EuropeAid

ENVIRONMENT & CLIMATE CHANGE

EC Cooperation:

Responding to climate change

Sector Script for Trade & Investment

Information Note

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This document was developed by EuropeAid in cooperation with DG RELEX, DG DEV, DG ENTR, DG TRAD and DG ENV with the support of the "environmental integration advisory services" project. It was designed to provide practical guidance on the links between climate change and a specific sector, together with possible responses to climate-related challenges. The purpose of this "script" is to support political dialogue on climate change implications between the European Commission, partner governments and other national partners involved in EC development and external cooperation activities, as well as to facilitate strengthened climate change integration in ongoing and future cooperation programmes and projects, with a focus on developmental benefits for the partner countries.

This sector script is one of a series prepared in a standard format. Scripts are available for the following topics:

- Introduction and Key Concepts
- Agriculture & Rural Development *(incl. forestry, fisheries and food security)*
- Ecosystems & Biodiversity Management
- Education
- Energy Supply
- Governance
- Health
- Infrastructure *(incl. transport)*
- Solid Waste Management
- Trade & Investment *(incl. technological development, employment and private sector development)*
- Water Supply & Sanitation

Note that the script is not country or region-specific, and has been prepared to cover a wide range of possible effects and responses. Users are invited to appreciate which elements, among those proposed, are relevant to their specific needs and circumstances.

Note: This sector script was written with a focus on some specific aspects of economic development which are typically supported by EC-financed programmes, trying to avoid overlaps with the contents of other scripts. It addresses trade and investment as well as three closely related topics: technological development, private sector development and employment. The text makes references to other related and complementary scripts.

Users of this script are advised to read it in conjunction with the Introduction and Key Concepts information note, which introduces the series and puts things in context.

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RESPONDING TO CLIMATE CHANGE: SECTOR SCRIPT

SECTOR: TRADE & INVESTMENT

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0. EXECUTIVE SUMMARY

Climate change impacts on trade, investment and other specific aspects of economic development

As far as international trade is concerned, the most direct and obvious potential impacts of climate change are those impacts that affect the production and transport activities that underlie international trade flows. Climate change also has the potential to affect international trade in more indirect but potentially significant manners. The demand for certain products and the associated international trade patterns and volumes may change over time, in some cases in ways that are hard to predict. Furthermore, the way in which adaptation and mitigation costs end up being distributed is likely to affect the international competitiveness of enterprises – and therefore the size and direction of trade flows, through changes in comparative advantages. The cost and reliability of energy supply, in particular, is a key element in the international competitiveness of enterprises. The magnitude and distribution of mitigation efforts and the international financial architecture to support them in the post-Kyoto (i.e. post-2012) regime remain to be defined, but are likely to have strong implications for the (real as well as perceived) international competitiveness of firms, in particular industrial ones.

As far as investment is concerned, the levels and focus of both private and public investment in coming years and decades are likely to be increasingly influenced by climate change. Private investors (both domestic and foreign) will increasingly consider the threats and opportunities associated with climate change in their investment decisions. Climate change is likely to increase the general level of risk associated with investment. How trade prospects are affected by climate change and the international mitigation regime, in the wider context of the current financial and economic crisis, will also have an impact on private investment decisions in the future. So will regulation and the structure of incentives (and/or disincentives) to invest in general and specifically in climate adaptation and mitigation measures. Governments will be expected to scale up public investment, notably as a means of reducing vulnerability and enhancing capacity to adapt to the effects of climate change. Their ability to do so, however, will be constrained by their capacity to mobilise resources – but potentially enhanced by the availability of international funding for climate change adaptation.

Innovation and technological development are key factors determining the ability of societies to respond to the challenges posed by climate change. In this regard, climate change may create more opportunities than threats: climate-related challenges may indeed provide significant opportunities and incentives to step up developing countries' efforts to "catch up" with more developed ones in the uptake of technologies that promote both adaptation and mitigation. The ability of developing countries to seize these opportunities may nevertheless be constrained by the availability of resources and by a number of barriers to innovation and the adoption of new technologies, which must be identified and addressed. The capacity to innovate and to deploy new technologies is also determined in part by trade and investment policies, hence the importance of considering these aspects jointly.

Climate change may affect private sector development (including small and medium-sized enterprise development) in a variety of ways. Threats will result from the large variety of risks to all sectors and human activities that arise from climate change. Opportunities may also arise, however, as adaptation and mitigation responses can be expected to generate new business opportunities. Over time, climate change is likely lead to changes in patterns of economic activity, with some sectors shrinking while others develop, and some technologies being replaced with others.

How climate change might affect the level, composition and quality of employment in any country will depend on its impacts on all the aspects reviewed above, and on the associated policy responses. Jobs are likely to be lost in the sectors that suffer most, directly or indirectly, from the impacts of climate change. On the other hand, jobs should be created in new and emerging sectors, including more modern, better adapted types of agriculture and industries based on low-carbon technologies.

Adapting to climate change

Adaptation measures in support of international trade should address identified threats to productive activities in all sectors, to infrastructure, to the availability of water, energy, transport and communication services. Equally important is addressing the competitiveness of enterprises. Trade-related policies can promote the competitiveness of domestic enterprises in the context of adaptation to climate change by undertaking public investments that enhance the resilience of essential infrastructure and the overall economy, and by supporting the adaptation efforts of enterprises. Generally speaking, open trade policies should enhance overall capacity to adapt to climate change. Low tariffs on imports, for instance, are likely to lower the cost of implementing some adaptation measures.

Given the importance of investment for increasing resilience and adaptability to the effects of climate change, any measures adopted to improve the climate for private investment, including institutional capacity building, are likely to have positive effects on adaptation capacity. Among other measures, improvements in essential economic infrastructure, as well as improvements in economic and political governance, may be particularly important to encourage continued flows of private investment. Efforts should be made to identify and dismantle barriers to investment – while adopting rules to ensure that new investment is made on a sustainable basis (including from the point of view of climate adaptation and mitigation). Targeted measures can be used to provide incentives for private investment in climate adaptation measures. Public investment also has a critical role to play in propping up investment in the context of climate change. Climate-related aspects should be fully integrated in poverty reduction and other national development strategies, so that the allocation of budgetary resources also takes them in consideration.

Under the UNFCCC, developed countries have made a commitment to transfer "environmentally sound technologies" and know-how to developing countries – in support of both adaptation and mitigation. Technology transfers from developed to developing countries are however only one part of the story: endogenous innovation, as well as technology development that addresses developing countries' specific needs and circumstances, "south-south" technology transfers and the fostering of domestic technology uptake mechanisms, all have a role to play in promoting adequate responses to climate change. Efforts should be made to step up research, innovation, technological development and the dissemination and uptake of effective new technologies, and also to remove barriers to technology transfers, technology diffusion and endogenous innovation.

Possible adaptation measures in support of private sector development are quite similar to those advocated to support trade and investment. More specific measures include, for instance, running awareness campaigns targeted at private enterprises about climate-related risks and challenges, setting up capacity building programmes focused on the dissemination of adaptation-related good practices and the development of adaptation plans, and setting up financial services to support the implementation of SME climate adaptation programmes.

Possible adaptation measures in relation to employment are aligned with those advocated above in relation to trade, investment, technological development and private sector development: employment creation and in particular the creation of formal and higher-quality jobs are directly dependent on performance in these other aspects of economic development. The creation of "green jobs", i.e. jobs associated with the deployment of clean technologies and the adoption of improved environmental practices, is a real opportunity in the context of climate change and should be fostered. Green jobs can be created in a wide range of sectors; they are associated with both adaptation and mitigation. Exploiting opportunities associated with green jobs requires the development and implementation of active training and capacity building policies to close the skills gap and anticipate future needs.

Contributing to climate change mitigation

Economic development, in its multiple forms, is the primary cause of anthropogenic greenhouse gas (GHG) emissions. Particular efforts are thus required to ensure that the activities that promote economic development consider GHG abatement constraints. The ultimate goal is to achieve "low-carbon" or "climate-neutral" development paths.

Although international trade can generate significant GHG emissions and other environmental nuisance, it will play an important role in the development of markets for low-carbon goods and services and the dissemination of solutions needed to achieve low-carbon growth by countries around the world. Ongoing efforts should continue and be scaled up to make international trade more sustainable, in all aspects and in particular with regard to climate mitigation. At the international level, the transport sector will increasingly be targeted by and included in schemes aimed at controlling and reducing GHG emissions. There are also potential synergies between ongoing global trade and climate negotiations. In the context of national and regional trade support programmes, climate mitigation efforts can be supported by stepping up efforts to make export-oriented and domestic production more efficient (notably with regard to energy consumption) and environmentally more sustainable.

Huge amounts of investment will be required if the world is to move swiftly enough to a low-carbon economic model. In the context of national development policies that clearly opt for the adoption of a low-carbon development path, both public and private investment policies can be formulated to encourage the adoption of clean technologies and environmentally sustainable production practices. Climate sustainability objectives can be encouraged by a mix of instruments, including regulation, the lifting of identified barriers to investment in clean technologies, economic incentives, and policy commitments and concrete measures aimed at stabilising energy and carbon prices at reasonably predictable and sufficiently high levels to justify investment in abatement technologies. One significant obstacle to investment in GHG abatement technologies is that they often require a significant initial investment – and the cost of capital tends to be higher in emerging and developing countries. Developed countries can help sustainable investment in developing ones by supporting a share of capital costs, by providing investment loans at low interest rates, and by transferring funds to reward investments that contribute to the mitigation effort.

As a complement to the above measures, developing countries can promote climate mitigation through measures aimed specifically at encouraging innovation and technology development. Provided they can mobilise the financial and human resources required to do so, they have the opportunity to "leap-frog" outdated technologies and base their development on the "best available techniques" in terms of carbon emissions and other aspects of technical and environmental performance. Tose countries that first and most decisively opt for a low-carbon development path are likely to benefit from the "first mover advantage", with rewards in terms of competitiveness of their economy, energy independence, access to markets, etc. To make use of these opportunities, developing countries will have to identify and systematically address existing barriers to innovation and technological development while also providing positive incentives. Note that not all abatement technologies are necessarily of the "high-tech" variety: agriculture- and forestry-related measures generally have low capital intensity, generally entail low (sometimes negative) abatement costs and are relevant to many developing countries.

Private sector development policies can contribute by enhancing opportunities for the private sector to "surf the wave" of the adoption of clean technologies. Specific measures are similar in nature to those advocated in relation to adaptation, and partly overlap with them. As for employment policies, they should be aligned with trade, investment, technological and private sector development policies. The deployment of clean technologies can in general be expected to promote the creation of formal, better-qualified, better-paid, "greener" jobs. Both traditional education and adult education and training programmes have a major role to play in developing the local supply of skills required for the implementation of new techniques and technologies.

1. HOW CLIMATE CHANGE MIGHT AFFECT TRADE, INVESTMENT & OTHER SPECIFIC ASPECTS OF ECONOMIC DEVELOPMENT

Climate change may affect trade, investment and other specific aspects of economic development (e.g. technological development, private sector development, employment) through a range of biophysical and socio-economic impacts. The table below shows the main links between such impacts and these aspects. Note that many impacts are in fact likely to be felt indirectly, notably through climate change impacts on productive sectors (e.g. agriculture, fisheries, forestry, industry), energy and infrastructure.

	Empl	Inv	PSD	Tech	Tra
Biophysical effects					
Changes in temperature and rainfall patterns					√
Increase in extreme weather events / natural disasters	√	√	√		√
Raised sea level and increased coastal erosion					√
Increased river bank erosion					√
Desertification, soil erosion					√
Reduction in the availability of freshwater	√	√	√		√
Changes in hydrological flows, in permafrost	√	√	√		√
Loss of habitats, changes in ecosystems and related services					√
Increase in disease and pest outbreaks					√
Socio-economic impacts					
Damage to infrastructure	√	√	√	√	√
Reduced availability of energy (hydropower)	√	√	√	√	√
Economic and social disruption, loss of livelihoods	√	√	√	√	√
Increased mortality and morbidity	√		√		
Increased probability and intensity of conflicts	√	√	√	√	√
Population displacement and human migrations	√				

Legend:
Empl = employment
Inv = investment
PSD = private sector development
Tech = technological development
Tra = trade

Both the biophysical effects of climate change and its socio-economic impacts are likely to affect the overall prospects for trade, investment, innovation, technological development, private sector development and employment, creating threats but also a number of opportunities. In the sections below, we review how the achievement of objectives in these selected aspects of economic development support programmes could be impacted by climate change, notably against the background of the global financial and economic crisis.

1.1. INTERNATIONAL TRADE

The most direct and obvious potential impacts of climate change on trade are those *impacts that affect the production and transport activities that underlie international trade flows*. For instance:

- productive activities in the primary sector (in particular agriculture, forestry and fisheries) are at risk in some countries and regions as a result of changes in weather and rainfall patterns and/or the increased frequency/severity of extreme weather events – although in specific cases climate change may actually provide opportunities for increasing production; these aspects are covered extensively in the script dedicated to Agriculture & Rural Development;

- productive activities in the secondary sector (manufacturing and industry) are at risk primarily from damage to infrastructure caused by rising sea levels and the increased frequency/severity of extreme weather events, as well as disruption in the availability of energy, water, transport and communication services; these aspects are covered extensively in the scripts dedicated to Infrastructure, Energy Supply and Water Supply & Sanitation;
- trade in some services (e.g. tourism, call centres, IT development and support, insurance and financial services) could be affected by damage to commercial and service infrastructure, and more generally be disrupted by damage to the public infrastructure on which the functioning of many service industries depends (particularly energy, telecoms, water and transport); again, these aspects are covered in the scripts dedicated to Infrastructure, Energy Supply and Water Supply & Sanitation;
- transport activities, in particular, are sensitive to rising sea levels (which may damage harbour infrastructure) and the damage to infrastructure and/or disruption in operations (e.g. interruption of air traffic) caused by extreme weather events – for more details on these aspects, please refer to the script dedicated to Infrastructure; some trading routes may become impracticable or more hazardous, while new trading routes may open up.

Apart from these obvious impacts climate change has the potential to affect international trade in more indirect but potentially significant manners. The *demand for certain products*, and the *associated international trade patterns and volumes*, may change over time, in some cases in ways that are hard to predict:

- international trade in goods and services associated with "clean" and efficiency-enhancing technologies (e.g. renewable energy, carbon capture and storage, low-consumption light bulbs, less carbon-intensive materials) is likely to increase, although how fast and in which proportion remains to be seen;
- international trade in goods and services associated with carbon-intensive and other "climate-unfriendly" technologies can be expected to gradually decrease, but not necessarily very fast or on the basis of regular or uniform patterns; for instance, trade in fossil fuels will depend on both supply and demand policies, which are driven by multiple and complex factors; imports of nitrogen fertilisers may decrease in some regions where their excessive use now contributes to greenhouse gas (GHG) emissions, but increase in other regions (e.g. most of sub-Saharan Africa) which currently make little use of them but will need more of them in future to intensify production and boost agricultural yields;
- trade in agricultural commodities may increase as some regions see their agricultural productivity negatively impacted and become more dependent on food imports – but it may also decline if, as happened not so long ago, some food producers respond to concerns about food security by banning the export of cereals and other agricultural commodities.

Furthermore, the way in which adaptation and mitigation costs end up being distributed is likely to affect the *international competitiveness of enterprises* – and therefore the size and direction of trade flows, through changes in comparative advantages:

- In the developing world, enterprises involved in international trade may have to bear relatively high adaptation costs (e.g. adaptation and/or relocation of production infrastructure), especially if they have (on top of adapting their own infrastructure and processes) to make investments to offset insufficient adaptive investment in public infrastructure. As emerging and developing countries are increasingly required to take their share of the global climate mitigation efforts, their industries and enterprises may also gradually incur abatement costs. The cost and reliability of energy supply, in particular, is a key element in the international competitiveness of enterprises: those countries that have significant renewable energy potential (e.g. hydropower, solar power, geothermal energy, wind power, possibly biofuels) and actually develop it are likely to enjoy significant comparative advantages over those that lack such endowments or remain very dependent on fossil fuels for lack of investment in alternative sources of energy.

- In developed countries, public and private investment costs will have to be incurred in relation to adaptation, but the highest costs are likely to be associated with mitigation efforts: the more ambitious the GHG emission reduction targets, the higher the (short-term) costs. Businesses and especially industrial companies in developed countries fear the erosion of their competitiveness as a result of high costs associated with emission reductions, especially if their competitors in developing countries are not required to make similar efforts. "Carbon leakage", i.e. the possibility that emission reductions in countries with ambitious climate policies are offset, or even more than offset, by an increase in emissions in the rest of the world as the production activities of carbon-intensive industries are relocated to regions with less stringent mitigation requirements[1], is invoked as an argument for ensuring that the burden of controlling and reducing emissions is shared between developed and developing countries… or for introducing some border measures that level the playing field between domestic and imported products. [2]

The debate on whether stricter environmental legislation and regulations really reduce the competitiveness of firms and distort trade has been raging for decades, and many studies have concluded that they usually had limited influence on production costs and the choice of location for investments – with some exceptions, notably for heavily polluting industries. However, the perception that differences in environmental standards distort trade remains high – and concerns about competitiveness, whether they are founded or not, are likely to be exacerbated in the current context of economic downturn. There is thus clearly a *risk of resurgence of protectionism in response to perceived distortions in competition*. The magnitude and distribution of mitigation efforts and the international financial architecture to support them in the post-Kyoto (i.e. post-2012) regime remain to be defined[3], but are likely to have strong implications for the (real as well as perceived) international competitiveness of firms, in particular industrial ones, in both the developed and the developing world, with impacts on trade and possibly the emergence of a new global "economic architecture".

To conclude on the question of how adaptation and mitigation costs may affect the competitiveness of enterprises and thereby international trade flows, we should also note that:

- failure to adapt is likely to carry even more significant costs than adapting, at least for some businesses;
- failure to mitigate GHG emissions, or insufficient efforts in this regard, may reduce the short-term costs incurred by individual businesses and societies but are likely to result in much higher and wide-ranging long-term costs;
- some mitigation measures at least (e.g. energy efficiency measures) require upfront investment but generate net positive returns (thanks to cost savings), and may thus enhance rather than reduce the competitiveness of the enterprises that implement them.

[1] Carbon leakage may also result indirectly from the lower fossil fuel prices associated with reduced demand as a result of successful mitigation: these lower prices may indeed stimulate increased demand from countries that do not take part in mitigation efforts.

[2] A recent report on international trade and climate change finds that "industrial competitiveness in Kyoto-Protocol implementing countries suffers more from energy efficiency standards than from carbon taxation policies", and that "the effects of carbon taxation policies on industrial competitiveness are often offset by 'policy packages'" aimed at shielding the competitive sectors of industrialised countries. ("Carbon taxation" is meant here to encompass the costs induced by other economic instruments such as cap-and-trade schemes.) In other words, there is "no evidence that industries' competitiveness is affected by carbon taxes", but "some evidence supports relocation (leakage) of carbon-intensive industries to developing countries" – in particular energy-intensive industries (WB 2008:11). Note also that under multilateral trade rules, trade restrictions based on poor environmental performance are possible under some specific circumstances, but are rather strictly regulated.

[3] International negotiations to define post-Kyoto Protocol commitments are to be concluded at the Conference of the Parties to UN Framework Convention on Climate Change (UNFCCC), to be held in Copenhagen in December 2009. Once an overall agreement is reached, further work will be required to define detailed implementation mechanisms.

1.2. INVESTMENT

In coming years and decades, the levels and focus of both private and public investment are likely to be increasingly influenced by climate change. For instance:

- Among many other factors, private investors (both domestic and foreign) will *increasingly consider the threats and opportunities associated with climate change in their investment decisions*. In some regions and sectors, the significant uncertainties regarding the direction and magnitude of changes in climate patterns, their potential impact on infrastructure, energy supply, water availability, agricultural and natural resource productivity, etc., as well as the security risks related to the potential exacerbation of conflicts (e.g. over access to natural resources), are likely to increase the general level of risk associated with investment, especially in the case of investments with long return periods. Climate change impacts and the related adaptation constraints (e.g. more stringent building codes) may increase the cost of some initial investments, require the retrofitting of existing infrastructure and equipment, entail the relocation of some activities or reduce the lifetime of some infrastructure – which may have either positive or negative effects on the total amount of investment, depending on whether investors keep investing in spite of a more risky environment or are discouraged from doing so. Similarly, mitigation efforts may generate a mix of investment opportunities (e.g. investment in energy efficiency or more climate-friendly processes in order to sell emission credits in international carbon markets) and threats to investment (e.g. higher energy costs, caps on GHG emissions).
- Trade opportunities are of course an *important determinant of (domestic and foreign) private investment*, in particular in developing countries. How trade prospects are affected by climate change and the international mitigation regime, in the wider context of the current financial and economic crisis, will have an impact on private investment decisions in the future.
- Regulation and the structure of incentives (and/or disincentives) *to invest in general and specifically in climate adaptation and mitigation measures* can also play an important role in determining overall private investment outcomes.
- Governments will be *expected to scale up public investment*, notably as a means of reducing vulnerability and enhancing capacity to adapt to the effects of climate change. Their ability to do so, however, will be: (i) constrained by their capacity to mobilise resources, which is likely to be put under stress by the economic downturn, notably by the contraction of international trade flows[4] – and also by the economic impacts of climate change, which may cause widespread disruption in key sectors; (ii) but potentially enhanced by the availability of international funding for climate change adaptation, for instance from the Adaptation Fund set up in the context of the UNFCCC. Climate change may thus lead either to a fall or to a surge in public investment, depending on the availability of domestic and external resources as well as the willingness and ability of governments to develop sound climate change response strategies with an investment component.

1.3. INNOVATION AND TECHNOLOGICAL DEVELOPMENT

Innovation and technological change are *key factors determining the ability of societies to respond to the challenges posed by climate change*. In this regard, climate change may create more opportunities than threats: climate-related challenges may indeed provide significant opportunities and incentives to step up developing countries' efforts to "catch up" with more developed ones in the uptake of technologies that promote both adaptation and mitigation.

The ability of developing countries to seize these opportunities may be constrained by the availability of *resources* as well as by a number of *barriers* to innovation and the adoption of new technologies (see Section 2), which must be identified in order to be addressed. The capacity to innovate and to

[4] With their low tax bases, developing countries are typically more dependent on trade-related taxes and duties than developed countries for generating public revenue.

deploy new technologies is also determined in part by trade and investment policies, hence the importance of considering these aspects jointly.

1.4. PRIVATE SECTOR DEVELOPMENT

Climate change may affect private sector development (including small and medium-sized enterprise (SME) development) in a variety of ways. It generates both threats and opportunities:

- Threats result from the large variety of risks to all sectors and human activities that arise from changing climatic patterns, the rise in sea levels, the increased frequency and severity of extreme weather events, the degradation of ecosystems, etc. These threats are described extensively in the scripts dedicated to Agriculture & Rural Development and Infrastructure, among others. Formal and informal, large, medium and small enterprises may all suffer directly from damage to their own infrastructure and operations, and indirectly from damage to the public infrastructure (e.g. transport, energy, water, telecoms) on which they depend to operate. How much they might suffer depends on their own ability to adapt to new risks and operating conditions, as well the effectiveness of adaptive responses at local, regional, national and international level.
- Opportunities may also arise, however, as adaptation and mitigation responses can be expected to generate new business opportunities (e.g. retrofitting of buildings for improved energy efficiency, development and deployment of renewable energy technologies, construction of protective infrastructure, development of educational and training services, strengthening of health services).

Over time, climate change is likely lead to *changes in patterns of economic activity*, with some sectors shrinking as they become less economically viable while others develop, and some technologies being replaced with others. Climate change impacts and the associated policy responses with regard to international trade, public and private investment, innovation and technological development will play a role (alongside other factors such as the overall response to the current financial and economic crisis[5]) in determining structural economic changes and their positive and negative impacts for the private sector. The ability of legislative and regulatory frameworks to accommodate climate-driven challenges and opportunities will be an important factor in determining future patterns of activity.

1.5. EMPLOYMENT

How climate change might affect the *level, composition and quality of employment* in any country will depend on its impacts on all the aspects reviewed above – i.e. trade, investment, technological development and private sector development[6] – and on the associated policy responses.

Jobs are likely to be lost in the sectors that suffer most, directly or indirectly, from the impacts of climate change. Traditional agricultural jobs, in particular, may be lost as a result of desertification, soil erosion, losses in productivity and the limited adaptive capacity of poor smallholders – contributing to further urban migration and pressures on salaries. Jobs are also likely to disappear in the industrial sectors that fail to adapt, or use obsolete carbon- and energy-intensive technologies phased out in favour of better ones (e.g. jobs in coal mining and coal-based power plants, unless carbon capture and storage becomes widely available at an affordable cost). On the other hand, jobs should be created in new and emerging sectors, including more modern, better adapted types of agriculture (e.g. irrigated agriculture, conservation agriculture, agrofuel production) and industries based on low-carbon technologies (e.g. solar and wind power). Ultimately, whether climate change contributes to net job creation or destruction, to a move towards more formal or informal employment,

[5] The economic stimulation packages of many countries include provisions for promoting a "greener" economy.

[6] The public sector also creates employment, of course. However, given the budgetary constraints experienced by developing countries and the widespread tendency to control or reduce the number of civil servant jobs while seeking to improve the efficiency of public administration, climate change is more likely to affect overall employment through changes in private sector than in public sector employment.

and towards "higher-quality" or "lower-quality" jobs, is hard to predict but will clearly depend on the quality of economic, employment and educational policies.

Another aspect closely related to employment is public health. Climate change is reckoned to have significant potential impacts on the health of populations, which are described in the Health script. In some countries, workers (like the rest of the population) may be exposed to increased risks of malnutrition, disease and injury – which may notably affect labour productivity, safety in the workplace, the profitability of enterprises and ultimately employment levels. These aspects should be considered in any review of how climate change may affect employment and employment policies.

2. ADAPTING TO CLIMATE CHANGE

Adaptation to climate change involves the adoption of measures both to mitigate potential negative impacts and to maximise potential opportunities. In the sections below, for each selected aspect we review possible adaptation measures in response to the threats and opportunities identified in Section 1 – and also show how some measures may contribute to enhancing overall adaptive responses.

Trade, investment, technological development, private sector development and employment are closely related facets of economic policies. For convenience, we will keep addressing them separately, but obviously all these aspects should be considered jointly, looking for consistency and synergies, when reflecting on how to address climate change adaptation and mitigation in economic development support programmes. More generally, coherent economic, environmental and social policies are critical for a successful response to climate-related challenges.

2.1. INTERNATIONAL TRADE

As discussed in Section 1, the most direct potential impacts of climate change on trade are those impacts that affect the production and transport activities that underlie international trade flows. Adaptation measures in support of international trade should therefore *address identified threats to productive activities* in all sectors, to infrastructure, to the availability of water, energy, transport and communication services. Possible adaptation measures are described in the scripts dedicated to Agriculture & Rural Development, Infrastructure, Energy Supply and Water Supply & Sanitation. In most cases these measures will be placed under the competence of other ministries than the Ministry of Trade, hence the importance of good inter-sectoral coordination in support of economic development.

Equally important to foster adaptation is *addressing the competitiveness of enterprises*. Trade-related policies can promote the competitiveness of domestic enterprises in the context of adaptation to climate change by:

- undertaking public investments that enhance the resilience of essential infrastructure (e.g. transport, energy supply, water supply, telecoms) and the overall economy to the prevailing and anticipated climatic conditions;
- supporting the adaptation efforts of enterprises, notably but not exclusively in key export-oriented sectors, e.g. by means of awareness-raising campaigns, capacity building and training, the funding of demonstration projects, the dissemination of information and good practices, subsidised loans in support of adaptation investments, etc.

Generally speaking, *open trade policies should enhance overall capacity to adapt to climate change*. Low tariffs on imports, for instance, are likely to lower the cost of implementing some adaptation measures. In a context of increasing scarcity of natural resources aggravated by climate change, importing some resource-intensive goods may also support adaptation goals by reducing pressures on

domestic resources (e.g. countries faced with climate-exacerbated water stress may opt to import some water-intensive commodities from less stressed countries rather than produce them locally).

2.2. INVESTMENT

Given the importance of investment for increasing resilience and adaptability to the effects of climate change (see other sector scripts for examples of this), any measures adopted to *improve the climate for private investment*, including institutional capacity building, are likely to have positive effects on adaptation capacity. Among other measures, improvements in essential economic infrastructure (which often depend at least in part on public investment), as well as improvements in economic and political governance, may be particularly important to encourage continued flows of private investment in a context of increased physical, economic and political risks. Participation in regional and multilateral trade agreements should also help stimulate investment as such agreements provide access to larger markets while reducing the risk that a country gets embroiled in damaging trade wars.

In general, efforts should be made to *identify and dismantle barriers to investment*[7] – while adopting rules to ensure that new investment is made on a sustainable basis (including from the point of view of climate adaptation and mitigation). Considering that investment decisions will increasingly have to be re-directed to meet the challenges associated with climate change, targeted measures can also be used to *provide incentives for private investment in climate adaptation measures*. For instance, regulations aimed at improving resilience to climatic shocks (e.g. more stringent building codes and location requirements for all new economic infrastructure) may carry less risk of discouraging investment if they are accompanied by financial incentives or other supporting measures.

Finally, *public investment has a critical role to play* in propping up investment in the context of climate change. Climate-related aspects should be fully integrated in poverty reduction and other national development strategies, so that the allocation of budgetary resources also takes them in consideration. Significant public investment will be required in most countries to adequately address the challenges associated with climate change. Given the constraints on public resources, cost-benefit and risk-benefit analysis should be conducted to prioritise climate-related investments and align them with national and local poverty reduction and development objectives. Developing country governments that develop articulated climate adaptation policies and strategies, and adopt transparent and credible methodologies for prioritising the related investments, will be in the best position to benefit from international financial assistance to implement them.

2.3. INNOVATION AND TECHNOLOGICAL DEVELOPMENT

By the definition of the IPCC (2007:148), "'technology' refers to more than simply devices. Technology includes hardware (machines, devices, infrastructure networks etc.), software (i.e. knowledge/routines required for the production and use of technological hardware), as well as organizational/institutional settings that frame incentives and deployment structures (such as standards) for the generation and use of technology." Innovation is one of the phases in technological change: for actual change to take place, it must necessarily be followed by technology implementation and diffusion. Expert opinions vary regarding the adequacy of current technologies to address climate change. Many believe that today's technologies can already go a long way towards achieving emission reductions while also supporting adaptation – but that the crux of the matter is whether sufficient resources can be allocated to the timely uptake of climate adaptation and mitigation technologies, given resource constraints (exacerbated by the economic crisis) and the tradeoffs this is likely to

[7] Barriers to investment typically include economic barriers (unstable macroeconomic framework, absence of a sufficiently large domestic market, lack of transport and communication infrastructure), financial barriers (high upfront capital costs), legal and regulatory barriers (e.g. lack of protection for property rights, restrictions on capital flows, heavily regulated monopolies for the supply of energy), administrative and procedural barriers (e.g. burdensome customs procedures, difficulties in obtaining licensing permits, corruption), a lack of institutional capacities, skills shortages, etc.

involve. Sustaining efforts to innovate remains worthy since this it is likely to lower the costs of achieving both adaptation and mitigation objectives.

Under the UNFCCC, developed countries have made a commitment to transfer "environmentally sound technologies" and know-how to developing countries – in support of both adaptation and mitigation. Technology transfers are defined as "a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change among different stakeholders (…)". The term "transfer" is meant to encompass "diffusion of technologies and technology cooperation across and within countries", and "the process of learning to understand, utilize and replicate the technology, including the capacity to choose and adapt to local conditions and integrate it with indigenous technologies" (IPCC 2000:3). Technology transfers from developed to developing countries are thus only one part of the story: endogenous innovation, as well as technology development that addresses developing countries' specific needs and circumstances, "south-south" technology transfers[8] and the fostering of domestic technology uptake mechanisms, all have a role to play in promoting adequate responses to climate change.

Stepping up research, innovation, technological development and the dissemination and uptake of effective new technologies depends on:

- the availability of resources for these purposes – an aspect that can be supported by development cooperation;
- the readiness of developing countries to identify and remove barriers, and provide incentives, to innovation, technology transfers and technology adoption.

Barriers to technology transfers may notably include:

- financial capital barriers: the adoption of some technologies may require significant upfront investment costs, which less affluent countries and investors may not be able to afford without financial support;
- trade barriers (e.g. high tariffs on and/or non-tariff barriers to imports of clean technologies);
- administrative and regulatory barriers, acting as obstacles to trade, investment, the functioning of markets, the delivery of permits, etc.;
- legal barriers (e.g. lack of support for and enforcement of intellectual property rights, which make some technology developers reluctant to transfer know-how and expertise);[9]
- technical barriers, which may prevent the successful implementation of some technologies (e.g. insufficient or unreliable power supply, lack of transport infrastructure and logistical systems to ensure proper operation and maintenance);
- information barriers, i.e. the lack of awareness of and information about potentially useful techniques and technologies among national stakeholders;
- human resource constraints, e.g. the lack of qualified staff to successfully implement these techniques and technologies, and/or insufficient managerial skills;
- political reluctance to promote new technologies which may be less labour-intensive than older ones, and may therefore destroy more jobs than they create.

Barriers to endogenous innovation and technology diffusion may include:

- the lack of financial resources for research and development (R&D) – an issue that can be at least partly addressed in the context of development cooperation programmes;

[8] Developing countries that invest now to become players in the development and manufacturing of clean technologies are likely to have significant opportunities to become exporters of these technologies in future.

[9] Some argue that poor enforcement of intellectual property rights (IPRs) is an obstacle to technology transfers… while others argue that IPRs themselves are the obstacle.

- the absence of working markets and a favourable investment climate, for many possible reasons.

A comprehensive approach to addressing and *gradually dismantling these barriers*, and generally to creating an *enabling economic and institutional environment for private sector investment*, are thus key to ensuring the adoption and diffusion of both imported and locally developed technologies and techniques in support of adaptation.

By way of example (see other sector scripts, especially those dedicated to Agriculture & Rural Development, Infrastructure, Energy Supply, Health and Water Supply & Sanitation, for more details and further examples), technologies that support adaptation to climate change and may be particularly suitable for developing countries include:

- water-efficient irrigation systems;
- water efficiency and water conservation systems;
- drought-resistant and other climate-resilient crops;
- pest management;
- wetland and mangrove restoration;
- dykes, breakwaters, sea walls and other protective man-made infrastructure;
- renewable energies as a substitute for fuelwood (to relieve pressure on forests);
- climate proofing of infrastructure;
- electronics and know-how for developing management and monitoring systems (e.g. weather forecasting systems for agriculture and health, disaster early warning systems, coastal zone management, fishery management).

2.4. PRIVATE SECTOR DEVELOPMENT

Possible adaptation measures are quite similar to those advocated to support trade and investment. In addition to creating a generally favourable framework for private sector development, specific measures include:

- running awareness campaigns targeted at private enterprises (primarily SMEs since they are likely to be less informed than large business) about climate-related risks and challenges;
- setting up general and sector-specific capacity building programmes focused on the dissemination of adaptation-related good practices and the development of adaptation plans, again with a specific focus on SMEs; good practices and adaptation plans could cover a wide range of topics, such as the integration of climate risk management in overall business strategies, the response to natural disasters, the reduction in water and energy consumption, the diversification of energy supply sources, the adaptation of storage and distribution systems to reduce vulnerability, cooperation with suppliers for increasing the resilience of the supply chain, etc.;
- setting up financial services (e.g. subsidised loans) to support the implementation of SME climate adaptation programmes;
- identifying the sectors that are most likely to suffer (directly or indirectly) from the effects of climate change, and supporting the conversion of enterprises in these sectors to new technologies (e.g. more modern agricultural practices) and/or new activities more likely to be adapted to the new conditions.

2.5. EMPLOYMENT

Possible adaptation measures in relation to employment are aligned with those advocated above in relation to trade, investment, technological development and private sector development. Indeed,

employment creation and in particular the creation of formal and higher-quality jobs are directly dependent on performance in these other aspects of economic development.

The *creation of "green jobs"*, i.e. jobs associated with the deployment of clean technologies and the adoption of improved environmental practices, is a real opportunity in the context of climate change and should be fostered – especially as jobs are likely to be destroyed in other sectors of the economy. "Green jobs" can be created in a wide range of sectors, including energy supply (renewables), public transport, manufacturing (clean technology equipment), the building and construction industry, materials management (e.g. recycling), retail (e.g. promotion of locally produced goods), agriculture (e.g. soil conservation, water efficiency) and forestry (e.g. afforestation, reforestation, sustainable forestry, agroforestry). They are associated with both adaptation (provided they are implemented in an environmentally sustainable manner) and mitigation. For example, jobs related to the building and maintenance of irrigation and water conservation systems support adaptation objectives; jobs related to the retrofitting of buildings to improve thermal insulation, or to afforestation and reforestation projects, typically support both adaptation and mitigation goals.

Green jobs can be both direct and indirect (development of upstream supplier industries). They include both high-tech jobs (e.g. engineering jobs in the renewable energy sector) and low-tech ones (e.g. in recycling, construction, fuel crop production), thus offering opportunities to improve living standards across socio-economic categories and contribute to poverty reduction. Attention should be paid, however, to the quality of low-skilled jobs – which should be considered "green jobs" only if they meet "decent work" criteria (including freedom, equity, security and human dignity).

Exploiting opportunities associated with "green jobs" requires the development and implementation of active training and capacity building policies to close the skills gap and anticipate future needs (the Education sector script discusses how the education sector may contribute to the success of the response to climate change). To guide decisions in this regard, the potential for green jobs should be assessed, and actual green job creation monitored. Exploiting opportunities also requires stable policy frameworks and incentives (e.g. stringent efficiency standards), and sustained political support (green jobs tend to be concentrated in countries and regions that design and consistently implement proactive policies and support initiatives).

Finally, in the context of climate change adaptation, employment strategies and programmes should pay attention to the fact that changing climatic conditions may increase some risks of disease and injury in the workplace (see Health sector script). An assessment of such risks should be included in any *review of occupational health and safety standards*. Individually and/or collectively, employers (in particular but not exclusively large enterprises) may also want to consider adjustments in their corporate occupational health and safety policies to address any identified increase in the risk of disease (e.g. malaria) and malnutrition associated with climate change.

3. CONTRIBUTING TO CLIMATE CHANGE MITIGATION

Economic development, in its multiple forms, is the primary cause of anthropogenic greenhouse gas (GHG) emissions. Particular efforts are thus required to ensure that the activities that promote economic development consider GHG abatement constraints: ideally, climate mitigation objectives should be mainstreamed in the choice of development options. The ultimate goal is to achieve "low-carbon" or "climate-neutral" development paths[10], through initiatives in all sectors of activity as well as specific aspects of economic development. Many mitigation options are in fact congruent with adaptation options (e.g. the development of "green jobs", support for innovation, uptake of improved technologies). In Section 2, we primarily focused on measures to reduce threats and take advantage of

[10] Development paths can be defined as "a complex array of technological, economic, social, institutional, cultural and biophysical characteristics that determines the interactions between human and natural systems, including consumption and production patterns" (IPCC 2007:700).

some of the opportunities associated with climate change and the new global "economic architecture" likely to emerge from international climate negotiations. In this section, the focus is on measures that can support the efforts of developing countries (and others) to adopt and implement low-carbon development paths.

3.1. INTERNATIONAL TRADE

On the one hand, international trade can generate significant GHG emissions and other environmental nuisance:

- directly, by encouraging the transport of goods over large distances;
- indirectly, through complex trade effects on the scale and composition of the economy and the techniques used (e.g. goods manufactured in developing countries for developed countries' consumers may be produced in significantly worse environmental and resource-efficiency conditions than if they had been produced "at home"; unsustainable consumption patterns are encouraged by the comparative cheapness of some goods imported from developing countries; strong international demand for raw materials, agricultural commodities, timber, fish etc. encourages the unsustainable exploitation of natural resources in resource-rich but otherwise poor countries).

On the other hand, imports of some products may reduce pressure on domestic natural resources such as forests, with positive effects on GHG abatement; and trade liberalisation, as well as foreign direct investment, promote the transfer of clean technologies to developing countries. International trade can thus make a positive contribution to climate change mitigation by facilitating the transition to a low-carbon economy. It can support or stimulate specialisation and innovation, efficiency in production, investment in low-carbon production infrastructure, and the spread of "green" goods, services and technologies. Trade may thus have positive as well as negative indirect effects on a country's GHG emissions, and has very complex overall (global) effects.

International trade is also widely recognised as a source of economic growth, development and improved living standards, and a useful instrument in the fight against poverty. For these reasons, one of the official objectives of EU development cooperation is to support "the smooth and gradual integration of the developing countries into the world economy".[11] The UNFCCC itself calls for "an open international economic system that would lead to sustainable economic growth in all Parties, particularly developing country Parties, thus enabling them better to address the problems of climate change" (Art. 3 §5). Trade will play an important role in the development of markets for low-carbon goods and services and the dissemination of solutions needed to achieve low-carbon growth by countries around the world. Giving up international trade for the sake of mitigating global warming would thus not be an adequate response.

Rather, ongoing efforts should continue and be scaled up to *make international trade more sustainable*, in all aspects and in particular with regard to climate mitigation, based on the premise that "trade's ability to foster growth and increased wellbeing depends ultimately on a healthy environment" (IISD 2007a:1). At the international level, the transport sector will increasingly be targeted by and included in schemes aimed at controlling and reducing GHG emissions. This is likely to translate into higher transportation costs (e.g. as a result of fuel taxation, or investment in more energy-efficient ships, airplanes and vehicles to meet the emission ceilings imposed by cap-and-trade schemes); this should not be seen as a threat but as a correction of the existing economic distortions entailed by the fact that transportation prices fail to reflect the full costs this activity imposes on society ("internalisation" of external costs). Simultaneously, efforts could be made to "green" trade rules in the context of multilateral trade negotiations (e.g. development of energy efficiency-related standards, preference for low-GHG goods in the Agreement on Government Procurement), and to promote improved practices among private sector players in international trade.

[11] Art. 177 of the consolidated Treaty establishing the European Community.

In the context of national and regional trade support programmes, climate mitigation efforts can be supported by:

- stepping up efforts to make export-oriented and domestic production more efficient (notably with regard to energy consumption) and environmentally more sustainable; this can be facilitated through capacity building in both the public and the private sector; there is significant potential for efficiency improvements, in particular, in those countries in which energy consumption in relation to trade is concentrated in a few energy-intensive industries (e.g. mining, oil and gas extraction, cement, metals production);
- in specific cases (to be appreciated individually), promoting regional trade and regional economic integration as an alternative to transcontinental trade, where there is evidence this can lead to reduced GHG emissions.[12]

On top of these considerations, *open trade policies should enhance overall capacity to mitigate climate change*. There are potential synergies between ongoing global trade and climate negotiations:

- The liberalisation of trade in "clean" or "low-emission" technologies, goods and services[13], in particular those related to energy efficiency and renewable energy, would make it cheaper and easier for developing countries to adopt them on a wide scale[14] – although it may be complex to implement. True liberalisation would involve the removal not just of tariff barriers but also of non-tariff barriers, such as technical barriers (linked to standards, labelling and technical regulations) and subsidies for domestic production of clean technologies (which may be seen as a legitimate instrument by developing countries with nascent clean technology industries, but opposed by the countries that already dominate this market).
- At international level, the restructuring of the identification codes used to classify international trade flows by category of product, and greater harmonisation of classifications and descriptions, to allow precise identification of clean technologies and their components would facilitate such liberalisation. However, this is technically complex.
- One obstacle to the liberalisation of trade in clean technologies is that developing countries are suspicious of the subsidies many developed countries provide for the development and deployment of low-carbon technologies and products. The debate about subsidies is a difficult one. Many consider the provision of specific subsidies (aimed at giving industry incentives to innovate, and consumers incentives to change their behaviour) an absolute 'must' to successfully fight climate change – but of course, in an international perspective they should not be used in an "unfair" and "trade-distorting" manner. Re-examining the rules that apply to subsidies linked to R&D and environmental/climate protection, in the context of multilateral trade negotiations, has been suggested as a way of promoting the adoption of climate-friendly technologies while ensuring compatibility with trade rules.

[12] Regional trade is not necessarily more climate-friendly than transcontinental trade. Geographic distances within regions are sometimes longer than between continents; and road transport, typically used for regional transport, emits more GHG per tonne of goods transported than maritime transport.

[13] "Environmental goods and services" are one of the topics of the Doha Round trade negotiations. The definition of what constitutes clean technologies, goods and services to be subjected to lower trade barriers may be challenging however. Technologies for renewable energy generation and cleaner utilisation of conventional energy sources are uncontroversial – although tricky questions may arise in relation to parts that can be put to different uses. Including goods that are carbon-efficient either in their end use or in their production is technically much more complicated, since objective criteria and baselines would have to be defined and regularly re-assessed for a multitude of goods.

[14] The World Bank report on international trade and climate change finds evidence that "varied levels of tariff and non-tariff barriers (NTBs) are impediments to the diffusion of clean energy technologies in developing countries" (WB 2008:12).

3.2. INVESTMENT

Huge amounts of investment will be required if the world is to move swiftly enough to a low-carbon economic model. In the same way that trade policies can (positively or negatively) influence outcomes in terms of GHG emissions, so can investment policies. In the context of national development policies that clearly opt for the adoption of a low-carbon development path, both public and private investment policies can be formulated to encourage the adoption of clean technologies and environmentally sustainable production practices – and investment proposals can be vetted against clearly defined sustainable development criteria and national strategic priorities. National policies may for instance subject any new investment in energy-intensive sectors (e.g. mineral extraction, cement and metals production) to strict efficiency standards, curb new investment that may aggravate deforestation, encourage reforestation and good agricultural practices, etc. Climate sustainability objectives can be encouraged by a mix of instruments, including:

- regulation (e.g. stricter environmental regulation and enforcement thereof; stringent efficiency standards imposed for all new investment);
- the lifting of identified barriers to investment in clean technologies;
- "green" procurement rules for public investment;
- economic incentives (e.g. subsidies compatible with trade rules, subsidised loans and tax breaks);
- policy commitments and concrete measures aimed at stabilising energy and carbon prices at reasonably predictable and sufficiently high levels to justify investment in abatement technologies: indeed, the large price swings recently experienced in relation to the economic cycle create huge uncertainty in the estimation of returns on investment, which tends to delay investment decisions.

Measures can also be taken at national level to facilitate the exploitation of investment and financing opportunities associated with carbon markets and the Clean Development Mechanism. For instance, national competence centres could be created to raise awareness of opportunities (among both national and foreign potential investors), advise investors on the procedures to follow to access funding, and help them prepare solid application files.

One significant obstacle to investment in GHG abatement and cleaner technologies is that they often require a significant initial investment – and the cost of capital (both in financial terms and in terms of opportunity cost) tends to be higher in emerging and developing countries. Compared with investments in traditional technologies (assuming these are less capital-intensive, as in the case of energy technologies for instance), investments in technologies that contribute to climate mitigation may thus be less profitable; given the scarcity of capital, they may also be less easily justifiable in developing countries than in more developed ones. This aspect should definitely be considered and addressed in the context of international climate-related financing mechanisms. Developed countries can help sustainable investment in developing ones by supporting a share of capital costs (by means of grants), by providing investment loans at low interest rates, and by transferring funds (e.g. through purchases of certified emission reductions) to reward investments that contribute to the mitigation effort.

3.3. INNOVATION AND TECHNOLOGICAL DEVELOPMENT

As a complement to the measures identified above in relation to trade and investment, developing countries can promote climate mitigation through measures aimed specifically at encouraging innovation and technology development – essential ingredients in GHG mitigation and the implementation of a low-carbon development path.

Provided they can mobilise the financial and human resources required to do so, developing countries have the opportunity to "leap-frog" outdated technologies and base their development on the "best available techniques" in terms of carbon emissions and other aspects of technical and environmental

performance. As international pressures increase to take bold action to cut GHG emissions, those countries that first and most decisively opt for a low-carbon development path are likely to benefit from the "first mover advantage", with rewards in terms of competitiveness of their economy, energy independence, access to markets, etc. First movers will notably find that their new investments do not "lock them in" high-energy consumption patterns for several decades; they will also develop skills and technical know-how that in future may enable them to become developers and exporters, rather than just importers, of abatement technologies. Late adopters, on the other hand, may find themselves locked in with long-lived, carbon-intensive energy and industrial infrastructure.

To make use of these opportunities, developing countries will have to identify and systematically address existing barriers to innovation and technological development (see Section 2) while providing positive incentives, in the form of both "technology push" (i.e. policies that stimulate R&D) and "demand pull" (i.e. policies that increase market demand for lower-emission goods and services through regulation, taxation and other instruments). In this regard, flexible, results-oriented policies (e.g. ambitious energy efficiency standards to be achieved which whatever technology producers deem suitable) are more likely to deliver low-cost compliance with mitigation objectives than prescriptive, regulatory approaches that impose the use of given technologies. Policies in support of innovation and technological deployment should also aim, to the extent possible, to reduce the uncertainties and create a stable policy framework with regard to energy and carbon prices, which are strong determinants of investment and therefore also of technology diffusion.

To enhance the chances of success of low-carbon development paths, it may be particularly useful to use strategic planning based on three pillars:

- *strategic prioritisation in the choice of technologies to be deployed*: given their limited human and financial resources, developing countries may want to focus initially on the adoption of a limited number of low-carbon technologies that:

  (i) best match their development strategies[15], as well their natural resource endowment, existing infrastructure, institutional, technical and other characteristics (e.g. a country with a poverty reduction strategy much focused on the development of agriculture may give priority to the adoption of agricultural techniques that promote the sequestration of carbon in soils, as well as the development of climate- and environmentally friendly biofuel technologies; a country with a development strategy based on industrialisation may focus on process and energy efficiency in the industries it wants to promote, as well as on the production of energy from renewable sources; a country that gets a lot of sunshine may focus on solar power generation as a source of renewable energy; countries that already possess advanced technical skills may reasonably opt for technically more sophisticated options than others); technologies that combine mitigation benefits with other developmental benefits (e.g. enhanced soil management, reforestation, clean energies that reduce air pollution) are particularly attractive;

  (ii) are already sufficiently proven and established, and likely to remain so in the foreseeable future (so that investments made now do not become obsolete before the end of their planned lifetime): some low-carbon technologies are now mature or very close to being so (e.g. wind power, solar power), and may be "safer bets" than others that may have long-term potential but are currently still speculative (e.g. because they have not resolved some significant technical issues);

  (iii) are economically viable at (average) recent energy and carbon prices[16] (e.g. clinker substitution with fly ash in cement production, electricity generation from landfill gas, organic soil

[15] Technological choices should be aligned with development strategies, but of course governments should also consider adjusting their development strategies to climate-related imperatives, which is the essence of the concept of a "low-carbon development path".

[16] The economic viability of various abatement technologies depends on energy and carbon prices. For instance, carbon capture and storage, which may cost 30-50 USD/tCO_2, would be economically viable with the tonne of CO_2 equivalent (tCO_2-eq) priced at or above 50 USD but not at 25 USD, let alone the low prices of CO_2 that have prevailed in the EU Emissions Trading Scheme since the onset of the economic crisis. The IPCC's Fourth

restoration), or close to becoming so; pending more clarity on the possible evolution of carbon prices in the new global climate agreement, technologies that are not yet considered economically viable should be considered with more caution, particularly by countries that have very limited resources;

- the *concentration of resources dedicated to R&D, technological skills and institutional development on* the deployment and (as relevant) the customisation and/or further development of *the selected "strategic" technologies*, to avoid the inefficiencies associated with the dispersion of resources and efforts;[17]
- the analysis of patterns of consumption in the domestic market, in order to *identify opportunities for efficiency gains and emission reductions*; this may not be relevant everywhere but may be so in emerging countries in which domestic markets have already achieved a certain level of development.

Strategic technology choices may notably be guided by:

- the GHG emission reduction methodologies approved in the context of the Clean Development Mechanism (which by definition are proven, and open the possibility of benefiting from financial transfers for the sale of emission reduction credits);
- the research work undertaken by McKinsey & Company (2009) on the "global GHG abatement cost curve" and "pathways to a low-carbon economy", which provides an indication of the average abatement cost (per tonne of CO_2 equivalent) and capital intensity of a wide range of abatement technologies.

By way of example (see other sector scripts, especially those dedicated to Agriculture & Rural Development, Infrastructure, Energy Supply and Solid Waste Management, for more details, further examples and a discussion of the pros and cons of some techniques and technologies), technologies that support the mitigation of climate change and may be particularly suitable for developing countries include:

- energy-efficiency technologies;
- renewable energy technologies;
- agricultural and forestry techniques that enhance carbon sequestration in soils and biomass;
- public transport systems.

To conclude, note that not all abatement technologies are necessarily of the "high-tech" variety. For instance, the McKinsey (2009) report finds, among other things, that: (i) approx. 33% of total potential for reducing GHG emissions at a cost not exceeding €60 per tCO_2e is related to land use (forestry and agriculture); (ii) 90% of the abatement opportunities associated with these sectors (many of them not particularly sophisticated from a technological point of view) are located in developing countries; (iii) agriculture- and forestry-related measures generally have low capital intensity (i.e. do not require particularly high extra upfront investment per unit of abatement achieved), while also entailing low (sometimes negative) abatement costs[18] – a combination that should make them attractive to resource-constrained investors.

Assessment Report estimates that "carbon prices in the range of 20-50 US$/$tCO_2$-eq could deliver substantial emission reductions from most sectors" (IPCC 2007:660).

[17] Nevertheless, in view of the importance of cross-technology and cross-industry "spillover effects" (i.e. the fact that one technology developed for a particular purpose or sector may find useful applications elsewhere), excessive specialisation is not recommended either: a "broad and robust technological base" provides an ideal framework for innovation and technological advance (IPCC 2007:158), but the fact is that such conditions are not present nor possible everywhere.

[18] By contrast, technologies associated with power supply have on average both higher abatement costs and higher capital intensity.

3.4. PRIVATE SECTOR DEVELOPMENT

In the context of climate change and more specifically the implementation of low-carbon development paths, private sector development policies can contribute by enhancing opportunities for the private sector to "surf the wave" of the adoption of clean technologies. Specific measures are similar in nature to those advocated in relation to adaptation, and partly overlap with them. They may include:

- running information campaigns targeted at private enterprises (including small and medium-sized ones) about the country's strategic options with regard to the deployment of clean technologies, and the related opportunities to start new businesses and develop new markets;
- setting up capacity building programmes (targeted at energy-intensive sectors, and also SMEs where it makes economic and technical sense) focused on the acquisition of skills required to participate in this deployment;
- setting up financial services (e.g. subsidised loans) to support the adoption of these clean technologies by enterprises, and/or the acquisition of skills required for their participation in public and private tenders related to new technology deployment;
- developing a stable regulatory framework, providing clear signals to private investors with regard to the country's commitment to low-carbon development.

3.5. EMPLOYMENT

To support the implementation of low-carbon development paths, employment policies and strategies should be aligned with trade, investment, technological and private sector development policies. The deployment of clean technologies can in general be expected to promote the creation of formal, better-qualified, better-paid, "greener" jobs (although, as already mentioned, continued attention should be paid to the quality of newly created jobs, which cannot always be taken for granted). Both traditional education and adult education and training programmes have a major role to play in developing the local supply of skills required for the implementation of new techniques and technologies.

Quite frequently, new techniques and technologies turn out to be less labour-intensive than traditional ones, and also require very different skills. The number of green jobs will grow but these jobs will at least partly replace existing ones. It is generally considered that investments in climate-friendly technologies generate more jobs than investments in conventional ones (e.g. the renewable energy sector employs more people per unit of energy output than the fossil-fuel-based energy sector), but net effects on employment may depend on the interaction of complex factors. The risk that more jobs are destroyed than created should not be dismissed without investigation – and there is clearly a risk that people with low skill levels find it increasingly hard to get access to the "new jobs". Employment policies and strategies should pay specific attention to the structural changes in employment patterns entailed by technological change, both across and within sectors. In addition to supporting "winners", they should identify the likely "losers" and take transitional measures to promote their conversion to other activities (e.g. through re-training schemes).[19]

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