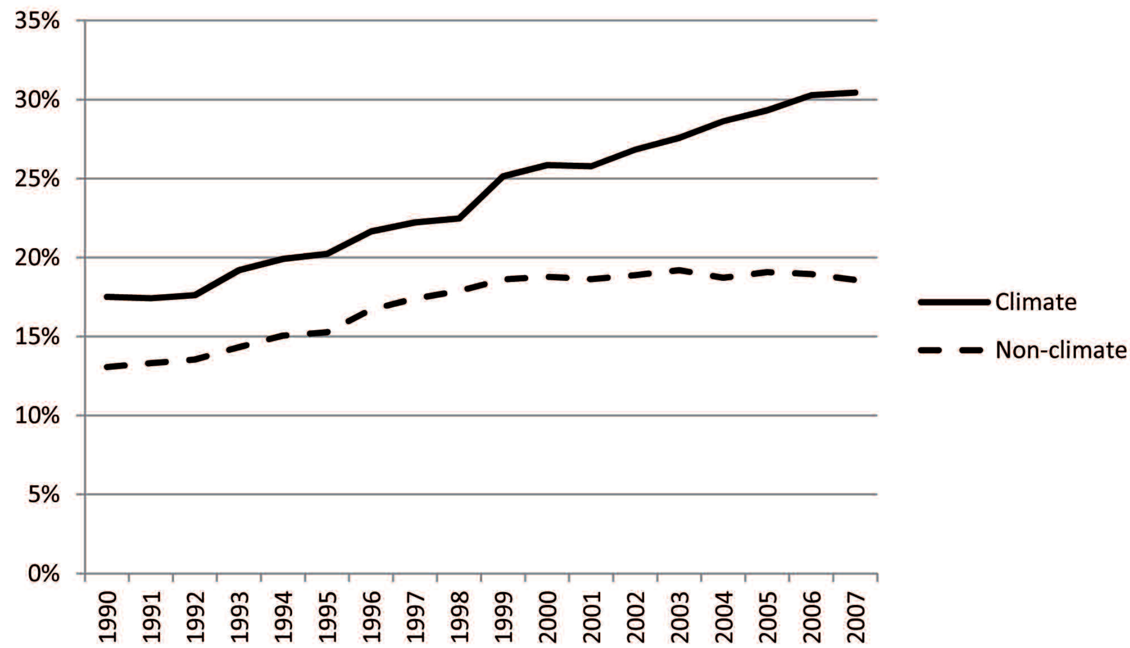
Key words: technologies, transfer, CO_2, climate, negotiations, Warsaw.

ANNEX 1: LIST OF TECHNOLOGIES COVERED BY THE CERNA STUDY

Domain	Technology	Patents	Trade in goods	FDI
Energy	Biofuels	X		X
	Fuel from waste	X		X
	Geothermal	X		X
	Hydroelectric	X	X	X
	Marine	X		X
	Solar photovoltaic	X	X	X
	Solar thermal	X	X	X
	Wind	X	X	X
	Nuclear	X	X	X
	Cleaner coal	X		X
	CO2 capture and storage	X		X
	Capture or disposal of non-CO2 GHG	X		X
	Energy storage	X	X	X
	Technology	X		X
	Fuel cells	X		X
	Electricity distribution	X		X
Transport	Electric vehicles	X	X	X
	Hybrid vehicles	X	X	X
	Fuel efficiency in motors	X		X
	Fuel efficiency-improving vehicle design	X		X
	Rail locomotives powered by electric accumulators		X	
Buildings	Energy efficient cement	X	X	X
	Heating	X	X	X
	Insulation	X	X	X
	Lighting	X	X	X
Industry	Electric arc furnace for aluminium production	X		X
	Economizers, super-heaters, soot removers, gas recoverers		X	

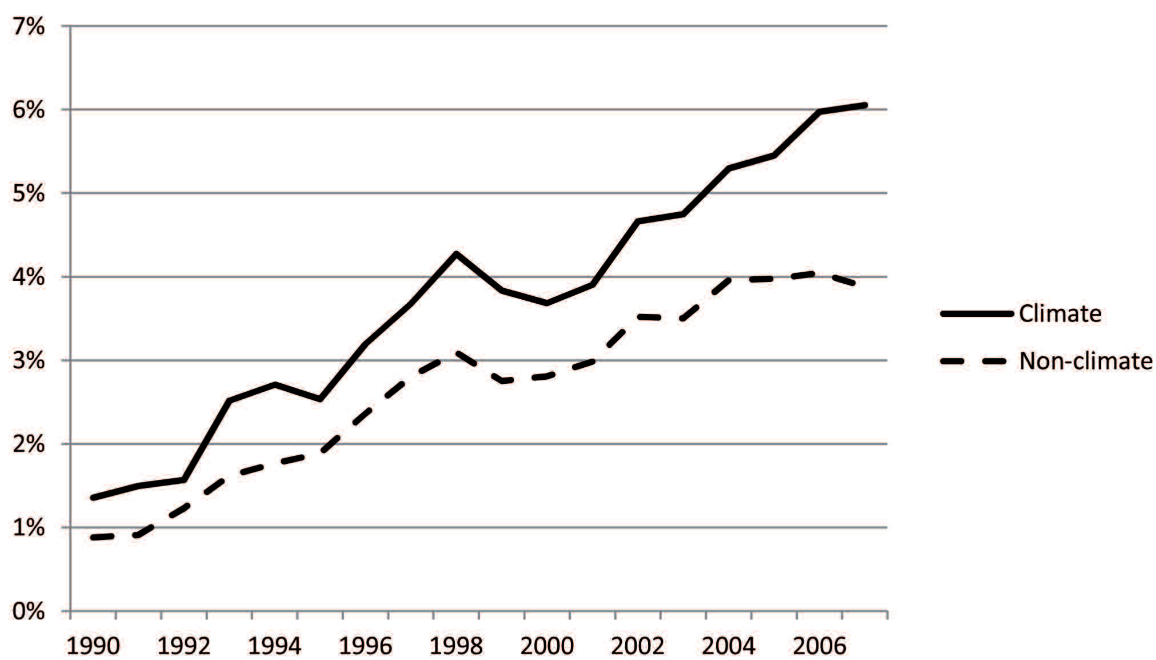
ANNEX 2:

SHARE OF INTERNATIONALLY-PATENTED INVENTIONS FILED IN AT LEAST ONE DEVELOPING COUNTRY FOR CLIMATE AND NON-CLIMATE-RELATED TECHNOLOGIES (1990-2007)



Source: CERNA.

SHARE OF INTERNATIONALLY-PATENTED INVENTIONS FOR CLIMATE AND NON-CLIMATE-RELATED TECHNOLOGIES (1990-2007)



Source: CERNA.

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