

Trade and Sustainable Energie Series



Climate Change and Trade on the Road to Copenhagen



ICTSD Global Platform on Climate Change, Trade Policies and Sustainable Energy



International Centre for Trade
and Sustainable Development

Policy Discussion Paper

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ABBREVIATIONS AND ACRONYMS

A4T	Aid for Trade
BIT	Bilateral Investment Treaty
CCS	CO ₂ Capture and Storage
CDM	Clean Development Mechanism
COP	Conference of the Parties
EGS	Environmental Goods and Services
EGSA	Environmental Goods and Services Agreement
EPO	European Patent Office
EPP	Environmentally-Preferable Product
ESCO	Energy Service Companies
ET	Emissions Trading
ETS	Emissions Trading System
EU	European Union
GATS	General Agreement on Trade in Services
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HS Code	Harmonised System Code
ICTSD	International Centre for Trade and Sustainable Development
IEA	International Energy Agency
IIA	International Investment Agreement
IISD	International Institute for Sustainable Development
IMO	International Maritime Organisation
IP	Intellectual Property
IPCC	Intergovernmental Panel on Climate Change
ISO	International Standards Organisation
ITA	Information Technology Agreement
JI	Joint Implementation
LCD	Liquid Crystal Display
LULUCF	Land Use, Land Use Change and Forestry
MEA	Multilateral Environmental Agreement
MEPS	Minimum Energy Performance Standard
NAFTA	North American Free Trade Agreement
NTB	Non-tariff Barrier
PPM	Production and Process Method
ODI	Overseas Development Institute
ODS	Ozone-depleting Substances
OECD	Organisation for Economic Co-operation and Development
REDD	Reduced Emissions from Deforestation and Degradation
S & DT	Special and Differential Treatment
SCM	Subsidies and Countervailing Measures
SIDS	Small Island Developing States
SFM	Sustainable Forest Management
SME	Small and Medium Enterprise
SP	Special Product

SSM	Special Safeguard Mechanism
TERI	The Energy Research Institute
TNA	Technology Needs Assessment
TRIM	Trade-related Investment Measure
TRIPS	Trade-related Aspects of Intellectual Property Rights
UNFCCC	United Nations Framework Convention on Climate Change
US	United States of America
WBCSD	World Business Council for Sustainable Development
WEO	World Energy Outlook
WTO	World Trade Organization

FOREWORD

The global effort to address climate change will require a fundamental transformation of our economies and of the ways in which we use energy. Addressing climate change requires the internalisation of carbon costs, which will have significant effects on what we produce, where we produce, what we trade and how we trade. For international co-operation on climate change to be effective, international regulatory frameworks need to support this effort.

The current phase of negotiations under the UN Framework Convention on Climate Change (UNFCCC) is set to lay the groundwork for the necessary policy reforms, and will require concerted and co-operative efforts by individual countries, the business sector and civil society. Innovation - with regard to both the technologies of the future and the regulatory frameworks used to usher them in at the scale needed - will be key to the successful implementation of the Convention. In this context, both the global trade regime through the World Trade Organization (WTO) and regional trading arrangements may need to be moulded and reformed to support action on climate change.

As negotiations accelerate in the lead-up to the Copenhagen meeting in December 2009 and beyond, trade-offs and trade-related issues have emerged as elements of the discussions. Some of the issues within the future climate regime will have direct repercussions on the trade realm, and need to be well understood and prepared for. In order to contribute to the debate, this paper provides information on the most salient and pressing policy linkages. It addresses issues in the climate-trade interface that are relatively well known as well as emerging areas that need to be further researched.

The debate on trade and climate change has often treated climate change and trade policies as either friends or foes. The approach adopted in this paper takes climate change as the entry point. It frames the discussion within the five pillars of the Bali Road Map: i) the long-term vision, ii) mitigation of climate change, iii) adaptation to climate change, iv) technology and v) financing. The paper examines the various trade and climate change policy interlinkages with a view to identifying a positive agenda for trade and trade policies to contribute to a successful global climate change agreement and its implementation.

Produced by ICTSD under its Global Platform on Climate Change, Trade Policies and Sustainable Energy, this paper includes contributions from ICTSD staff in the programmes on climate change and energy, intellectual property and innovation, agriculture and development.

The Global Platform is aimed at contributing to effective international co-operation towards addressing climate change. It does so by advancing analytical capacity of stakeholders and their interaction with policy makers such that effective solutions can be identified and agreed by the international community at the Copenhagen Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in December 2009.



Ricardo Meléndez-Ortiz
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EXECUTIVE SUMMARY

The Bali Road Map adopted at the Conference of the Parties (COP) to the UN Framework Convention on Climate Change (UNFCCC) in December 2008 in Bali, Indonesia, launched a process of negotiations on global co-operative action on climate change up to, and beyond, 2012. The Bali map set forth a roadmap for such negotiations, with a view to concluding them by the 15th Conference of the Parties to be held in 2009, in Copenhagen.

Negotiations towards Copenhagen must result in global consensus on five elements of the Bali map: i) a shared vision for long-term co-operative action, including a long-term global goal for emissions reductions, ii) enhanced national/international action on climate change mitigation, iii) enhanced action on adaptation to climate change, iv) enhanced action on technology development and transfer to support action on mitigation and adaptation, v) enhanced action on the provision of financial resources and investment to support action on mitigation and adaptation, and technology co-operation.

There is wide recognition that action in these areas will come at a cost. But exactly what the cost is, and how it will be distributed across countries and sectors under different policy scenarios, remains uncertain. The international distribution of that cost is at the centre of the climate change negotiations. As such, economics is set to be an important element of the framework, the institutional mechanisms, and the range of policy tools needed to advance international co-operative action on climate change. The Bali Road Map recognises the importance of “opportunities for using markets to enhance cost-effectiveness of, and to promote, mitigation actions”. It also gives due regard to “means to incentivise the implementation of adaptation actions” (UNFCCC Secretariat 2007a).

As the international community embarks on the road to climate talks in Copenhagen in 2009, three categories of economic and trade-related concerns are likely to influence the process and outcomes of the negotiations: incentives for participation by developing countries, leakage and competitiveness in industrialised countries, and trade and development concerns of developing countries.

The first relates to incentives aimed at encouraging participation by developing countries, in particular through transfer of technologies and provision of financial resources to support action on mitigation and adaptation. Developing countries have stated clearly that financing and technology transfer will be essential if they are going to be able to mitigate their emissions and adapt to warming temperatures.

Leakage and competitiveness concerns in industrialised countries are another trade-related question with critical implications for the climate negotiations. While not formally part of climate negotiations, the threat of unilateral measures such as border taxes, could prove disruptive and could complicate the climate negotiations. This is already visible in discussions on sectoral approaches to mitigation, which certain developing countries are seeing as a backdoor to address developed countries' competitiveness concerns.

The third set of issues relates to the trade and development concerns of developing countries in certain economic sectors that are likely to be negatively affected by either the physical impacts of climate change or the socio-economic consequences of response measures. Related to that is the adaptation needs and modalities of their financing.

All of these economic and trade-related issues have implications for the on-going negotiations on mitigation, adaptation, technology and financing under the UN Framework Convention on Climate Change.

Mitigation

Significant shares of greenhouse gas (GHG) emissions that are responsible for climate change originate from the energy and industrial sectors. Globally, the bulk of these emissions are attributed to industrialised countries. Emissions from land use and land use change, including agriculture and forestry-related emissions, are also significant. Most of those emissions originate in developing countries and constitute sectors with the greatest potential for mitigation.

Energy and Carbon

A quarter of global emissions of greenhouse gases comes from the energy sector. For economies to move onto a low-carbon track, a global and swift energy transition is necessary. This would entail improvements in the generation and use of energy, as well as the development and diffusion of new and clean sources of energy. Support measures to render the transition economically and socially viable will be necessary.

Energy subsidies

Reforming energy subsidies will be important, but is unlikely to be part of the current round of multilateral trade negotiations. A proper reform of energy, motivated by a transition towards cleaner fuels, would need to go beyond subsidies and address issues related to technology, standards, investment and production methods. For this reason, some have suggested the need for a completely new agreement on energy, following the model of the WTO agreement on agriculture. In the meantime, the process of negotiations towards a post-2012 climate regime sets the stage for a global effort to reform energy subsidies in ways that are supportive of climate change and sustainable energy objectives. Such an approach would provide an opening for accelerating reform in other policy fora, including at the WTO.

Energy standards and labelling

Standards and technical regulations provide a vehicle for promoting energy efficiency, as well as credible solutions for monitoring, measuring, verifying and reporting greenhouse gas emissions and their trading. While energy efficiency standards are widespread around the world, there are great variations in the technical specifications, the testing procedures and modalities of enforcement across countries.

The role of carbon labelling schemes is likely to grow in the future, providing consumers with the option of decreasing their personal carbon footprints. These schemes provide positive product differentiation and market opportunities. From a trade policy perspective, standards and labels represent non-tariff measures and, as such, are potential obstacles to market entry. The WTO establishes a number of conditions that will be relevant to national and regional efforts to promote energy efficiency. International trade rules can thus play an important role in fostering a market transformation towards greater efficiency, while avoiding unnecessary trade distortions.

Land Use

Agriculture and forestry cumulatively account for over 30 percent of global carbon emissions. For achieving long-term climate objectives, the Intergovernmental Panel on Climate Change (IPCC) reports indicate that agricultural mitigation options are found to be more cost competitive than mitigation efforts in other sectors.

Agriculture, climate change and trade

Global agricultural trade and rules governing this trade affect overall carbon management, as changes in land use patterns have major impacts on the carbon balance. Because rules on agricultural trade affect production patterns, by influencing farmers' decisions on the choice of products and production volumes, they also have consequent ramifications for climate change. The nature of the global agricultural trading system and the rules that are established by governments to manage agricultural trade flows are thus a critical component in the package of policies that will be required to mitigate and adapt to climate change.

The overhaul of agricultural subsidies under the Doha Round provides an opportunity to promote genuinely sustainable agricultural production and practices. While there are few agricultural subsidy programmes focusing on carbon sequestration specifically, these may become more prominent in the future. Current subsidy reform, with the emphasis shifting towards decoupled payments and extensification, may also naturally lead developed countries towards practices that support carbon sequestration.

Policy-makers need to provide adequate attention to the needs of smallholder farmers and rural communities, especially in the developing world. In addition to the evident imperative to ensure the food security of these poor communities, governments also need to take into account the fact that the knowledge and practices of these producers may also offer new solutions. Not only do small farmers frequently practice more sustainable traditional agricultural practices - such as crop rotation and mixed cropping, leaving land lying fallow and the use of low levels of artificial chemical inputs - but they are also often the custodians of agricultural biodiversity, selecting and sharing seeds of plant varieties that are particularly well-suited to local conditions. In the context of a changing global climate, this storehouse of biodiversity could be critical in developing the varieties that are needed to adapt to a changing world environment.

Forestry

Deforestation and forest degradation contribute approximately 18 percent of global carbon emissions. The three main areas for mitigating climate change using forestry and wood products are: activities that reduce greenhouse gas emissions from forests (such as reducing biomass burning and deforestation - including illegal logging, increasing efficiency of burning fuelwood and other biofuels, increased use of wood and other biofuels in place of fossil fuels, increasing efficiency of timber-harvesting practices), activities that help maintain the ability of forests to store carbon (such as management techniques including low impact logging, and long-term use of forests and forests products) and activities that expand the capacity of forests to store carbon (such as reforestation and agroforestry).

Market-based tools, such as certification of forest management and labelling of forest products, are one option to promote trade in forest products from sustainably-managed forests. More also needs to be done to improve market access for sustainable forest products, especially with regard to non-tariff barriers and unilateral measures.

Competitiveness

International competitiveness and trade have always been a consideration underlying multilateral negotiations to address climate change. Only recently has the debate become open and politicised. While competitiveness concerns have been more related to the debate over border tax/carbon adjustments, it is important to also acknowledge that there are a number of climate change-related measures in various sectors that would also affect the competitiveness of developing countries.

Embodied carbon in trade

The concept of “embodied” carbon in trade, which refers to emissions related to the production of a good, has emerged in the political debate. Several recent studies show that between one fifth and one quarter of Chinese carbon emissions can be directly attributed to the production of goods that are exported. Under the UNFCCC’s national carbon inventories emissions are, however, accounted for in the country of manufacture, not of consumption. Therefore, developed countries have been accused of “carbon laundering” their economies by outsourcing polluting industries to developing countries.

Leakage and border measures

Countries set to take on stringent mitigation obligations worry that this may affect the international competitiveness of their energy and carbon-intensive industries. Concerns centre on the economic and social implications of the real or perceived relocation of industries to countries without such obligations. In addition, such relocation may lead to carbon leakage - or higher overall carbon emissions from the production of the same volume of goods in countries with less efficient processes.

While firms in carbon-constrained economies already are responding by turning to increasingly specialised high-value products in sectors such as steel, they are also among the main demanders for legislation instituting carbon-related “competitiveness provisions” in the form of mandatory carbon offsetting allowances on imports or border tax adjustments. Such border measures are controversial as they are seen as “sticks” rather than “carrots” to encourage an inclusive approach to deal with the problem. Their legality under the WTO is unclear, and recent studies have found them unlikely to be effective in encouraging climate action in targeted countries.

Sectoral agreements

In this context, there is renewed interest in sectoral agreements - covering energy-intensive and heavily trade-exposed industries such as steel, aluminium, pulp and paper, cement and agro-chemicals - since they potentially could help address some of the international competitiveness issues. Developing countries have cautioned, however, that these might open a backdoor to new standards and obligations that they are unwilling to take on.

Standards

The role of voluntary carbon labelling schemes is likely to grow in the future, providing consumers with the option of decreasing their personal carbon footprints. There are, however, risks associated with such schemes if they are not well designed. The first experiment with a crude form of labelling - airplane stickers in supermarkets to indicate fresh produce that had been air-freighted - generally missed the point and ended up hurting some of the poorest and most vulnerable countries. Carbon labelling schemes thus provide opportunities as well as challenges for developing countries. Any future carbon schemes would need to balance the need for accurate and useful data with the need to be simple, transparent and involve sufficiently low transaction costs to include small countries and players.

Transport sector and tourism

Regulating emissions from international transport - both air and maritime - has entered the climate policy debate, and various options are being considered. Emissions cut in this sector would potentially mean raising costs for moving goods and people around the globe, with potential implications for international trade. Certain service sectors such as tourism are likely to be affected by new emission cuts in the international transport sector. For the many countries, including small island developing states (SIDS), that greatly depend upon mono-crop agricultural production and export and tourism for foreign exchange earnings, employment and contribution to gross domestic product

(GDP), it is crucial that mitigation measures in the transport sector take account of any adverse economic impacts and that appropriate adjustment responses be considered both in the trade and climate regimes.

Adaptation

Key adaptation challenges

As countries focus on addressing their adaptation needs, trade remains largely uncharted territory. Sectors such as agriculture that provide the greatest trade potential for many developing countries will be most affected by climate change, and therefore the most in need of adaptation. The IPCC forecasts that by 2020, rain-fed agricultural production in several African countries will decline by 50 percent. On the other hand, in temperate regions, production may increase due to warmer weather, allowing the generation of a surplus. Such changes are likely to affect patterns of international trade, with gains in some places and losses in others, in ways that are yet to be fully understood. As many poor countries depend on export revenues from agriculture, these economic implications need to be given careful consideration in trade and climate policy processes.

Trade tools and instruments for adaptation

In the current Doha Round of trade negotiations, governments have discussed various mechanisms that will allow developing countries to protect small farmers and rural communities, such as the “special products” (SP) that will be allowed to undertake gentler tariff cuts, or the special safeguard mechanism (SSM) that will allow developing countries to raise tariffs temporarily in the event of an import surge or price depression. To the extent that these mechanisms are accompanied by other measures aimed at reinforcing the competitiveness of developing country agriculture, they may provide a tool for developing country governments to support their small-scale producers to adapt to climate change, while maximising their potential contribution to mitigation efforts.

Technological Innovation and Dissemination

Rapid development, diffusion and transfer of clean technologies will be key to climate change mitigation and adaptation. To the extent that they can expand the market for climate-friendly products, protect and reward innovation without constraining access to relevant technologies, trade policies could be instrumental in promoting the technological transformation needed to address climate change.

Technology needs identification

A range of technologies needed for mitigation and adaptation to climate change have already been identified. These include technologies needed for observation and monitoring of climate change, technologies for mitigation (e.g. energy efficient and renewable energy technologies, energy efficient transportation technology, energy- and material-saving building and construction technologies, low-GHG emission technologies for agriculture and animal husbandry etc.) and technologies for adaptation (e.g. water-saving, water capture and water reuse technologies, agricultural biotechnology, disease and pest control technology, flood, drought, sea level rise, agricultural disasters and desertification control technologies).

A range of economic and trade-related instruments provide opportunities for multilateral action to promote climate-relevant innovation and technology transfer, thus creating an “enabling environment”.

Intellectual property and climate change

Intellectual property rights have long been a tool to promote innovation and the dissemination of new ideas and inventions. Nevertheless, in some cases the excessive scope or level of protection of intellectual property rights in fact provides a disincentive for further research and development, as well as an obstacle to access for the broader public. Therefore, a balance will need to be achieved between patents and access to climate-related technologies.

Trade liberalisation in low-carbon goods and technologies

At the WTO, developed country producers and exporters have proposed to single out environmentally-friendly technologies (among these, climate-friendly technologies) for tariff liberalisation in order to aid their diffusion. Many developing countries are, however, reluctant to make such blanket commitments under the Doha trade Round, which are undertaken as a single package across all sectors. However, the picture is rapidly changing, with the emerging economies growing fastest and becoming the new producers and exporters on the clean technology market.

Financing and Investment

The 2007-2008 United Nations Human Development report has estimated the financing of low-carbon technologies in developing countries at an additional USD 25-50 billion per annum (UNDP 2007). The UNFCCC secretariat (2007b) has estimated that by 2030, developing countries will need USD 28 - 67 billion to enable adaptation to climate change, corresponding to 0.2 - 0.8 percent of global investment flows or 0.06 - 0.21 percent of projected global GDP in 2030. The relationship between financing for climate change and trade policy is often hazy and has not been examined in a lot of detail. Nonetheless, three trade policy areas can be considered in this regard: subsidies, investment and aid for trade.

Subsidies

It is generally agreed that for many clean technologies, such as renewable energy technologies, to achieve market penetration some form of government support will be needed, including through the granting of subsidies. As in any other sector, production- and consumption-related subsidies are affected by a number of trade rules and principles, making it critical to examine the implications of rules on subsidies. In discussing specific subsidy-related rules of relevance to climate change, some have suggested the reintroduction of an expired clause in the subsidies agreement specifying that certain environmental subsidies were “non-actionable” (meaning that they could not be challenged) as a way of encouraging support for clean technologies.

Investment

Private sector investment in clean energy has been growing rapidly from USD 30 billion in 2004 to USD 148 billion in 2008. This is however still just one-twelfth of the 22 trillion dollars that the International Energy Agency says are needed for new energy infrastructure in developing countries by 2030 (IEA 2006). In that context, how trade-related investment measures affect private investment flows relevant to climate change mitigation and adaptation becomes an important consideration. A straightforward case might be the existence of trade barriers to the provision of environmental services. Indeed investment (through establishment of commercial presence) will be a major channel of delivery of environmental services as well as clean energy services. Liberalising investment barriers

that exist in this regard is subject to negotiations under the WTO's General Agreement on Trade in Services (GATS).

Provisions on investment in multilateral agreements, and more extensively, regional or bilateral trade agreements deal with "expropriation" and "fair and equitable treatment". To the extent that they may be seen as inconsistent with "stabilisation clauses" contained in such agreements, certain environmental measures, including climate change-related measures, can be considered as *de facto* expropriations or indirect expropriation. These aspects will need consideration by trade, investment and climate change policy-makers seeking to attract greater private investment or as they draw up investment agreements or chapters of bilateral and regional trade agreements.

Aid for trade

Set up in the course of the long-running Doha Round of global trade talks, the WTO work programme on aid-for-trade (A4T) aims to mobilise additional funding to help poor countries overcome supply-side constraints that hamper their ability to benefit from the multilateral trading system. While A4T is primarily trade-related, the economic resilience that it creates could have positive effects in helping countries deal with the potential impacts of climate change. This would be particularly true if aid for trade can anticipate possible climate impacts on trade-related infrastructure and respond accordingly in the design, implementation and financing of relevant projects.

Conclusion

The global effort to address climate change will require action in several policy areas, and use of a multitude of policy instruments and measures. Economic and trade-related instruments will be of paramount importance in this context. The Bali Road Map provides a basis for launching a comprehensive process for long-term co-operative action on climate change, recognising the need to harness "opportunities for using markets to enhance cost-effectiveness of, and to promote mitigation actions", as well as "means to incentivise the implementation of adaptation actions".

There is a fundamental premise that a strong multilateral regime that effectively leads to the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system will have to include significant commitments on CO₂ reductions by developed countries and probably by some developing countries. This will only be possible if such a regime also provides real economic incentives, effective technology transfer provisions and appropriate cross-border financing mechanisms.

As such, economic and trade-related instruments are bound to be critical determinants in the design of the framework, and the implementation of a post-2012 climate regime.

The trade regime provides opportunities for using markets to support action on climate change, not least through a successful liberalisation of trade in low carbon goods and technologies at the WTO, but also by means of reform in other areas such as agricultural and non-agricultural market access. Nevertheless, from a strategic perspective, it must be recognised that the Doha Round is in its final phase and the scope to introduce major new proposals is very limited, if not inexistent.

More importantly, the informal meeting of trade ministers in Bali marked the emergence of a consensus that climate-related issues should be first and foremost addressed through the UNFCCC process, and that the trade regime should be supporting those efforts. For these reasons, many of the opportunities

for using markets to support action on climate change will need to focus on the ongoing negotiations under the UNFCCC, initiated in December 2007 in Bali, and expected to be completed in December 2009 in Copenhagen. Such efforts will aim at brokering a highly needed global consensus on what is increasingly referred to as the economic architecture of the post-2012 multilateral climate regime.

A successful deal in Copenhagen, encompassing a strong economic architecture, would send the necessary signal and provide the much-needed opening for further reform of the multilateral trading system, such that it can better support global action on mitigation of, and adaptation to, climate change.

1. UNPACKING THE TRADE AND CLIMATE CHANGE LINKAGES

The causes of climate change and the responses required to address it have crucial implications for economic activity through production, consumption and international trade. Responding to climate change will therefore require a fundamental restructuring across key economic sectors such as energy, industry, transportation and agriculture. It will also require action within a wide range of global regulatory frameworks, well beyond the climate regime itself.

The IPCC has been at the forefront of asserting the scientific basis for climate change. While the three first assessment reports of the IPCC focused on generating greater scientific understanding of the causes and consequences of climate change, the fourth assessment report was particularly powerful, not only in elevating the degree of scientific certainty with regard to climate change and its anthropogenic dimension (the link with human activities), but also in revealing the economics of mitigation and adaptation. Similarly, the Stern review on the economics of climate emphasised the economic dimension of climate change, noting that “climate change is the greatest market failure the world has ever seen” (Stern 2006).

The search for solutions to global warming has generated reflection across a range of policy arenas, and responses have also been sought within the international trade system. The relevance of climate change to the international trading system, and vice-versa, culminated when over thirty trade ministers and senior officials met on the fringes of the landmark UN conference on climate change in Bali in December 2007. At Bali, ministers “recognised the importance of concrete efforts to address climate change issues for the future of sustainable development and the mutually supportive linkages between climate change, international trade and development” (Pangestu 2007).

The UN Framework Convention on Climate Change, in its article 3.5, was the first to recognise

that action to address climate change may have trade implications. Hence, in setting the guiding principles for the Convention, Parties cautioned that “measures taken to combat climate change, including unilateral ones, should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade” (United Nations 1992). Similarly, Annex I Parties to the 1997 Kyoto Protocol have agreed to “strive to implement policies and measures ... in such a way as to minimise adverse effects, including the adverse effects of climate change, effects on international trade, and social, environmental and economic impacts on other Parties, especially developing country Parties” (United Nations 1998).

In effect, while the Convention provides a broad framework for action and the Protocol sets targets that countries must reach through domestic policies and international co-operation, neither agreement mandates specific policies or measures for countries to follow. However, in a number of areas, measures seeking to reduce greenhouse gas (GHG) emissions may have trade effects. At the national level, economic policy responses to climate change have broadly consisted of three categories of measures: regulatory measures (e.g. energy efficiency standards, mandatory targets for renewable energy), fiscal measures (e.g. domestic carbon and energy taxation, carbon/energy tax on imports or exports, and subsidies and domestic support mechanisms to producers and consumers) and market-based and incentive measures [e.g. Kyoto Protocol flexibility mechanisms - emissions trading (ET), Joint Implementation (JI), Clean Development Mechanism (CDM)]; market access for low carbon goods and services, and government procurement. In the implementation of such economic and regulatory measures, a number of trade rules and agreements may come into play. These include WTO disciplines on subsidies, technical requirements, market access, border measures, rules concerning trade in services and investment, government procurement and taxes (see Table 1).

Table 1. Examples of climate change measures and related trade implications

Climate change measure	GATT-WTO Related Agreement
Examples of regulatory measures	Trade-related issues/implications
<p><i>Energy efficiency standards</i></p> <ul style="list-style-type: none"> • These have been introduced in most OECD (Organisation for Economic Co-operation and Development) countries, but also in certain developing countries. • 57 countries with 80 percent of the world's population now have energy efficiency standards and labelling programmes. 	<ul style="list-style-type: none"> • WTO's Technical Barriers to Trade agreement prohibits standards that create unnecessary obstacles to trade, and favours international standards over national ones. • It is unclear whether standards can be set on production and process methods (PPMs) that do not affect the end characteristics of final products.
<p><i>Regulations, standards and targets for renewable energy</i></p> <ul style="list-style-type: none"> • EU: 20 percent of energy from renewables by 2020. • US: 35 billion gallons of renewables and alternative fuels in 2017. • China: 15 percent from renewables by 2020. 	<ul style="list-style-type: none"> • In many jurisdictions, renewable energy targets have been made a requirement for energy producers and electricity generators under feed-in-laws and renewable obligations. These policies involve producer subsidies that may raise trade concerns.
Examples of fiscal measures	Trade-related issues/implications
<p><i>Domestic carbon and energy taxation</i></p> <ul style="list-style-type: none"> • Energy taxes common in most countries. • Carbon taxes proposed in many countries but actually implemented in a few. 	<ul style="list-style-type: none"> • Domestic carbon and energy taxes do not raise trade concerns as long as national treatment and non-discrimination principles apply.
<p><i>Carbon/energy tax on imports or exports</i></p> <ul style="list-style-type: none"> • Border tax adjustment on imports/exports proposed in some countries but not yet implemented in any. 	<ul style="list-style-type: none"> • Under GATT rules border tax adjustments are possible for direct taxes. • It is unclear whether adjustment can be made for indirect taxes on unincorporated input during the production of goods.
<p><i>Subsidies and domestic support mechanisms</i></p> <ul style="list-style-type: none"> • Subsidies to fossil fuels and renewables common in many developed and developing countries 	<ul style="list-style-type: none"> • The SCM (subsidies and countervailing measures) agreement prohibits industry and sector-specific subsidies.
Examples of market-based and incentive measures	Trade-related issues/implications
<p><i>Emissions trading (ET), joint Implementation (JI), Clean Development Mechanism (CDM).</i></p> <ul style="list-style-type: none"> • These have been implemented in developed (JI, ET) and developing countries (CDM, ET). 	<ul style="list-style-type: none"> • Can CDM projects be used as benchmarks for defining environmental goods? • It remains unclear under which conditions there may be a subsidy element in the allocation of emissions allowances in ETS (emissions trading system).
<p><i>Trade liberalisation in low-carbon goods and services</i></p> <ul style="list-style-type: none"> • Ongoing negotiations in the Doha Round – complexity and difficulty of defining environmental goods and services. 	<ul style="list-style-type: none"> • Liberalisation in climate-friendly goods and services has been considered in the negotiations on EGS (environmental goods and services).
<p><i>Government procurement</i></p> <ul style="list-style-type: none"> • Procurement policies in several countries. 	<ul style="list-style-type: none"> • Environmental factors can be taken into account in government procurement decision under the WTO Agreement on government procurement.

On the other hand, trade regulatory frameworks provide a range of opportunities for harnessing action in support of climate change objectives. In recognition of these linkages, the Bali Road Map envisages action on climate change, including through “opportunities for using markets to enhance cost-effectiveness of, and to promote mitigation actions”, as well as “means to incentivise the implementation of adaptation actions” (UNFCCC Secretariat 2007a). In so doing, the Bali plan recognises the “catalytic role of the Convention in building on synergies among activities and processes, as a means to support mitigation in a coherent and integrated manner”. As such, a number of economic and trade-related policies and instruments are set to be key determinants in the design of the architecture and the implementation of a future global climate agreement.

Three categories of economic and trade-related concerns can be seen as likely to influence the process and outcome of the negotiations towards Copenhagen. The first relates to incentives aimed at encouraging participation by developing countries, in particular through transfer of technologies and provision of financial resources to support action on mitigation and adaptation. Developing countries have stated clearly that financing and technology transfer will be essential if they are going to be able to mitigate their emissions and adapt to a changing climate.

Leakage and competitiveness concerns in industrialised countries are another trade-related question with critical implications for the climate negotiations. While not formally part of climate negotiations, the threat of unilateral measures such as border taxes, could prove disruptive and complicate the climate negotiations. This is already visible in discussions on sectoral approaches to mitigation, which certain developing countries are seeing as a backdoor to address developed countries’ competitiveness concerns.

The third set of issues relates to the trade and development concerns of developing countries in certain economic sectors that are likely to be negatively affected by either the physical impacts of climate change or the socio-economic consequences of response measures. Related to that is the adaptation needs and modalities of their financing.

This paper will examine these concerns in greater detail in the context of each of the four pillars of the climate negotiations, namely: (i) enhanced national/international action on mitigation of climate change, (ii) enhanced action on adaptation to climate change, (iii) enhanced action on technology development and transfer to support action on mitigation and adaptation, and (iv) enhanced action on the provision of financial resources and investment to support action on mitigation and adaptation, and technology co-operation.

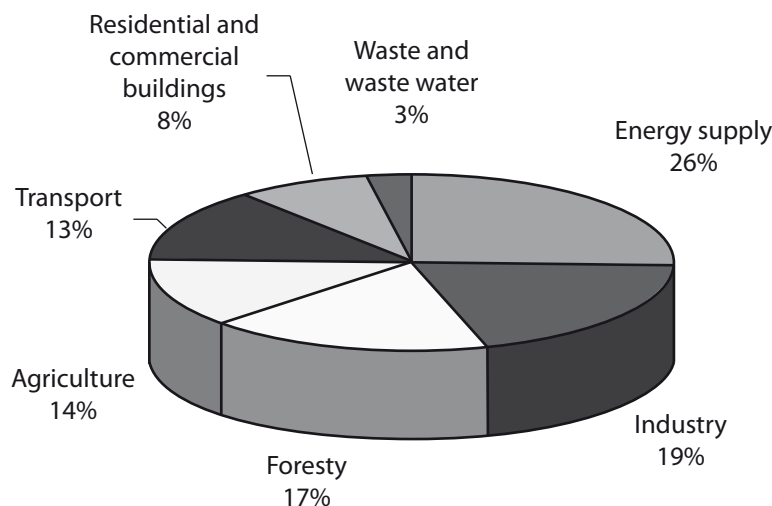
2. MITIGATION

Significant shares of GHG emissions that are responsible for climate change originate from the energy and industrial sectors. Globally, the bulk of these emissions is attributed to industrialised countries. Emissions from land use and land use change, including agriculture and forestry-related emissions, are also significant. Most of these emissions originate in developing countries.

Between 1970 and 2004 the energy supply sector accounted for the largest growth in global GHG emissions between 1970 and 2004 (an increase of

145 percent). The growth in direct emissions from transport in the same period was 120 percent, followed by industry with 65 percent and land use, land use change, and forestry (LULUCF) with 40 percent. Between 1970 and 1990 direct emissions from agriculture grew by 27 percent. Owing to a high level of electricity use, the total of direct and indirect emissions from the building sector grew by 75 percent (IPCC 2007a). Figure 1 below presents the main sectors' cumulative contribution to GHG emissions for the period 1970-2004.

Figure 1: Global anthropogenic GHG emissions by sector, 1970-2004



Sources: IPCC 2007a

The potential to reduce GHG emissions varies by sector and depends on the specific situation of different regions. However, globally, it is estimated that the sectoral economic potential¹

for global mitigation in 2030 could be especially high in buildings, agriculture, industry, energy supply, forestry and transport (IPCC 2007b).

2.1 Energy and Carbon

The generation and consumption of energy is a major source of GHG emissions. With growing energy demand, especially in emerging economies, emissions from the energy sector will increase, with much of the future

increase originating in developing countries. Energy will be a central aspect of climate change mitigation, warranting specific policy intervention that will need to span across several policy fora.

¹ Economic potential is the mitigation potential, which takes into account social costs and benefits and social discount rates, assuming that market efficiency is improved by policies, and measures and barriers are removed (IPCC 2007).

2.1.1 The global energy landscape and emissions scenarios

As global energy demand and consumption surges, fossil fuels (oil, gas and coal) are expected to remain the dominant source of energy up to 2030, accounting for 83 percent of the overall increase in energy demand between 2004 and 2030, according to calculations by the International Energy Agency (IEA 2006). The share of biomass falls marginally as developing countries increasingly switch to using modern commercial energy, offsetting the growing use of biomass as feedstock for biofuel production and for power and heat generation. Renewables (other than hydropower) including wind, solar and geothermal, are expected to grow quickest. Meeting current and future energy needs without a significant change in the sources of energy, poses serious ecological, climate-related and human costs.

In the 2007 World Energy Outlook's (WEO) Reference Scenario - which assumes that governments pursue existing policies - the world's energy needs would be well over 50 percent higher in 2030 than today. China and India together account for 45 percent of the increase in global primary energy demand in this scenario. Energy use in the two countries is set to more than double between 2005 and 2030 (WEO 2007).

Along with growing energy consumption is the increase in energy-related emissions, from 27 Gt in 2005 to 42 Gt in 2030 - a rise of 57 percent (WEO 2007). Fast growing energy use in developing countries will change the landscape of global carbon emissions. China is considered to have overtaken the United States to become the world's biggest emitter in 2007, while India is expected to become the third-biggest emitter by around 2015. By 2030, China's per capita emissions will almost reach those of OECD Europe. Globally, CO₂ emissions are likely to stabilise in OECD countries, but increase in non-OECD countries.

Government policies considered in an "Alternative Policy Scenario" would result in global energy-related CO₂ emissions levelling off

in the 2020s and reaching 34 Gt in 2030 - almost a fifth less than in the Reference Scenario. Emissions savings from the energy sector would come from improved efficiency in industry, buildings and transport, switching to nuclear power and renewables, and the widespread deployment of CO₂ capture and storage (CCS). Improvements in energy efficiency are the cheapest and fastest way to curb energy demand and emissions growth in the near term.

Achieving these objectives would require rapid and widespread technological changes and associated investments, particularly in large emerging and high-energy consuming countries. The WEO (2007) emphasises the urgency for these technological choices in clean and more efficient technologies to be made over the next ten years as energy-supply infrastructure expands rapidly, especially in China and India.

A global and swift energy transition would entail the implementation of alternative energy policies outlined above, together with necessary support measures to render the transition economically and socially viable.

For renewable energy to take off it is widely recognised that government support or incentives are needed. It is important to examine the subsidies and other incentive schemes countries use or are planning to use to support renewable energy and energy efficiency, and to ensure that a future climate agreement provides the space for such instruments to operate. Meanwhile, it has become clear that the greatest potential for reducing emissions from energy generation and use lies in gains from efficiency improvements. A rapid convergence of energy standards would contribute to levelling the playing field and would allow market transformation to take place.

2.1.2 Energy subsidies

Conventional energy is heavily subsidised, both at the production and consumption ends, leading to distorted domestic and global energy markets. The Kyoto Protocol to the UNFCCC

specifically calls for progressive reduction or phasing out of market imperfections and subsidies in all greenhouse gas emitting sectors, and the development and increased use of new and renewable forms of energy.

Globally, subsidies are regulated by the WTO Agreement on Subsidies and Countervailing Measures, which sets the ground rules for permitted subsidies in the trade context. The SCM Agreement requires that subsidies not target exports, and specifies that they should be general rather than aimed at specific industries, and should not lead to discrimination against like imported products. These provisions are seen by many as posing serious challenges for a global energy agenda that seeks to reform harmful subsidies while favouring subsidies for clean energy.

Nonetheless, several options are being contemplated and warrant further analysis and careful consideration. An expired clause in the subsidies agreement specified that certain environmental subsidies were “non-actionable”, meaning they could not be challenged. This category applied provisionally for five years ending 31 December 1999 and, pursuant to Article 31 of the Agreement, could be extended by consensus of the SCM Committee. So far, no such consensus had been reached. As negotiations on climate change progress, WTO Members may need to consider reactivating this clause for the purpose of climate and clean energy objectives or under a broader sustainable development mandate.

Reforming energy subsidies, however, is unlikely to become a major priority in the current round of multilateral trade negotiations, and most analysts believe that it can only be envisaged as part of a medium- to long-term agenda at the WTO. Drawing on the experience with fisheries subsidies, some have suggested addressing energy subsidies under a separate and stand alone mandate - possibly as part of a next round of multilateral trade negotiations. In fact, a proper reform of energy, motivated by a transition towards cleaner fuels, would need to go beyond subsidies and address issues related to technology, standards, investment

and production methods (reason why some have suggested the need for a completely new agreement on energy, following the model of the agreement on agriculture).

In the meantime, the process of negotiations towards a post-2012 climate regime sets the stage for a global effort to reform energy subsidies in ways that are supportive of climate change and sustainable energy objectives. Such an approach would provide an opening for accelerating reform in other policy fora, including at the WTO. In so doing, a future climate regime would need to give consideration to the fact that certain forms of support, even to clean sources of energy, may result in production and market distortions that would need to be addressed in a careful manner.

As part of a future climate agreement, negotiators may envisage a specific commitment to phasing out subsidies to fossil fuels under an agreed timeline, while defining certain support mechanisms for clean energies that would be encouraged and exempted from restrictions in the trade realm.

2.1.3 Energy efficiency, standards and labelling

The development and dissemination of new and efficient energy technologies provides one important element in the levelling off of the current energy growth trends, contributing to the reduction of emissions from energy use. Standards and technical regulations provide a vehicle for promoting energy efficiency, as well as credible solutions for monitoring, measuring, verifying and reporting greenhouse gas emissions and their trading. Accelerated energy efficiency improvement is credited with 78 percent of the emissions reduction savings potential by 2030, making it critical for a future climate regime to harness that potential.

Given that the vast majority of energy-intensive equipment and consumer products are traded globally, an important question is how markets can be made to work better for scaling up

energy efficiency. A global trade-led market transformation effort would require expanding markets for more advanced technologies, while eliminating outdated equipment. Mandatory minimum energy performance standards (MEPS) aim to raise the efficiency level of new products entering the market. Governments can take these a step further by phasing out older technologies and products that use more energy and produce more greenhouse gas emissions. Examples include replacing incandescent light bulbs with more energy-efficient compact fluorescent lamps, which use only about 20 percent of the power to produce the same amount of light and last longer. Consumer information that can influence purchasing decisions is an essential component of market transformation. Energy-information labels are required by all OECD and EU Member countries, and by a growing number of non-OECD countries. In addition, voluntary seal-of-approval labels can be selectively awarded for products that meet strict environmental requirements.

Several countries have taken steps aimed at directing energy performance standards for a range of consumer appliances. Mandatory minimum energy performance standards have been introduced in most OECD countries, but also in many developing countries. In 2006, 57 countries representing 80 percent of the world's population had energy efficiency standards and labelling programmes in place.

While energy efficiency standards are widespread around the world, there are great variations in the technical specifications, the testing procedures and modalities of enforcement across countries. Such differences are recognised in the climate Convention, which notes in its preamble that “environmental standards (...) should reflect the environmental and developmental context to which they apply, and that standards applied by some countries may be inappropriate and of unwarranted economic and social cost to other countries, in particular developing countries.”

From a trade policy perspective, standards and labels represent non-tariff measures and, as such, are potential obstacles to market entry.

As a result, the WTO establishes a number of conditions that govern the application of standards. In addition, WTO rules require standards and technical regulations to be based on international standards where they exist.

Tariff liberalisation, if selectively applied to efficient products, could provide opportunities for emerging developing countries to rapidly penetrate a large portion of the market with high efficiency equipment. A number of technical and procedural obstacles must be overcome for a coordinated trade liberalisation effort to succeed. First, for some of the products concerned, there is no appropriate code under the Harmonised System Codes (HS Code). While some of these products can be located through the six-digit HS code, most would need to be considered at eight or ten digits and may require new classes to be devised. Second, in a few cases visual inspection might suffice to identify a relatively efficient good: e.g. compact fluorescent lamps or liquid crystal display (LCD) monitors. Generally, however, an energy-efficient electrical appliance can only be identified through testing and comparison according to test procedures, product categories and efficiency metrics, which often differ by country.

For energy-efficient goods to be included in tariff-reduction or elimination initiatives, there would have to be agreement on a standard set of product descriptions, reference testing standards and efficiency thresholds, etc. This implies a major effort towards harmonisation. An alternative would be to set lower/zero tariffs on goods that meet some percentage of improved performance compared to existing national energy efficiency thresholds.

A number of proposals for including products based on their energy performance characteristics have been made in the WTO discussions on environmental goods and services (see in Chapter 4.3 below).

An effort towards harmonisation of energy efficiency standards would generate greater coherence at the international level. Whether

that can be achieved under the UNFCCC umbrella or through other fora, such as the International Standards Organisation (ISO), requires further consideration. Overall, views diverge on the desirability and need for harmonisation of energy standards at the international level. Some argue that this is a sphere for “regulatory competition” where consumers play an arbitration function.

International experience suggests that there already is a convergence of efficiency levels in the industrial sector (power generation, production of iron and steel, petrochemicals, paper and pulp, non-ferrous metals, and non-metallic minerals), but that variations still persist in the transport and residential (building and construction) sectors. The future climate agreement could pave the way for a global agreement on energy efficiency by including specific sectors (e.g. industrial sector) for which internationally-coordinated

minimum performance standards would be adopted for specific equipment classes in conjunction with support for research and development to help manufacturers achieve the new targets. This could also include an effort towards standardisation of product labelling and adequate incentive measures to improve market penetration of the most energy-efficient products. Such an approach could be considered as part of potential sector-specific initiatives discussed above.

Finally, the phasing out of outdated technology, following the model of the Montreal Protocol, could be envisaged for certain categories of technologies with a range of commercially available alternatives. An initiative under the climate regime could provide an opening for further reform within the multilateral trading system, as well as in other trade arrangements.

2.2 Land-Use

Agricultural production has a significant effect on climate change, and furthermore is also affected by climate change in important ways. Because rules on agricultural trade affect production patterns by influencing farmers’ decisions on the choice of products and production volumes, they have consequent ramifications for climate change. The nature of the global agricultural trading system and the rules that are established by governments to manage agricultural trade flows are thus a critical component in the package of policies that will be required to mitigate and adapt to climate change.

Forests can make an important contribution towards tackling the problem of climate change. Forest ecosystems affect climate through the absorption of carbon in wood, leaves and soil. Deforestation and forest degradation, on the other hand, threatens to greatly reduce such absorption and increase emissions, with negative consequences for climate as well as ecosystems.

2.2.1 The impact of agriculture on climate change

Agriculture is a major source of greenhouse gases, currently contributing an estimated 10-12 percent of global anthropogenic greenhouse gas emissions. Methane and nitrous oxide emissions are particularly significant, with agriculture accounting for about 50 percent of total global anthropogenic emissions of methane, and about 60 percent of nitrous oxide (Smith *et al* 2007).

Deforestation (especially of tropical forests) and related drainage of peat bogs, for agricultural production are an important cause of GHG emissions. Methane from livestock production, and particularly from ruminant animals such as cows, sheep and goats, is another major agricultural source of greenhouse gases, as is methane produced during the cultivation of rice (due to the anaerobic fermentation of soil organic matter). Finally, nitrous oxide emissions due

to fertiliser application are believed to be another significant factor contributing to the climate change impact of agriculture.

Other secondary factors - such as the use of fossil fuels for agricultural transportation, irrigation and the production of fertilisers - also play a role.

2.2.2 Emerging patterns of agricultural production and trade

Currently, demand for agricultural products is growing, partly as a result of population increases and partly due to changing dietary preferences in the "emerging markets" of middle-income developing countries - in particular, a growing demand for meat products in China and India. In the context of greater demand for biofuels, these increases in global demand are placing greater pressure on agricultural production systems and leading to growing levels of international trade.

The ongoing Doha Round of trade negotiations at the WTO is expected to lead to some increased liberalisation of agricultural trade, with reductions in the maximum permitted levels of domestic subsidies, some increases in market access through tariff reductions and expanded import quotas, and the eventual elimination of export subsidies. Efficient agricultural exporters in countries such as Argentina, Australia, Brazil, Canada and New Zealand are expected to reap particular benefits from the new trading regime, as well as, to a lesser extent, large producers in the EU. However, the intensive agricultural practices that often characterise export-oriented industrial agriculture in these countries have been associated with a number of negative environmental consequences, including many of those indicated above which are associated with climate change.

2.2.3 Mitigating the impact of agriculture on climate change

In order to address the impact of agriculture on climate change in an effective way, governments will have to co-operate on the establishment of policy frameworks and regulations that minimise or eliminate the most harmful agricultural practices and provide incentives for more sustainable models of farming. Because climate change is a global challenge, as activities in one region of the world inevitably have an impact on livelihoods, food security and development prospects in another, international co-operation is a *sine qua non* for effective intervention.

Among other things, governments will need to consider how crop and grazing land management can be improved so as to increase soil carbon storage. Where soils have been degraded, for example through deforestation and subsequent nutrient leaching, or through compaction by livestock and the draining of cultivated peaty soils, measures need to be taken to restore them. While a number of technological solutions to the problem of methane emissions from both ruminant livestock and rice fields are currently under exploration, further efforts are also needed to identify management techniques that may reduce emissions levels. Improved nitrogen fertiliser application techniques may go some way towards helping to reduce nitrous oxide emissions; however, government support for organic agriculture and appropriate restrictions on the use of these inputs may present a more sustainable long-term solution. Finally, both governments and producers need to explore the role of energy efficiency and alternative energy sources (such as biofuels, see Box 1) that contribute to fossil fuel emissions in the agricultural sector.

Box 1. Biofuels

At best, biofuels offer countries an opportunity to reduce greenhouse gas emissions, increase energy security, and generate employment and markets in the agriculture sector. At worst, biofuel production can drive up food prices, encourage deforestation and biodiversity loss, and even increase emissions and energy use - all at considerable expense to taxpayers. A sensible biofuels policy would require governments to create appropriate regulatory frameworks at the local, national and international levels. A key challenge will be to develop rules governing biofuel markets in conjunction with trade liberalisation.

Research has been inconclusive on the extent to which bioethanol and biodiesel save emissions compared to the fossil fuels they replace. Net emissions savings depend on many factors, ranging from the type of crop, energy embedded in the fertiliser and water used, energy used in gathering and transporting feedstocks, alternative land uses, and fuel used in the conversion process. However, some general observations can be made. Ethanol from sugarcane currently provides the greatest reduction in greenhouse gas emissions - up to 90 percent. Corn-based ethanol provides the smallest advantage, and may even increase emissions. Reductions from rapeseed-based biodiesel range between 40 to 60 percent. Second-generation biofuels, produced from feedstocks not used for food, offer greater potential for emissions reductions, but remain years away from large-scale production.

Several efforts to develop biofuel sustainability requirements are underway. These initiatives have articulated a set of environmental and social justice principles: biofuel production and use should reduce greenhouse gas emissions, should not compromise food security or endanger wildlife conservation or the environment, should not violate human, labour, or land and water rights, and should contribute to the development of local, rural and indigenous communities. National rules have incorporated similar principles to varying degrees. For example, the European Commission has proposed that biofuels must achieve at least a 35 percent reduction in greenhouse gas emissions compared to the fossil fuels that they replace. It would also prohibit the use of raw materials grown on land with high biodiversity or high carbon stock. The US requires a 20 percent reduction for renewable fuels (corn-based ethanol), a 50 percent reduction for advanced biofuels and biodiesel, and a 60 percent reduction for cellulosic (second-generation) biofuels.

In order to avoid running afoul of WTO rules, biofuel certification schemes would have to be transparently developed, easy to apply, and backed by financial and technical assistance for aspiring compliers in poor countries.

Although ethanol and biodiesel production has increased dramatically in recent years, most has been for domestic consumption. This is set to change, as countries, especially in the OECD, set renewable fuel targets, driving demand beyond production capacity. Biofuel exports could contribute to employment, economic growth, and poverty alleviation. Technological expertise in biofuels production may provide services export opportunities in the future. For such benefits to be maximised, production efficiency gains will have to be accompanied by trade liberalisation. Indeed, biofuel trade has been limited by various tariff and non-tariff barriers. Heavy farm subsidies in developed nations have undermined export opportunities for biofuel producers in developing countries. Cutting farm subsidies and tariffs could boost international trade in biofuels.

Under WTO rules, biodiesel is traded as an industrial product, while bioethanol is traded as an agricultural product. This classification has implications for their tariff treatment. If WTO Members manage to strike a deal in the troubled Doha Round of trade negotiations, liberalisation commitments on agriculture and the likely sharper tariff cuts on manufactured products will respectively apply to ethanol and biodiesel. The negotiations on expedited liberalisation for so-called "environmental goods" offer an avenue for cutting barriers to trade in biofuels, but there is currently no agreement on counting ethanol as an environmental good.

Source: ICTSD 2008c

2.2.4 Forestry, climate change and trade

The total global forest area is estimated to be about 4 billion hectares (about 40 million km²) or 30.3 percent of total land area. This is equivalent to around 0.62 hectares per capita. The world's ten most forest-rich countries, the Russian Federation, Brazil, Canada, the United States, China, Australia, the Democratic Republic of the Congo, Indonesia, Peru and India, account for around two thirds of the total forest area. Forty-five countries have forests on more than 50 percent of their total land area (FAO 2006).

Each year about 13 million hectares of the world's forests are lost due to deforestation, but the rate of net forest loss is slowing down, thanks to new planting and natural expansion of existing forests. From 2000 to 2005, net forest loss was 7.3 million hectares per year - an area the size of Sierra Leone or Panama and equivalent to 200 km² per day. Forest loss tends to occur in low-income countries, largely in the tropics, whereas a number of higher-income countries have reversed their earlier forest losses and are already experiencing forest expansion (FAO 2006).

Forests can make an important contribution towards tackling the problem of climate change. Forest ecosystems affect climate through the absorption of carbon in wood, leaves and soil. This carbon is released into the atmosphere when forests are burned or during forest clearance and harvesting. Deforestation and forest degradation contribute approximately 18 percent of global carbon emissions and are predicted to contribute a further 40 Gt CO₂ between 2008 and 2012, unless urgent action is taken soon. Deforestation and forest degradation have a twofold impact on the carbon cycle, through loss of photosynthetic capacity and through the release of carbon stocks that are accumulated in forest ecosystems, and importantly, the soil organic matter carbon pool.

The three main areas for mitigating climate change using forestry and wood products are: activities that reduce greenhouse gas emission from forests (such as reducing biomass burning and deforestation - including illegal logging,

increasing efficiency of burning fuelwood and other biofuels, increasing efficiency of timber-harvesting practices), activities that help maintain the ability of forests to store carbon (such as management techniques including low impact logging, and long-term use of forests and forests products), and activities that expand the capacity of forests to store carbon (such as reforestation, forest restoration and agroforestry).

When considering measures to mitigate climate change using forestry and wood products, it should be recalled that forests provide multiple socio-economic and environmental services, including industrial wood production, fuelwood production, supply of non-timber forest products, protection of natural resources (e.g. water and soil), wildlife habitat and recreational areas. An important obstacle to slowing deforestation and forest degradation is that markets generally fail to capture the value of these services that forests provide. Market forces favour the most financially competitive land uses, often to the detriment of sustainably-managed natural forests. Contributory market factors include:

- Profitability of other land uses (often agriculture), such as palm oil in South East Asia or soy production in Brazil.
- Failure to capture non-market benefits (including biodiversity and wilderness values) upon which much of the value publicly ascribed to natural forests is based.
- High sustainable forest management (SFM) costs - easily marketable products (such as timber and pulp) are much more cheaply produced in plantations and by harvesting operations based on forest clearance.
- Market trends currently favour uniform product quality and design flexibility - increasingly served by softwood fibre-based and moulded products - rather than a multiplicity of variable hardwood species.
- High cost of protecting property rights in remote locations and over the long timeframes that sustainable forest management requires.

2.2.5 Harnessing trade options in the forest sector

Market-based tools, such as certification of forest management and labelling of forest products, represent a positive option to promote trade in forest products from sustainably-managed forests. To support these efforts, countries need to ensure that the outcomes of discussions on eco-labelling at the WTO under the trade and environment mandate cater for the certification of sustainably-harvested timber and non-timber forest products. Also of relevance here, in particular for developing countries, is ongoing work at the WTO to finalise the conditions for recognising the equivalence of sanitary and phytosanitary measures. This would include the mutual recognition of countries' forest certification schemes in an effort to avoid having to apply different schemes and standards.

More also needs to be done to improve market access for sustainable forest products, especially with regard to non-tariff barriers and unilateral measures. Such considerations can shape the negotiations on market access for non-agricultural products at the WTO, as well as ongoing negotiations on the elimination of tariff and non-tariff barriers for environmental goods and services. While the definition of environmental goods is yet to be resolved, it could feasibly cover sustainably-harvested forest products, thereby improving market access for such products and providing an incentive for their production. The protection of forests and promotion of sustainable forestry has also been

suggested for inclusion as an environmental service, thereby helping to give monetary value to some of the non-timber benefits of forests, although the proposal has so far not received much backing in the negotiations.

2.2.6 Mitigation options in forestry under the UNFCCC

Examining the possibility of payments from developed to developing countries to reduce emissions from deforestation and forest degradation (REDD) within carbon trading mechanisms has been included under the Bali Road Map. The Clean Development Mechanism of the Kyoto Protocol to the UNFCCC was designed to generate investment within developing countries and to enhance the transfer of environmentally-friendly technologies. The mechanism allows industrialised countries to implement sustainable development projects that reduce emissions in developing countries. The CDM allows afforestation and reforestation projects, although not much has been done yet in this area. There is also a growing voluntary market in tree planting to offset carbon dioxide emissions; however, there is some debate over its effectiveness. It seems very likely that native forests will be more resilient to climate change than plantation forests, and so their retention or restoration offers a better mitigation potential in the long term than the creation of plantations. Afforestation of non-forested ecosystems can result in loss of valuable wildlife habitat and the use of non-native species is likely to result in less new habitat for forest species.

2.3 Competitiveness Issues

International competitiveness and trade have always been a consideration underlying multilateral negotiations to address climate change. Only recently has the debate become open and politicised.

It is clear that climate change mitigation comes at a cost. What exactly the cost is, and how it will be distributed within countries and sectors under different policy scenarios, is less clear.

The international distribution of that cost is at the centre of the climate change negotiations. The economic integration of countries in an open global economy, including through supply chains that are increasingly spread across countries, complicates the matter. In addition, referring to the principle of "common but differentiated responsibilities", developing countries have said that competitiveness issues have no legal ground in the UNFCCC context. Indeed, Parties to the

Convention have agreed to put most of the burden of tackling climate change in the present regime on industrialised countries based on their historical responsibility for past emissions. While concerns over trade and economic competitiveness have tended to be related to the potential use of border tax/carbon adjustments in developed countries, it is also important to acknowledge that there are a number of measures related to climate change that would affect the competitiveness of developing countries in various sectors. Concerns to both developed and developing countries on competitiveness issues are outlined below.

2.3.1 Leakage

Countries set to take on stringent mitigation obligations worry that this may affect the international competitiveness of their energy- and carbon-intensive industries. Concerns centre on the economic and social implications of the real or perceived costs of relocating industries to countries without such obligations. In addition, such relocation may lead to higher overall carbon emissions from the same volume of production of goods in countries with less efficient processes (Kraemer *et al* 2007). This would be the environmental angle of carbon leakage: the same amount of production and increased amounts of related pollution.

While the picture is not yet clear-cut, the issues have become controversial. Some dispute that significant carbon leakage is taking place, pointing, among other, to the fact that developed countries still are producing most of their energy-intensive steel and cement products domestically (Houser *et al* 2008; World Bank 2007). Certain economists say that trade leads to greater production efficiencies, including lower overall greenhouse gas emissions.

2.3.2 Embodied carbon in trade

Carbon emissions related to internationally-traded goods also raise issues of responsibility. Several recent studies (Peters and Hertwich *forthcoming*; Wang and Watson 2007; Shui and Harriss 2006) show that around one quarter of Chinese carbon

emissions can be directly attributed to the production of goods that are exported - many to consumers in developed countries that are no longer engaged in such manufacture.

Therefore, developed countries have been accused of “carbon laundering” by outsourcing polluting industries to developing countries. Critics stress the need for developed countries to take strong first steps to tackle climate change in order to address their responsibilities both with regard to their historic and their current emissions, taking into account the embodied carbon in their imports. Some exporting countries have, in fact, hinted at the need to redefine emission reduction responsibilities since part of their emissions are directly related to consumption in developed countries.

Carbon inventories are centred on the nation state and are carried out by states. Perhaps one day each traded good will be accompanied by its own carbon passport, allowing the transfer of carbon responsibilities across border. However, initial life cycle analyses of traded goods from a carbon perspective have demonstrated just how complex this process would be - and how costly.

2.3.3 Border measures

While firms in carbon-constrained economies already are responding by turning to increasingly specialised high-value products in sectors such as steel, they are also among the main demanders for legislation instituting carbon-related “competitiveness provisions” in the form of mandatory carbon offsetting allowances on imports, or border tax adjustments.

Draft legislation in the US contains provisions for carbon barriers targeting China and other emerging economies currently not obliged to make emissions reductions. In Europe, border measures were left out of draft climate and energy legislation - at least for the moment - however, they are very much part of the debate, and the European Parliament has been calling for border measures against climate “free riders”, mainly the US, for several years.

Such border measures are controversial, as they are seen as “sticks” rather than “carrots” to encourage an inclusive approach to deal with the problem. Their legality under the WTO has also been questioned. Recent studies have pointed to the potential ineffectiveness of unilateral trade measures to encourage action on climate change (Houser *et al* 2008). For more discussion on border measures, see Brewer (2008), ICTSD (2008a), ICTSD (2008b), Pauwelyn (2007) and ICTSD (2007).

2.3.4 Sectoral agreements

Given their implications for trade-related competitiveness, there is renewed interest in sectoral agreements - covering energy-intensive and heavily trade-exposed industries such as steel, aluminium, pulp and paper, cement and agro-chemicals - since these could potentially help address some of the international competitiveness issues. The sectoral approach is designed to reduce carbon leakage by coordinating action and policies across countries according to an overall plan and target for specific industries. The sectoral approach allays competitiveness concerns by creating international standards while broadening participation in a climate regime for developing countries.

Sectoral approaches have the potential to remove troublesome industries that face greater adjustment costs from negotiations. Proponents argue that the sector by sector approach is more manageable for governments and focuses efforts where they are most necessary, and where reducing emissions is least costly and most efficient. Sectoral baselines are less cumbersome and less costly to monitor than the current project-by-project orientation of the Clean Development Mechanism. National efforts can be focused on data collection in emissions-intensive sectors. The increase in technology to reduce global emissions under a sectoral agreement could, in a best case scenario, be a tipping point for a grander technological transformation and would enhance the transfer of most efficient technologies to developing countries.

For a sectoral approach to be successful a balance needs to be struck between participation and stringency on the emissions baseline. The best conditions for a sectoral approach in an international industry are homogeneity of the industry, a small number of owners, similar existing regulatory regimes, a large scope for emissions reduction and high levels of trade.

The sectoral approach has its disadvantages, however. There is a need for quality data and detail for comparison between countries, something many developing countries lack. The complexity of sectoral approaches may raise costs and increase the negotiation burden of states, while pulling policy in many directions. In international law, there is no clear precedent for regulating specific industries on a global basis, and there may be the need for new international institutions under the climate regime.

In addition, there are issues to be addressed related to national sovereignty and independence of national policy. The definition of a sector is difficult to pin down in certain industries, and there is the possibility of carbon leakage in the case of substitutable products. In designing the reductions, it is clear that there is great asymmetry of information between business and the state on the possible emissions reductions. In certain industries, a sectoral approach may not be viable as there are great differences in emissions' intensities and emission reduction potentials across countries in an industry.

As such, sectoral agreements offer no clear-cut solutions and have thus far not been widely endorsed in the climate negotiations. Developing countries have cautioned that these might open the back door to new standards and obligations, which would hinder or complicate developing country exports. They stress that developed countries must take the lead in combating climate change, taking on hard targets.

2.3.5 Carbon labelling

The role of voluntary carbon labelling schemes is likely to grow in the future, providing consumers

with the option of decreasing their personal carbon footprints. There are, however, risks associated with such schemes if they are not well designed. The first experiment with a crude form of labelling - airplane stickers in supermarkets to indicate fresh produce that had been air-freighted - generally missed the point and ended up hurting some of the poorest and most vulnerable countries. These developing countries had managed to capture high-value niche markets in developed countries by air-freighting fresh produce during the northern winter. The stickers singled out just one part of the carbon footprint, namely transport, ignoring other parts of the process. Overall, the exporters were carbon efficient compared to their counterparts in developed countries who were producing out-of-season vegetables in a highly mechanised fashion in greenhouses. Under a different scheme, the small developing-country producers may have been the ones to benefit.

Some embryonic carbon labelling schemes based on life cycle analysis have been set up by the private sector, covering just a few products. These have mainly been agricultural goods, since they tend to be less processed than industrial goods and thus simpler to analyse. In addition, some global companies have started using carbon footprinting to identify carbon hotspots in their supply chains and target these for mitigation action.

Carbon labelling schemes thus provide opportunities as well as challenges for developing countries. Any future carbon schemes would need to balance the need for accurate and useful data with the need to be simple, transparent, and involve sufficiently low transaction costs to include small countries and players.

Among developing countries there is widespread suspicion regarding private sector labelling schemes in particular, as they feel they are not represented and their voice is not heard in the development of these schemes. While such private sector schemes can hurt their export interest, the countries have little room to manoeuvre given that the international trade rules governing standards and

technical regulations, namely the WTO Agreement on Technical Barriers to Trade, essentially binds Member countries, not private organisations.

This discussion also applies to trade-related aspects of the more established labelling schemes focusing on energy efficiency, as well as voluntary or mandatory standards in this area. These schemes provide opportunities for positive product differentiation and market opportunities. On the other hand, many producers are concerned that labelling and standards become barriers to market access. In fact, they see the rise in such “non-tariff barriers” as potential obstacles to market entry, a vehicle for green protectionism.

2.3.6 Transport sector and tourism

During every moment of the day, ships, trucks, trains and planes are criss-crossing the globe to transport goods from their point of production to their point of consumption. The international transport sector is of a particular nature, as reducing its greenhouse gas emissions does not fall directly within the jurisdiction of any single country. Traditionally, the emissions have been “out of sight and out of mind”, and so regulation in this area has been lagging behind. In the climate change negotiations the issue of bunker fuels has been held in abeyance for years, and was only recently put back on the active agenda.

The aviation sector contributes around two percent of global carbon dioxide emissions. However, when indirect effects from other pollutants as well as cloud formation are added, aviation contributes up to nine percent of radiative forcing, or global warming effect. Aviation is also one of the fastest-growing sectors. Emissions have doubled since 1990 and are projected to further grow by 3.5 percent annually. In addition to passenger transport, the aviation industry is increasingly used to transport goods.

The aviation industry is heavily subsidised by the public sector, starting with development and manufacture. Major disputes at the WTO have involved such subsidies, pitting Brazil and Canada against each other over support to Embraer and

Bombardier, and the US challenging subsidies paid to Europe's Airbus, and Europe simultaneously going after subsidies paid to US manufacturer Boeing. Airports are also subsidised, while international tickets and jet fuel are still exempt from taxes in many jurisdictions.

While the significant carbon footprint of air-freight has been well known for some time, shipping has recently also come into the spotlight. Recent studies by the International Maritime Organisation (IMO) show that shipping contributes much more carbon dioxide than previously thought. According to Intertanko, the global association of tanker owners, annual emissions from the world's merchant fleet have already reached 1.12 billion tonnes of carbon dioxide, or nearly 4.5 percent of all global emissions (ICTSD 2008d). In addition, emissions are set to rise by a further 30 percent by 2020, as global trade expands. The worldwide fleet of 90,000 ships transports 90 percent of the world's goods. The IMO is now preparing strategies to act on the issue, to be presented at the UNFCCC Copenhagen meeting in December 2009.

Regulating emissions from international transportation would potentially mean raising costs for moving goods and people around the globe, with potential implications for international trade. Certain service sectors, such as tourism, are likely to be affected by new emissions cuts in the international transport sector.

Many small island developing states are dependent upon mono-crop agricultural production and export, and tourism and its associated services, for foreign exchange earnings, employment and contribution to GDP. In the Caribbean region, travel and tourism account for 14.8 percent of GDP, 12.9 percent of employment and 14.6

percent of total exports. Oceania also has a similar economic profile with tourism accounting 11.7 percent of GDP, 12.4 percent of employment and 16.9 percent of total exports. However, for both regions, ten-year forecasts (2018) by the World Travel and Tourism Council (2008) suggest declining contributions to GDP and employment but not to exports (Nurse, in ICTSD 2008b).

These countries are also highly dependent on the importation of food and energy for domestic consumption, and therefore, mitigation measures in the transport sector should also take account of any adverse economic impacts.

The nature of the potential impacts of regulating emissions from international transport may depend on the approach to regulation and the kind of accompanying measures that could be considered in the UNFCCC. For example, studies have demonstrated that a uniform international levy on shipping covering all ships could generate between USD 10 and USD 45 billion annually. This would slow export growth only by a maximum of 1-2 percent and would have a small impact on tourism. In addition, such a uniform policy is unlikely to raise the cost of food imports by much more than 0.5 percent, even for islands dependent on food imports. On the other hand, the funds generated could be channelled to developing countries for adaptation, mitigation and REDD, with the ultimate effect that developing countries could benefit by 2-15 times their costs (Mace 2008). Accordingly, carefully designed approaches to regulating emissions cut in this area could minimise negative impacts on developing countries, while providing effective adjustment mechanisms. Discussions at the UNFCCC need to factor in these considerations and also take into account the principle of common but differentiated responsibilities.

3. ADAPTATION

The IPCC defines the adaptation process as an “adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities” (IPCC 2007c).

The impacts of climate change, from more frequent and intense weather events to changing patterns of temperature and precipitation, will be felt disproportionately by the poor, who are both most exposed and least equipped to cope. Complicating the picture is the fact that the areas most likely to be affected by climate change - agriculture, biodiversity, forests, water resources and coastal zones (see Annex II), to name a few

- include some with the greatest potential for trade in many developing countries.

Take agriculture, for instance: the IPCC forecasts that rain-fed agriculture in several African countries will decline by 50 percent by 2020. Meanwhile, farms in more temperate regions might increase their output. How such changes in agricultural production will affect international trade patterns is yet to be fully understood. Nonetheless, the need for adaptation and adjustment in the agricultural and other trade-exposed sectors susceptible to changing weather and climate is an important policy concern, in both the climate change and trade regimes.

3.1 Trade tools and instruments for adaptation

The boundaries of what constitutes adaptation policy are by definition blurred. Much of what we think of as traditional development policy boosts adaptive capacity as well. A new water source, or a new road, or human capital-boosting investments in education and health, would all raise a community’s human development assets. They would also be likely to better equip inhabitants to deal with climate change (or to participate in international trade, for that matter). Insofar as trade-driven economic growth helps to give poor people and poor countries more resources, it will help with adaptation.

What is uniquely “adaptive” about development policies, according to a report by the World Resources Institute and the International Institute for Sustainable Development (McGray *et al* 2007), is not how solutions are implemented, but how problems are defined, strategies selected, and priorities set. Smart adaptation strategies would involve “climate-proofing” development efforts: reducing the new water source’s vulnerability to climate change, for example, or ensuring that

new roads can withstand more frequent flooding. A clear delineation of what constitutes adaptation activities, even if it might seem artificial, is essential to mobilise funding to support adaptation.

While adaptation projects should increase the resilience of communities over and above a “without-adaptation” baseline, widely varying conditions in different places mean that there can be no “one size fits all” strategy.

In the context of trade, one potential focus would be to assess how trade-related development assistance affects recipients’ vulnerability to climate change - how particular aid-for-trade efforts might build or reduce adaptive capacity. The WTO’s two-year old “aid-for-trade” initiative offers one potential vehicle to put this into practice. Conceptually, the basis of the initiative - the notion that donor countries should help equip poor ones so that they can deal with trade liberalisation - is comparable to the UNFCCC’s call for industrialised nations to help developing countries reduce their vulnerability to climate change.

3.2 The impact of climate change on agriculture

Climate change is expected to lead to a number of environmental changes that will affect agricultural production and trade, both directly and indirectly. Growing aridity in some world regions, such as southern Africa, some parts of Asia and some parts of Latin America, is expected to directly affect agricultural productivity, especially where accompanied by land degradation and soil erosion. Water scarcity, and associated pressures on water resources for agriculture, is therefore likely to become an important issue. The increased volatility in climatic conditions which, along with increased global temperatures, is expected to be an important feature of climate change, is likely to have major ramifications for agriculture, with producers being less capable of predicting weather patterns and environmental conditions, and trade flows consequently becoming more erratic and unpredictable. While price volatility has long been a concern of developing country commodity

producers, climate change is likely to mean that this issue becomes a more systemic concern. Increases in the prevalence of pests and diseases in some regions may also become a problem.

Production and trade patterns are likely to change as some regions become less suited to agricultural production, and others become better adapted. Currently, experts anticipate that the production potential of mid- to high-latitudes is likely to increase, and to decrease in low latitudes. As a result, trade flows of high-latitude and mid-latitude products are expected to increase, with products such as cereals and livestock products being exported towards low-latitude regions. However, the exact nature of these shifts in production and trade patterns remains unclear, and more research is needed before policy-makers can properly understand the likely implications.

3.3 Adapting to the impact of climate change on agriculture

In many parts of the developing world, agriculture accounts for a significant part of GDP and supports the livelihoods of large populations, as well as providing a crucial source of foreign exchange. The continued health of the sector will be crucial for sustained poverty reduction and the achievement of the Millennium Development Goals.

Orthodox economic theory emphasises that trade liberalisation - the removal of trade barriers such as tariffs and the elimination of trade-distorting subsidies - is crucial in ensuring the efficient allocation of productive resources, therefore concentrating production in those regions that are most able to cope with (or even benefit from) climate change. The role of governments, in this view, is limited to investment in agriculture, ensuring the free flow of trade and supporting research (such as into new technologies that may support adaptation).

While the removal of trade-distorting subsidies is clearly important in allowing producers to respond to market signals, there may nonetheless

be grounds for caution in assuming that trade liberalisation will, in and of itself, automatically lead to an adequate adaptation response in the agricultural sector. Rather, trade policy reform needs to be seen as part of a broader package of policy measures that are interlinked and mutually supportive. In the absence of supporting measures, and in particular of an appropriate regulatory framework, trade liberalisation may even hinder countries' ability to adapt appropriately to climate change and ensure food security for their populations.

In this context, policy-makers need to give adequate attention to the needs of smallholder farmers and rural communities, especially in the developing world. In addition to the evident imperative to ensure the food security of these poor communities, which may be among the most vulnerable to the negative effects of climate change, governments also need to take into account the fact that the knowledge and practices of these producers may also offer new solutions. Not only do small farmers frequently

practice more sustainable traditional agricultural practices such as crop rotation and mixed cropping, leaving land lying fallow, and the use of low levels of artificial chemical inputs, they are also often the custodians of agricultural biodiversity, selecting and sharing seeds of plant varieties that are particularly well suited to local conditions. In the context of a changing global climate, this storehouse of biodiversity could be critical in developing the varieties that are needed to adapt to a changing world environment.

In the current Doha Round of trade negotiations, governments have discussed various mechanisms that will allow developing countries to protect small farmers and rural communities, such as the “special products” (SP) that will be eligible for gentler tariff cuts, or the special safeguard mechanism that will allow developing countries to raise tariffs temporarily in the event of an import surge or price depression. To the extent that these mechanisms are accompanied by other measures aimed at reinforcing the competitiveness of developing country agriculture, they may provide a tool for developing country governments to support their small-scale producers to adapt to climate change, while maximising their potential contribution to mitigation efforts.

Mitigating the negative impact of price volatility, especially for developing country commodity producers, is an issue that has been discussed extensively over the last thirty or forty years. However, in a new era of high global prices and low government stockpiles, it has acquired a new urgency and a wider application. While some favour a supply management approach to this challenge, others point to the failures of this approach in the past and advocate instead a variety of market-based solutions to the problem.

Adapting to climate change in the agricultural sector will require new technologies, in addition to traditional practices. Anthony Okon Nyong (in Boko *et al* 2007), a Nigerian academic who studies this area, has stated that over the long-term, building resiliency to climate change in the farming sector will involve both “soft” technologies such as information systems (including better weather

monitoring) or management practices, and “hard” technologies like equipment for irrigation, conservation tillage, new crop varieties (that could be drought-resistant, for instance) and integrated drainage systems. Long-term planning must be paired with short-term adaptation, which could potentially entail farm-level responses such as crop diversification, changed planting dates, or modifying practices to fit a shorter growing season or financial mechanisms designed to help cope with climate risk, such as agricultural insurance adapted to incorporate climate change-related considerations (which could offer price incentives for farmers to follow practices that might minimise losses). At the same time, better cropland management could help mitigate some greenhouse gas emissions that result from agricultural production itself.

These approaches feature in ongoing attempts to reduce the vulnerability of farmers and pastoralists to climate change. For example, better feeding and land management practices have been used in a number of countries to combat land degradation. A Swiss-funded project in Mali aims to teach farmers to collect climate data and factor it into planting decisions. The International Institute for Sustainable Development (IISD) and The Energy Research Institute (TERI) have documented how, following the liberalisation of the Indian insurance sector, private companies have developed insurance schemes indexed to historical weather patterns. By partially insulating farmers from the effects of, say, unusually low levels of rainfall, these schemes have made them better credit risks, enabling them to obtain bank loans at more favourable rates. None of these devices might have been created as a deliberate attempt to enhance the users’ ability to participate in international trade - but they could hardly hurt.

More analysis is necessary about how farm trade patterns might be affected by climate change, and where it might be wise to invest in ramped up production or support diversification out of agriculture. Projections, of course, have their limits, not to mention detractors: they are based on incompletely-understood complex

relationships, and furthermore, not only are future emission levels uncertain but the climate system's own response might surprise us (maybe unpleasantly).

Nevertheless, in a paper on climate change and agriculture (Slater *et al* 2007), the Overseas Development Institute (ODI) said that the most favourable scenario for future trade - in poverty reduction terms - would rest on boosting labour-

intensive agricultural exports (as opposed to capital-intensive production alone). It called for an "early and marked shift in public support to research and development, extension, market development, rural infrastructure, and services so as to specifically, but not exclusively, benefit directly smaller farmers able to produce for export." This is precisely the sort of investment being recommended as the core of a long-term solution to the current food price crisis.

4. TECHNOLOGICAL DEVELOPMENT, INNOVATION AND DISSEMINATION

Technological solutions are imperative in meeting the challenges of climate change. They are also fundamental to enhance existing abilities and to lower the costs of reducing emissions. Thus, innovation, development and diffusion of new technologies will be part of all mitigation and adaptation strategies.

Broad diffusion of current technologies and transition to new ones, for example, are expected to improve efficiency in energy use, introduce less carbon-intensive sources of energy and further develop renewable energy sources. Indeed, the transition to a low-carbon economy, as all previous energy transitions in history, will be driven by cycles of technological discontinuities and innovations.

Technological change will however, not necessarily lead towards a low-carbon economy. Incentives are required to ensure that technologies that provide climate-friendlier alternatives, increase energy efficiency and lower the cost of measures to address climate change, are being developed and disseminated. Technology development

and transfer at the rate needed for effective climate change mitigation and adaptation will in fact require actions within a wide range of global regulatory frameworks. In this context, determining the adequate role of the international trade system in relation to global efforts to harness technological solutions is central to achieving an effective and coherent post-2012 climate regime.

The UNFCCC and the Kyoto Protocol require Parties to promote and co-operate in the development and diffusion of technology, including transfer of technologies that control, reduce or prevent GHG emissions. As recognised in the Bali Road Map (see Box 2), enhanced action on technology development and transfer will be necessary to enable the full, effective and sustained implementation of the UNFCCC beyond 2012. Initial discussions on the Bali Road Map demonstrate that an agreement on such action will not be straightforward, given the complexity of technology-related issues and the diverse views among Parties and other stakeholders as to the manner in which these issues should be addressed.

Box 2. *Technology development and transfer in the Bali Road Map*

The Bali Road Map launched “a comprehensive process to enable the full, effective and sustained implementation of the Convention through long-term cooperative action” by addressing, inter alia:

“(d) Enhanced action on technology development and transfer to support action on mitigation and adaptation, including, inter alia, consideration of:

- (i) Effective mechanisms and enhanced means for the removal of obstacles to, and provision of financial and other incentives for, scaling up of the development and transfer of technology to developing country Parties in order to promote access to affordable environmentally sound technologies;
- (ii) Ways to accelerate deployment, diffusion and transfer of affordable environmentally sound technologies;
- (iii) Cooperation on research and development of current, new and innovative technology, including win-win solutions;
- (iv) The effectiveness of mechanisms and tools for technology cooperation in specific sectors;”

Source: UNFCCC Secretariat 2007a.

Trade can play an important role in the development and transfer of climate-related technologies. By promoting the exchange of goods using climate-friendly technologies, trade liberalisation is considered to generate a beneficial technology spill-over effect, and could be harnessed as an important element of climate-friendly technological change. Given the complexity of the technology development and transfer processes however, trade liberalisation is insufficient as a single policy approach. The rules of the WTO already contain references to the need to promote the transfer of technology to developing countries. Additional measures may be necessary to support UNFCCC action on the development and transfer of climate-related technologies, as well as to ensure that trade rules do not pose undue barriers to international, regional or national efforts to address climate change.

Intellectual property rules, particularly those established in the WTO context, are also relevant to climate-related technologies. Intellectual property rights, as private rights, have been established and conceived as instruments to

promote innovation and the dissemination of knowledge. Yet the excessive scope or level of protection of these rights may in fact stifle innovation or make access to knowledge more difficult or costly. There may also be particular industrial sectors or countries in which intellectual property rights do not provide adequate incentives for technology development and transfer. Ensuring that international intellectual property rules, or, if needed, other incentive mechanisms, support the development and transfer of the climate-related technologies will thus be important for an effective technology component of the climate regime.

Technology development and transfer issues will be critical on the road to the UNFCCC COP-15 in Copenhagen. Discussion on climate-related technologies is also already surfacing in trade and intellectual property fora. The sub-sections below will describe some of the existing difficulties and controversies that arise in the discussion on technology development and transfer issues, and will identify potential approaches to a more evidence-based and results-oriented debate.

4.1 Technology transfer

Both aspects of the technology-related actions in the Bali Road Map - the development and the transfer of technology - will be important in the full and effective implementation of the UNFCCC. The focus of technology-related discussions in the UNFCCC, however, has traditionally been on the issue of technology transfer. In addition, remaining technological disparities at the international level and the consideration of mitigation commitments for developing countries in a post-2012 climate regime now determine that transfer of technology is taking an unprecedented centre stage in the debate. Significant divergences remain, though, as to the obstacles that impede the effective transfer of technology for sustainable development and the types of measures that can and should be taken in overcoming these obstacles.

“Transfer of technology” can be characterised as the transfer of systematic knowledge for the manufacture of a product, for the application

of a process or for the rendering of a service. The transfer of a technology is thus not over with the transmission of the hardware, but also requires facilitating access to related technical and commercial information and the human skills needed to properly understand it and effectively use it. In this regard, a critical aspect of the technology transfer process is the development of the domestic capacities to absorb and master the received knowledge, innovate on that knowledge and commercialise the results.

Transfer of technology occurs through various channels or pathways, sometimes as the main objective of the transaction or initiative, other times as an intended or unintended by-product. The private sector plays a central role, using both market and non-market-based channels to transfer technologies. Market-based channels for technology transfer include trade in goods and services, foreign direct investment and

technology licensing. Non market-based channels include imitation and the mobility and migration of technical and managerial personnel.

The role of the public sector, however, is no less critical. Governments and other stakeholders, including international or non-profit organizations, may also be involved in the transfer of technology. Indeed, in certain sectors, including environmental technologies, much of the cutting-edge knowledge is developed with public funding. In addition, given that the transfer of technology is not automatic or free, legal and policy incentives are generally required to achieve the most effective rate and approach for transfer of technology in relation to national and international needs and objectives. Article 4.1 (c) of the UNFCCC, for example, requires all Parties to, taking into account their common but differentiated responsibilities, promote and co-operate in the transfer of technologies, practices and processes. Similarly, Article 10 of the Kyoto Protocol states that all Parties must take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally-sound technologies, know-how, practices and processes pertinent to climate change, in particular to developing countries. There are very different perspectives, however, on how the UNFCCC and its Parties can and should provide the necessary incentives for the transfer of climate-related technologies. These perspectives are based on diverse views on the nature of technology, the relevance of different technology-related processes, and the role of various actors in these processes.

As discussions on the technology component of the climate regime post-2012 continue, considerable work will thus be required to increase understanding and enhance dialogue on transfer of technology. In particular, further research, analysis and discussion are needed on the technologies necessary to advance mitigation and adaptation to climate change, and on the actual manner in which technology transfer mechanisms may be directed in order to enhance access to climate-related knowledge and technologies. Trade rules and policies are an

important consideration in both these areas.

4.1.1 Technology identification for mitigation and adaptation to climate change

All consideration of measures to promote technology transfer will necessarily be based on an identification of the climate-related technologies most relevant to developing countries. Many categories of technologies in a range of economic and industrial sectors are relevant for the mitigation of and adaptation to climate change. The UNFCCC expects developing countries to undertake assessments to determine their adaptation and mitigation technology needs. These country-driven exercises would engage a range of stakeholders to identify barriers to the transfer of necessary technology and would create measures to address these barriers. The needs assessments could identify both “soft” and “hard” technologies and look at regulatory options, financial incentives and capacity-building.

In this regard, a range of technologies needed for mitigation and adaptation to climate change have already been identified in the UNFCCC context. These include technologies needed for observation and monitoring of climate change, technologies for mitigation (e.g. energy efficient and renewable energy technologies, energy efficiency transportation technology, energy and material-saving building and construction technologies, low-GHG emission technologies for agriculture and animal husbandry etc.) and technologies for adaptation (e.g. water-saving, water capture and water reuse technologies, agricultural biotechnology, disease and pest control technology, flood, drought, sea level rise, agricultural disasters and desertification control technologies).

The IPCC, moreover, has conducted a sectoral analysis of technologies and practices that will reduce growth in GHG emissions, identifying relevant technologies in three energy end-use areas - commercial / residential / institutional buildings, transportation and industry, the energy

supply and transformation sector, and the agriculture, forestry and waste management sectors. In addition, country-level determination of relevant technologies to address climate change is conducted through technology needs assessments (TNAs). On the basis of TNAs, as well as other national communications, a 2006 UNFCCC report identified common needs for environmentally-sound technologies in developing countries (see Box 3).

Box 3. Summary of technologies identified in 2006 UNFCCC report

Technologies in TNAs are organised, as in the UNFCCC synthesis report, according to different sectors and sub-sectors.

In relation to climate change mitigation, the energy sector had the highest proportion of technology needs identified (53 percent of total number of mitigation technologies), followed by industry (19 percent) and transport (13 percent).

- With regards to energy generation, renewable energy technologies were identified as important by almost all countries, which highlighted the potential benefits of access to options such as solar photovoltaic and biomass technologies. Efficient energy use technologies, especially in the buildings and residential sub-sector, were the second most commonly selected technologies. Efficient lighting, solar water heaters, and efficient stoves and ovens were considered particularly important.
- In the industry sector, frequently-selected technologies included those that increase efficiency in energy use, and sectors privileged by countries included the steel and iron, and the cement industries.
- In transport, many of the technologies needed related to cleaner and more efficient passenger vehicles and trucks for urban public transportation. Technologies identified included production and use of biofuels, clean fuel vehicles using natural gas, high efficiency motors, hybrid vehicles and diesel tractor power.

As for technology needs for adaptation to climate change, countries identified the highest number of technologies in the agriculture and fishery sector (51 percent of the total number of technologies for adaptation), followed by coastal zones (13 percent). Within the agriculture and fishery sector, the most common technologies identified were for crop management, with a clear emphasis on developing and using tolerant/resistant crop varieties. Coastal zone management techniques and technologies and coastal protection techniques were identified by some countries on the basis of concerns about the impact on rising sea levels of economic and development activities located along the coast line. Among technologies to address sea-level rise, the most commonly identified were dikes, levees, bulkheads and seawalls.

Source: UNFCCC Secretariat 2006b.

The IPCC Fourth Assessment report also provides useful information on the importance and potential use of certain technologies for mitigation and adaptation to climate change. For example, with respect to mitigation of climate change in the energy supply sector, the report notes that a wide range of technologies are available (and cost effective at a certain level of carbon prices), including fuel switching and improvements in power-plant efficiency, nuclear power and renewable energy systems. However, greater public and private investment will be required for rapid deployment of low-carbon energy technologies and improved energy conversion technologies, energy transport and storage methods, load management and co-generation. The IPCC also notes that technology can serve as a potent means of adapting to climate variability and change, with new technologies possibly being developed to facilitate adaptation

to climate change and to enhance the transfer of already available technologies to developing countries.

4.1.2 Enhancing technology transfer

Legal and policy measures play an important role in the transfer of technology, even if technology is largely transferred by the private sector. In the UNFCCC context, the term “enabling environment” is used to describe government actions that create a context conducive to private and public sector technology transfer. Parties to the UNFCCC are urged to improve the enabling environment through the identification and removal of legal and policy barriers and the establishment of positive incentives for technology transfer. The barriers and policy tools identified as relevant for the transfer of climate-related technologies include sustainable markets, macroeconomic policy frameworks, and standards and certification. A balanced interaction between the trade and climate change regimes thus becomes essential to ensure the consideration of both: a) the potential impact of trade rules on measures to promote climate-related technology transfer and b) the economic and trade-related instruments that may be included in the emerging climate regime.

In this regard, several approaches are already being considered in the post-2012 climate regime to promote the transfer of technology. Possibilities include drawing from a global mechanism that would provide for the cost of technology acquisition. Indeed, though most efforts to

promote technology transfer in multilateral environmental agreements (MEAs) have “failed to fulfil expectations”, the Multilateral Fund for the Implementation of the Montreal Protocol is one successful example. This fund provides financial support to help developing countries comply with their obligations to phase out the use of ozone-depleting substances (ODS), including by addressing the costs of intellectual property. The financial and technical assistance is in the form of grants or concessional loans that cover the incremental costs incurred by developing countries in converting to non-ODS technologies. Through its financial support, therefore, the Multilateral Fund has ensured a fair price and conditions for the transfer of technology, and could indeed provide a useful model for the proposed Multilateral Technology Acquisition Fund in the UNFCCC.

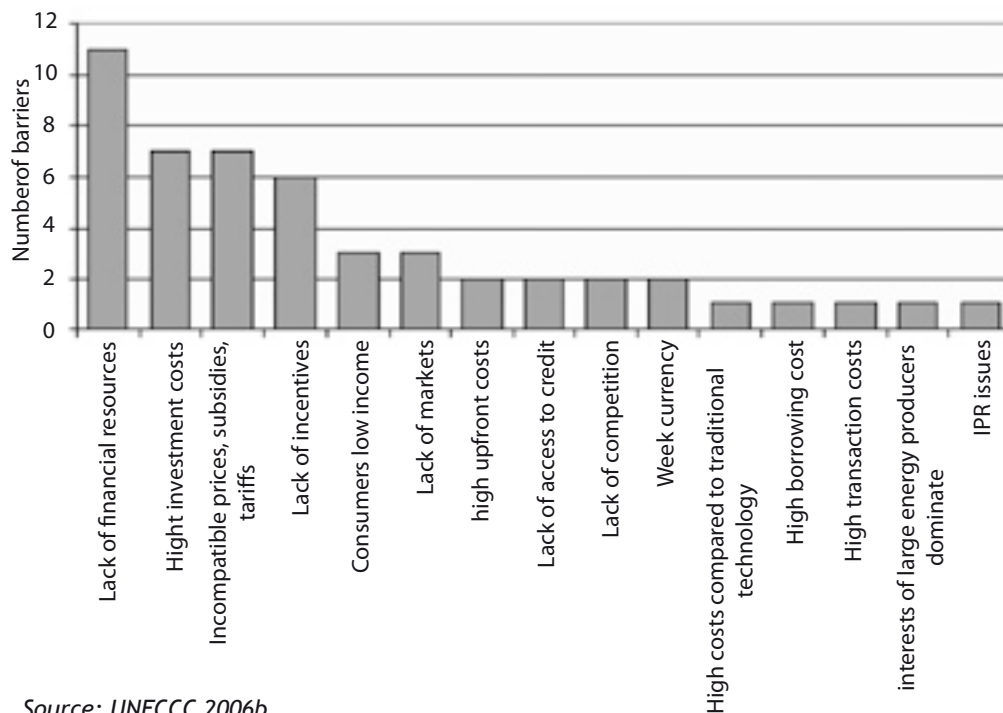
It may also be necessary to find new incentives for the transfer of appropriate technologies to developing countries which seek to create and expand markets for clean technologies, thereby scaling-up supply and demand and stimulating new investment. Protective measures might lead to a gradual phasing out of products and technologies that lead to emissions of greenhouse gases, including through trade disincentives. More analysis and discussion is needed to connect the experts and stakeholders in the trade and climate change contexts, however, and to engage them in a discussion of possible strategies and options for promoting international transfer of climate-relevant technology.

4.2 Role of intellectual property in innovation and dissemination of relevant technologies

In the climate change context, as in other public policy sectors, there is still significant uncertainty as to the manner in which to provide effective incentives for the development and transfer of technology, as well as to the relevant role of intellectual property. In a 2006 UNFCCC report

that identified common needs for and barriers to environmentally-sound technologies in developing countries, intellectual property-related issues were considered only minimally significant within a broad range of economic and market barriers to the transfer of technology (see Figure 2).

Figure 2. Types of economic and market barriers identified by UNFCCC non-Annex I Parties



Source: UNFCCC 2006b.

However, during negotiations following the adoption of the Bali Road Map, the issue of intellectual property (IP) as a potential barrier for accessing climate change technologies has come to the fore as highly controversial. Proposals submitted by developing countries, in particular by the G-77 and China group of countries, have raised concerns about IP and suggested the need to address it as a potentially hindering factor in the transfer of technology from developed to developing country Parties. The UNFCCC Expert Group on Transfer of Technology has also recently started to consider the matter with greater attention. The debate is still characterised by an incomplete analytical understanding of whether and to what extent intellectual property might be an obstacle to the transfer of technology.

Although no comprehensive study has been conducted on the potential impact of IP rights in the different categories of climate-

related technologies, initial research found that the impact of patents on access to solar, wind and biofuel technologies in developing countries would not be significant (see Table 2). Nevertheless, the study also acknowledged that the impact of intellectual property is likely to differ significantly in different industrial and technological sectors. In its consideration of biofuels, for example, an analysis by the European Patent Office (EPO) demonstrated that patent claims cover different areas - compounds, compositions or production methods - and have progressively increased with the price of oil. Another EPO study focused on the patenting of wind energy technology, which is increasing dramatically and covers not only turbine performance, but also their transport, erection, maintenance and operation. Additional research is required to deepen and extend the analysis of patent trends and their implications for access to climate-related technologies.

Table 2. Intellectual property and access to clean energy technologies in developing countries: The case of solar photovoltaic, biofuels and wind energy technologies

TECHNOLOGY	PHOTOVOLTAIC CELLS	BIOFUEL	WIND
IP access limitations on current market for energy (for reducing emissions or participating in CDM).	Few concerns over IP.	Essentially no concerns over IP.	Possible concerns over IP, but likely to involve at most a small royalty.
Major developing country concerns in future market for energy.	Possible difficulties in obtaining advanced IP-protected technologies.	Possible barriers or delays in obtaining cellulosic technologies.	Possible risk of anti-competitive behaviour given concentration of industry.
IP access limitations on entering the industry as a producer of key components or products	Possible barriers or delays in obtaining or creating the highest quality production systems.	Possible concerns over access to new enzymes and conversion organisms - but at most a royalty issue.	Possible difficulty in obtaining most advanced technologies.
Most important overall concerns in area.	Access to government-funded technologies, standards.	Global trade barriers in the sugar/ethanol/fuel context. Access to government-funded technologies, standards.	Access to government-funded technologies. Plausible anti-competitive behaviour, standards.

Source: Barton 2007

Nevertheless, there are already significant calls to address the potential adverse effects of intellectual property on the transfer of climate-related technology. On the eve of the Bali conference, for example, the European Parliament adopted a resolution, which stated that an ambitious post-Kyoto agreement might require “corresponding adjustments” to be made to other international agreements, including on intellectual property. In discussions on the Bali

Road Map, moreover, several developing countries have stated as their position that intellectual property is one of the critical obstacles that must be addressed in a systematic and cross-cutting manner to promote the transfer of technology. In the initial round of talks in 2008, Cuba, India, Tanzania, Indonesia, China and others stressed the need to address intellectual property within technology discussions, while some developed countries including Australia and the US,

affirmed their belief that intellectual property was not a barrier, but a catalyst for technology transfer. More empirical information is clearly needed to actually determine whether patents are facilitating or hindering the development and dissemination of clean energy and other climate-related technologies. An analysis of the potential contribution of existing flexibilities in the international intellectual property system to climate-related technology transfer might also be an important preliminary step.

Beyond the impact and role of existing intellectual property rules, there is also increasing realisation that innovation structures and activities can and should be enhanced to promote climate-related technology transfer. An EU-China Energy and Climate Security project, for example, has identified new technologies as a key area in which regional co-operation could improve the deployment of clean technology. The Clean Energy Group is proposing a “Consultative Group on Climate Innovation,” an international “distributed innovation” model and strategy

for climate technology. Barton has proposed a Treaty on the Global Scientific and Technological Commons. The World Business Council for Sustainable Development (WBCSD) is leading an Eco-Patent Commons initiative - a collection of patents on environmentally-related technology pledged by companies and made available free of charge.

The scope of the Bali Road Map would allow the consideration of a number of measures related to intellectual property and other innovations, and access to knowledge schemes in the context of a post-2012 climate regime. Some are already being discussed, including financial mechanisms to address the link between intellectual property and the transfer of technology, and guidelines on intellectual property protection for publicly-funded technologies. Other emerging topics include prizes as incentives for climate-related innovation and institutional arrangements for open or collaborative innovation, such as the examples mentioned above. Further research and analysis would be useful on all these issues.

4.3 Trade liberalisation in low carbon goods and technologies

Both the IPCC and the Stern Review (2006) on the economics of climate change have highlighted the potential gains from trade liberalisation in clean technologies. To the extent that trade in these products drives diffusion and access to cleaner energy technologies and sources, and improvements in energy efficiency, it can contribute positively to efforts at putting economies on a “low-carbon” trajectory.

A 2007 World Bank study entitled “*International Trade and Climate Change*” points to the potential for liberalisation in the area of low-carbon goods to lead to real increases in trade flows. According to study’s estimates, the removal of tariffs for four basic clean energy technologies (wind, solar, clean coal and efficient lighting) in 18 developing countries with high greenhouse gas emissions would result in trade gains of up to seven percent. The removal of both tariffs and non-tariff barriers could boost trade by as much as 13 percent. The net effect would, however, vary across technologies

and across countries, depending on existing barriers and the import elasticities of demand.

Paragraph 31(iii) of the World Trade Organization’s Doha Ministerial Declaration calls for a reduction or, as appropriate, elimination of tariffs and non-tariff barriers (NTBs) on environmental goods and services (EGS). The lack of a universally-accepted definition of EGS has meant that trade delegates have struggled over the scope of goods and services that would be eligible for liberalisation. There have been working definitions of the environmental industry, including one developed by the OECD. This defines the environmental industry as one undertaking “activities which produce goods and services to measure, prevent, limit, minimise or correct environmental damage to water, air and soil, as well as problems related to waste, noise and ecosystems.”

Within the WTO, negotiations on liberalising environmental goods are taking place separately

from the negotiations on liberalising environmental services. The Doha Round negotiations have met with challenges in a number of areas - many of key importance to developing countries. A major challenge is to define and classify environmental goods, not an easy task as most products with environmental end-uses may also have other non-environmental uses (the “dual-use” problem). Further the Harmonised Commodity Coding and Description system widely used in international trade to classify goods, often makes it difficult to identify and track relevant “climate-mitigation” goods as they are often lumped together with goods that may be less climate-friendly. While it is possible to identify such products at a more detailed classification level using “ex-outs”, WTO Members often lack harmonised product descriptions or codes for these more detailed classification levels.

Despite the lack of definition of environmental goods, a number of countries have proposed lists of goods that they deem relevant for environmental protection, including for climate change mitigation purposes. Early on in the negotiations, Qatar proposed liberalising natural gas fired generation systems and advanced gas-generation systems, citing a reference to its benefits under the UNFCCC. Qatar also referred to the IPCC Assessment Reports, which have recommended increased use of natural gas over other fossil fuels as a way to reduce greenhouse gas emissions.

However, other challenges have also affected progress in the negotiations. These include:

(i) Whether to include *process and production methods criteria* to classify environmental goods, with most WTO Members being unwilling to discuss such criteria. This implies that products derived from organic or “climate-friendly” agricultural practices might be excluded from discussions as it will be difficult to classify them under different tariff-headings for purposes of liberalisation. Such efforts will also require some agreement on standards, labelling and certification for these products.

(ii) *Impacts on domestic industries including small and medium enterprise (SMEs)*: Because of the “dual-use” nature of most environmental goods, a number of developing countries are worried about the impacts of import liberalisation on their established domestic industries, particularly SMEs, that may be producing similar goods.

(iii) *The distribution issue and inclusion of agricultural products*: A big challenge for the environmental goods negotiations is to include products of export interest to developing countries. The perception so far has been that environmental goods - which are capital- and technology-intensive - are of export interest only to developed countries and a few middle-income developing economies. Others, such as Hamwey (2005), see significant export opportunities for developing countries in a large number of lower-technology environmental goods, such as parts and components. However, these also happen to be the “dual-use” products with which most developing countries have concerns. Undoubtedly, many developing countries have emerged as leading producers in clean energy sectors such as China and India for wind and solar energy and Brazil, which is a world leader in biofuel manufacturing equipment.

According to the World Bank (2007), exports from developing countries of clean energy products, such as efficient lighting, are growing rapidly. Analysis by Jha (2008) reveals that China and Mexico were among the top 10 exporters in various categories of environmental goods relevant to climate change mitigation discussed in the WTO. On the other hand, interest in the inclusion of agricultural products early on in the negotiations from Kenya, Ghana, Mauritius and other African countries and later on by Latin American countries (particularly Brazil for ethanol) has met with some degree of resistance by traditional developed-country environmental goods proponents. With regard to least-developed countries, it is clear that possibilities of including products of export interest to them may largely be confined to environmentally preferable products (EPPs). However, few products, if any, may be explicitly linked to climate change mitigation objectives, except indirectly, for instance EPPs

harvested or gathered sustainably from rainforests. In any case these may bring up PPMs again and such products may not be significant in terms of generating export revenue.

(iv) *Approaches to liberalisation*: In addition to issues of product coverage, the question of how to approach the liberalisation exercise has been another big stumbling block in the Doha Round negotiations on EGS. For many developing countries, this issue needs to be resolved before the talks can progress to product coverage. Fundamentally, many developing countries are unwilling to commit to bound liberalisation on lists that comprise mostly dual-use products. Some have therefore proposed their own alternative approaches to liberalisation.

(v) The *List Approach* is favoured by the so called “Friends of Environmental Goods”, comprising Canada, the European Union, Japan, the Republic of Korea, New Zealand, Norway, Chinese Taipei, Switzerland and the United States. The approach essentially consists of identifying and submitting lists of what Members regard as environmental goods of interest for accelerated and permanent liberalisation by reducing or eliminating bound tariffs. India’s *Project Approach* proposes liberalising any good or service intended for a specific environmental project as approved by a designated national authority for CDM project activities and based on criteria developed by the WTO’s Committee on Trade and Environment. Such liberalisation would be temporary, lasting for the duration of the project and domestic implementation of the criteria would be subject to WTO Dispute Settlement.

The *Integrated Approach* proposed by Argentina resembles the project approach but with further identification of goods used in the various approved projects. Both approaches were driven by concerns over ensuring “environmental end-use” of products that are mainly dual-use. A third approach - the *Request Offer Approach* - has been proposed by Brazil whereby countries would request specific liberalisation commitments from each other on products of interest to them

and extend tariff cuts they deem appropriate equally to all WTO Members. Some Members have informally proposed combining various approaches, depending on whether the good in question was single or dual-use. At the time of writing, there appears to be no resolution on which approach or combination of approaches to follow.

The World Bank (2007) has proposed accelerated liberalisation of products, technologies and services used in CDM projects. According to its report, such liberalisation could reduce equipment costs and contribute to lowering transaction costs for potential investors as long as they are complemented by certain measures, such as supportive local regulatory measures.

(vi) *Technology transfer and special treatment of developing countries*: During the course of negotiations, many countries, including China, have stressed the need to facilitate technology transfer. Canada, among others, has stressed technology transfer as occurring through aid, private investment, technical assistance, partnerships between research organizations and small companies, and trade in environmental technologies themselves. Others, such as Cuba, prefer a differentiated treatment for developing countries, including transfer of technologies on favourable and preferential terms with related know-how and necessary training. Lack of adequate attention to technology transfer remains one of the main complaints with regard to the “list” approach. No WTO Member has, however, proposed a practical way to operationalise technology transfer through WTO EGS negotiations.

(vii) *Other cross-cutting issues* that have been raised during environmental goods discussions include the need to identify and deal with non-tariff measures and ensure special and differential treatment (S&DT) for developing countries. Various S&DT proposals - such as multiple product lists with different rates of tariff reduction, sensitive product exemptions and longer implementation periods - have been made by various WTO Members.

On 30 November 2007, as a contribution to the Bali trade ministers' summit on climate change, the US and the EU made a joint informal proposal at the WTO, suggesting the liberalisation of goods and services specifically relevant to climate change mitigation. They further suggested the negotiation of an innovative Environmental Goods and Services Agreement (EGSA) modelled on the existing WTO Information Technology Agreement (ITA). The aim was to boost market access for a wide range of EGS contributing to environmental protection objectives in addition to climate change.

The proposal identified 43 products directly relevant to climate mitigation based on the consolidated list of 153 goods compiled by the "Friends of Environmental Goods" group (see above). The proposal drew directly from a recent World Bank report on trade and climate change, suggesting that by removing tariffs and non-tariff barriers to key technologies, trade could receive an annual boost of 7-14 percent. In addition, liberalisation of climate-friendly technologies could facilitate more investment in high-end technology. The 43 goods included a wide variety of products such as solar collectors and system controllers, wind-turbine parts and components, stoves, grates and cookers and hydrogen fuel cells. The 43 products were intended to provide a starting point for the work rather than be an exhaustive list of goods; other relevant goods that Members agree on could eventually be added.

The objective of the submission was to create a "zero tariff world" for climate-friendly goods in the near future, and no later than 2013. Least-developed countries were encouraged to consider reducing and/or eliminating tariffs on these products given the environmental and developmental benefits. In terms of S&DT for developing countries, the proposal envisaged longer phase-in periods for tariff elimination for products as well as other types of S&DT.

The proposal also included liberalisation of relevant services, which contribute to Members' efforts to address climate change, such as: air pollution and climate control services; technical

testing and analysis; energy-related services (e.g. engineering and maintenance services to optimise the environmental performance of energy facilities); and services for the design and construction of energy-efficient buildings and facilities. The proposal stressed the importance of liberalising environmental goods and services in parallel. Designing more energy-efficient buildings would require, for instance, consulting, design and construction services in addition to solar panels for heating.

Despite the US pointing out that it was a net importer of these 43 goods and that developing countries such as China, Mexico, Malaysia, Chinese Taipei and Indonesia were among the top exporters, many developing countries questioned the "development dimension" of the proposed list. Brazil criticised the exclusion of ethanol from the list. Many developing countries were also concerned that the "climate goods" list, as with most other environmental goods proposed in the WTO, has "dual" i.e. both environmental and non-environmental uses.

It is important to recognise that trade liberalisation by itself may not be sufficient and will only have a miniscule impact on climate mitigation. A whole host of complementary measures - regulatory, capacity building, financial and technology-related - will be required. In this regard, analysis of the Friends' 153 EG list by Jha (2008) is revealing. Jha clearly shows that demand for these products may be determined by factors other than tariffs such as GDP, foreign direct investment, enforcement of environmental regulations (shown by environmental performance indices) and the number of bilaterally-funded "environmental" projects. For instance, many African countries already have very low tariffs on many environmental goods, but little or no imports because their GDPs are constrained and they have other import priorities. Trade liberalisation with a lack of purchasing power will certainly not help. In addition, according to Jha, technical assistance or tied aid projects also appear to be directed to those countries which have the relevant purchasing power. This gap in environmental goods' imports in a large number

of developing countries also points to the need for technical assistance projects, especially in Africa. Bilateral and multilateral donor assistance in this regard has focused especially on the relatively high income developing countries, notably China, the Republic of Korea, Brazil and Mexico.

Further, while categories within the “153” list that are relevant to climate change mitigation, such as renewable energy and heat and energy management, appear sensitive to tariffs, long-term (until 2015) dynamic comparative advantage in these products lies with developed countries (for renewable energy) and with middle-income developing countries (for heat and energy management products). It is thus important to ensure that benefits from trade liberalisation also accrue to the poorer developing countries that may either lack resources to import such products or the capacity to produce, operate and deploy them.

Intellectual property rights may also act as a barrier to access, particularly in emerging climate technologies. Trade liberalisation alone may not result in “take-off” of a technology in developing

countries if costs are kept high due to high licensing fees or royalty payments. From a long-term perspective, it will also be essential to help developing countries build up their own productive and technological capacities in this area. Article 66.2 of the TRIPS agreement for instance states that “Developed country Members shall provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer to least-developed country Members in order to enable them to create a sound and viable technological base.”

The World Bank report calls for smarter trade as an adjunct to freer trade, and proposes bundling trade liberalisation with a package of technical and financial assistance. Developing countries would also like to see requirements for technical assistance and technology transfer in any agreement. Progress in this area hinges on overall progress in the Doha Round. It is clear that the impact of trade liberalisation for climate change mitigation efforts, as with most other sustainable development objectives, will thus only be as effective as the broader enabling framework within which it is put into play.

5. FINANCING AND INVESTMENT AND ITS TRADE-RELATED IMPLICATIONS

Together with access to technologies, financing measures for climate change mitigation and adaptation will be key to developing countries coming on board a post-2012 climate agreement in Copenhagen.

According to the 2007-2008 United Nations Human Development report, the incremental costs of a low-carbon transition to support international climate change mitigation are linked to the capital requirements for new technologies, the increase in recurrent costs in power generation and the risks associated with the deployment of new technologies. According to the report, a multilateral framework for the post-2012 era will have to include mechanisms that finance these incremental costs, while at the same time facilitating technology transfer. While putting an exact figure on these costs was deemed difficult, the report indicated one ball-park estimate of

financing access to low-carbon technologies in developing countries at an additional USD 25-50 billion per annum (UNDP 2007).

The UNFCCC secretariat (2007b) has estimated that by 2030, developing countries will need USD 28-67 billion in funds for adaptation to climate change, corresponding to 0.2-0.8 percent of global investment flows, or 0.06-0.21 percent of projected global GDP, in 2030.

But current global funding for adaptation is a fraction of this figure and access to these funds for developing countries is often lengthy and complex. Additionally, financial flows to developing countries to enable them to undertake response measures (including technology transfer) for climate change mitigation, fall far short of what is required (Table 3) (ICTSD 2008b forthcoming).

Table 3. Comparison of requirements for and availability of financial resources

Funding Area	Current Estimates of Investments and Financial Resources Needed in Developing Countries by 2030	What is Currently Available or Estimated to be Made Available to Developing Countries under the GEF as an Operating Entity for the UNFCCC's Financial Mechanism
<i>Mitigation</i>	<p>USD 176 billion (FCCC/SBI/2007/21, Table 5)</p> <p>USD 86 billion a year by 2015 (0.2% of OECD GDP = 1/10 of OECD military expenditures) (UNDP 2007, p. 194)</p>	<p>USD 990 million from the GEF 4th Replenishment for the period 2006-2010, with co-financing to amount to USD 1.6518 billion² (see FCCC/SBI/2007/21, Table 1)</p>
<i>Adaptation</i>	<p>USD 28-67 billion (FCCC/SBI/2007/21, Table 3 and para. 51)</p>	<p>USD 20.4 million - GEF Trust Fund: Strategic Priority for Adaptation</p> <p>USD 23.5 million - Special Climate Change Fund (GEF administered)</p>

² This requirement for co-financing needs to be studied and analysed, with respect to its impacts on access to GEF financing for those developing countries which may not be able to, or may not wish to, have access to co-financing. In many instances, the co-financing requirement has meant that GEF funding is made conditional to co-financing from the World Bank which, with its associated policy conditionalities, may have adverse impacts on the developing country's policy space.

Funding Area	Current Estimates of Investments and Financial Resources Needed in Developing Countries by 2030	What is Currently Available or Estimated to be Made Available to Developing Countries under the GEF as an Operating Entity for the UNFCCC's Financial Mechanism
		<p>USD 147.0 million - Least Developed Countries Fund (GEF administered)</p> <p>USD 80-300 million per year for the period 2008-2012 from the 2% share of the proceeds of annual sales of certified emissions reductions from CDM projects - Adaptation Fund</p> <p>(see FCCC/SBI/2007/21, Table 2 and para. 62)</p>
<p>Technology transfer</p> <p>Emissions reduction-related technology deployment</p> <p>Deployment of renewables, biofuels and nuclear energy technologies</p> <p>Public energy R&D</p>	<p>USD 720 billion (an average of USD 24-26 billion per year) - (FCCC/SBI/2007/21, para. 93 - no breakdown for developing countries; figures based on IEA estimates)</p> <p>USD 33 billion per year (FCCC/SBI/2007/21, para. 94 - no breakdown for developing countries; figures based on Stern Review)</p> <p>USD 20 billion (FCCC/SBI/2007/21, para. 94 - no breakdown for developing countries; figures based on Stern Review)</p>	<p>The GEF estimates that 80-100 percent of GEF climate change mitigation funding fits the technology transfer definitions used by the Convention (see FCCC/SBI/2007/21, Table 2 and para. 62)</p> <p>By April 2007, USD 10.7 million were available from the Special Climate Change Fund under the UNFCCC, for the programme for transfer of technology (FCCC/SBI/2007/21, para. 90)</p>
<p>National communications under the UNFCCC</p>	<p>The need for resources recognized but no estimate provided (FCCC/SBI/2007/21, para. 109)</p>	<p>USD 60.08 million - GEF (FCCC/SBI/2007/21, para. 107)</p>
<p>Capacity-building</p>	<p>The need for resources recognized but no estimate provided (FCCC/SBI/2007/21, para. 121)</p>	<p>More than USD 1.46 billion allocated by June 2002 - GEF support for capacity-building activities in all its focal areas, but no indication as to future amounts (FCCC/SBI/2007/21, paras. 114-116)</p>
<p>Public awareness and outreach</p>	<p>The need for resources recognized but no estimate provided (FCCC/SBI/2007/21, para. 128)</p>	<p>GEF indicated that "it is not possible to quantify the amount that might have been dedicated to such activities under the GEF." (FCCC/SBI/2007/21, para. 126)</p>

Source: South Centre (2008) para. 6, Table 1.

The relationship between financing for climate change and trade policy is often hazy and has not been examined in a lot of detail. One area of overlap could relate to how policies and policy instruments used for climate change mitigation and adaptation could affect competitive conditions in various sectors underlying trade and thereby run afoul of WTO rules designed to promote fairer competition and non-discrimination. Subsidies are a prime example of such a policy instrument.

It is generally agreed that private investment will have to contribute to leveraging the financial resources needed for addressing climate change.

5.1 Subsidies

Subsidies to promote generation and use of renewable energy will be an important component of measures to put economies on a low-carbon path. Most forms of renewable energy require some measure of support from the government through subsidies or tax-breaks. Such subsidies seek to lower the cost of production and consumption of renewable energy in order to make them relatively competitive vis-à-vis fossil-fuels as well as making them more attractive to producers downstream that use the energy as inputs. If such subsidies are specific to certain sectors or industries and also provide a competitive advantage to the subsidising country vis-a-vis “like” energy sources or downstream products that are traded internationally by other countries, then such subsidies could run afoul of existing WTO subsidy disciplines under the “Subsidies and Countervailing Measures Agreement”. In this context, it has been suggested that an exemption under a formerly existing category of “non-actionable” subsidies

5.2 Investment

Private Investment will need to be a major driver of climate mitigation and (possibly adaptation) efforts. The International Energy Agency for instance, cites a need for 22 trillion dollars of new investment in energy infrastructure between 2005 and 2030 (IEA 2007). Much of this will be in developing countries that are

A second area of overlap could thus pertain to trade-related investment measures and other trade policy measures in goods as well as services, such as tariffs that affect private investment flows relevant to climate change mitigation and adaptation. A third sphere of overlap could relate to the area of aid for trade which although aimed at increasing countries’ capacity to trade as well as resilience of domestic economies, could also have the effect of promoting climate-related resilience in a number of sectors.

These important areas of overlap are outlined in further detail below.

may need to be revived for such categories of subsidies. However, subsidies provided to sectors producing “climate-friendly” goods or services may also provide a competitive advantage when such goods are traded and may come at a cost to similar industries that are located in developing countries. Issues of equity and ways and means of providing a level playing field may need to be found here.

Similarly it has to be ensured that while subsidies may be required under the “green-box” to promote climate-friendly agricultural methods and practices, these should not hinder legitimate trade opportunities for poorer countries that may not be able to afford such subsidies. For most developing countries that may not be able to afford a similar level of subsidisation, the relevance of international financing efforts to support similarly environmentally-friendly practices in developing countries therefore becomes all the more relevant.

hungry for energy to fuel their rapidly growing economies and provide their poorer communities with access to energy. At the same time there is a need to ensure that as much of this investment is also in clean energy generation. Public investment in clean energy has been increasing and big amounts have been pledged for bridging

the gaps between clean and dirty technology in developing countries (for instance, the 10 billion dollar Clean Technology Fund pledged by the US, UK and Japan in 2007). Despite this, such efforts, even if sustained annually at comparable levels, would meet only a miniscule proportion of developing country requirements. The private sector will obviously need to step up investments. While private sector investments in clean energy have been growing rapidly according to a recent IISD report (Cosbey *et al* 2008) from USD 30 billion in 2004 to USD 148 billion in 2008, it is still just one-twelfth of the 22 trillion-dollar requirement in energy that the IEA has called for.

Private investment in climate mitigation efforts will depend, among others, on the enabling environment. Important variables in this regard include fiscal incentives (such as subsidies and feed-in tariffs for clean energy), a strong environmentally-friendly regulatory framework and sound institutions, infrastructure and skills as well as a viable market for products and services created through such investments. Many of these variables are also related to the overall investment climate (such as infrastructure and quality of institutions) but some may be more climate-specific (such as existence of subsidies or feed-in tariffs).

What role can trade-policy play in facilitating such investment? Much more work will be needed in identifying and understanding the implications of trade rules for climate-friendly investment. A straightforward case might be the existence of tariff and non-tariff barriers for instance to environmental goods and technologies that are required for CDM projects or for providing climate-friendly environmental services. Indeed investment (through establishment of commercial presence) will be a major channel of delivery of environmental services as well as clean energy services. Liberalising investment barriers that exist in this regard is subject to negotiations under the WTO GATS. While actual liberalisation in developing countries may exceed the bound commitments under GATS, formally binding further liberalisation could provide

assurances of transparency and predictability to potential investors in these sectors with due consideration for developing country needs and concerns. Liberalisation of environmental goods could also ease access to specific goods needed by investors in environmental services. Other possible opportunities in terms of trade, that may or may not be related to EGS negotiations, could be the facilitation of market access for products arising from CDM certified projects in developing countries such as sustainable forestry.

The WTO's trade-related investment measures (TRIMs) prohibit a number of such measures that differentiate between imported and domestically produced goods (irrespective of whether or not there is discrimination between foreign investors and domestic companies). Thus, measures that require the purchase or use by an enterprise of products of domestic origin or domestic source (*local content requirements*) are inconsistent with TRIMS. Similarly TRIMs prohibit *trade-balancing requirements* which limit the purchase or use of imported products by an enterprise to an amount related to the volume or value of local products that it exports. Some exceptions are available for developing countries, for instance in times of balance of payment difficulties.

The provisions in investment chapters of regional or bilateral trade agreements such as the North American Free Trade Agreement (NAFTA) as well as provisions in international investment agreements (IIAs) that deal with "expropriation" and fair and equitable treatment, are more extensive than TRIMs. *De facto* expropriations or indirect expropriation could include measures (notably environmental regulatory measures) that do not involve an overt take-over but that effectively neutralise the benefit of the property of the foreign owner and could be subject to expropriation claims. According to Cosbey *et al*, (2008) a useful role of trade policy would be to clarify the definition of "expropriation" although the scattered nature of investment regimes could make this difficult. However one example cited is that of the 2004 US model bilateral investment treaty (BIT). The US model BIT cautions that "...the fact that an action or series of actions by

a Party has an adverse effect on the economic value of an investment, standing alone, does not establish that an indirect expropriation has occurred”, and further asserts that “..Except in rare circumstances, non-discriminatory regulatory actions by a Party that are designed and applied to protect legitimate public welfare objectives, such as public health, safety and the environment, do not constitute indirect expropriations.”

“Originally construed to mean government actions that would be so unfair and inequitable as to shock the conscience of the objective observer, the *‘fair and equitable treatment’* standard has expanded greatly over the years and now includes both procedural transparency requirements and a notion of not breaching the legitimate expectations for the investors.” (Cosbey *et al* 2008) Often governments may enter into commitments with private investors to avoid altering conditions of regulatory control, such as those related to pollution or environmental performance. These commitments are known as “stabilisation clauses” and breach of these commitments could constitute a breach of legitimate expectations. Under these agreements a number of climate-related measures could be construed as “expropriation” or breach of “fair

and equitable” treatment. These aspects will need consideration by trade, investment and climate change policy-makers while seeking to attract greater private investment, or to draw up investment agreements or chapters of bilateral and regional trade agreements. Trade policy-makers could also consider the impacts of host country stabilisation agreements on their climate-related obligations, as there is a dearth of analytical work in this area (Cosbey *et al* 2008).

Another issue related to trade, access to technologies and investment, is that of intellectual property rights. Many experts believe that access to technology is more an issue of investment rather than transfer of technology as most of these technologies are owned by the private sector. While developing countries are concerned about the implications of intellectual property rights in obtaining access to new climate-friendly technologies, domestic intellectual property regimes could be an important determinant of private investment into such technologies. A future climate agreement will need to strike the right balance between a level of intellectual property protection that is attractive to investors and enabling affordable access to these technologies by developing countries.

5.3 Aid for Trade

Set up in the course of the long-running Doha Round of global trade talks, the WTO work programme on aid-for-trade aims to mobilise additional funding to help poor countries overcome supply-side constraints that hamper their ability to benefit from the multilateral trading system. In theory, it should help them fill gaps in what the Director General of the WTO, Pascal Lamy, calls “the basic infrastructure that drives globalisation” - modern roads, ports, transportation and telecommunications networks that connect exporters to world markets, up-to-date customs facilities and other institutions, financial safety nets to cushion economic adjustment, and so forth.

As of early 2008, governments were continuing to develop national and sub-regional aid-for-

trade plans, identifying needs and priorities, and working with donors, development banks and other stakeholders to secure financing and proceed to implementation. Aid-for-trade efforts are set to be examined at upcoming technical reviews, intended to further implementation and then, crucially, monitoring. In this context, the work on the identification of needs could take climate change vulnerabilities into account and contribute to the development of a climate-resilient trade infrastructure.

Although funds from the Global Environmental Facility have been used to “climate-proof” development projects, in general, funding for adaptation is insufficient, though the issue is high on the UNFCCC agenda. In this regard while A4T is

primarily trade-related, the economic resilience that it creates could have positive effects in helping countries deal with the potential impacts of climate change. This would be particularly true

if aid for trade can anticipate possible climate impacts on trade-related infrastructure and respond accordingly in the design, implementation and financing of relevant projects.

6. CONCLUSION

The global effort to address climate change will require action in several policy areas and use of a multitude of policy instruments and measures. Economic and trade-related instruments will be of paramount importance in this context. The Bali Road Map provides a basis for launching a comprehensive process for long-term co-operative action on climate change, recognising the need to harness “opportunities for using markets to enhance cost-effectiveness of, and to promote mitigation actions”, as well as “means to incentivise the implementation of adaptation actions.”

It is widely acknowledged that a strong multilateral regime that effectively leads to the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system will have to include significant commitments for CO₂ reductions by developed and probably some developing countries. This will only be possible if such a regime also provides for real economic incentives, effective technology transfer provisions and appropriate cross-border financing mechanisms. As such, economic and trade-related instruments are bound to be critical determinants in the design of the architecture and the implementation of a post-2012 climate regime.

The trade regime provides opportunities for using markets to support action on climate change, not least through a successful liberalisation of trade in low-carbon goods and technologies at the WTO, but also by means of reform in other areas such as agricultural and non-agricultural market access. Nevertheless, from a strategic perspective, it must be recognised that the Doha Round is in its final phase and the scope to introduce major new proposals is very limited.

More importantly, there is a clear recognition, within the trade community, that climate-related issues should be first and foremost addressed through the UNFCCC process, and that the trade regime should be supporting those efforts. For these reasons, many of the opportunities for using markets to support action on climate change will need to focus on the ongoing negotiations under the UNFCCC, initiated in December 2007 in Bali and expected to be completed in December 2009 in Copenhagen. Such efforts will aim at brokering a much-needed global consensus on the economic architecture of the post-2012 multilateral climate regime.

A successful deal in Copenhagen, encompassing a strong economic architecture, would send a positive signal and an opening for further reform of the multilateral trading system, so that it can better support global action on mitigation of and adaptation to climate change.

ANNEXES

ANNEXE I. Selected examples of key sectoral mitigation technologies, policies and measures, constraints and opportunities

Sector	Key mitigation technologies and practices currently commercially available. <i>Key mitigation technologies and practices projected to be commercialised before 2030 shown in italics.</i>	Policies, measures and instruments shown to be environmentally effective	Key constraints or opportunities (Normal font = constraints; <i>italics = opportunities</i>)
Energy Supply	Improved supply and distribution efficiency; fuel switching from coal to gas; nuclear power; renewable heat and power (hydropower, solar, wind, geothermal and bioenergy); combined heat and power; early applications of Carbon Dioxide Capture and Storage (CCS) (e.g. storage of removed CO ₂ from natural gas); <i>CCS for gas, biomass and coal-fired electricity generating facilities; advanced nuclear power; advanced renewable energy, including tidal and wave energy, concentrating solar, and solar photovoltaics</i>	Reduction of fossil fuel subsidies; Taxes or carbon charges on fossil fuels	Resistance by vested interests may make them difficult to implement
		Feed-in tariffs for renewable energy technologies; Renewable energy obligations; Producer subsidies	<i>May be appropriate to create markets for low emissions technologies</i>
Transport	More fuel efficient vehicles; hybrid vehicles; cleaner diesel vehicles; biofuels; modal shifts from road transport to rail and public transport systems; non-motorised transport (cycling, walking); land-use and transport planning; <i>Second generation biofuels; higher efficiency aircraft; advanced electric and hybrid vehicles with more powerful and reliable batteries</i>	Mandatory fuel economy, biofuel blending and CO ₂ standards for road transport	Partial coverage of vehicle fleet may limit effectiveness
		Taxes on vehicle purchase, registration, use and motor fuels, road and parking pricing	Effectiveness may drop with higher incomes
		Influence mobility needs through land use regulations, and infrastructure planning; Investment in attractive public transport facilities and non-motorised forms of transport	<i>Particularly appropriate for countries that are building up their transportation systems</i>

Sector	Key mitigation technologies and practices currently commercially available. <i>Key mitigation technologies and practices projected to be commercialised before 2030 shown in italics.</i>	Policies, measures and instruments shown to be environmentally effective	Key constraints or opportunities (Normal font = constraints; <i>italics</i> = opportunities)
Buildings	Efficient lighting and daylighting; more efficient electrical appliances and heating and cooling devices; improved cook stoves, improved insulation; passive and active solar design for heating and cooling; alternative refrigeration fluids, recovery and recycling of fluorinated gases; <i>Integrated design of commercial buildings including technologies, such as intelligent metres that provide feedback and control; solar photovoltaics integrated in buildings</i>	Appliance standards and labelling	Periodic revision of standards needed
		Building codes and certification	<i>Attractive for new buildings.</i> Enforcement can be difficult
		Demand-side management programmes	Need for regulations so that utilities may profit
		Public sector leadership programmes, including procurement	<i>Government purchasing can expand demand for energy-efficient products</i>
		Incentives for energy service companies (ESCOs)	<i>Success factor: Access to third party financing</i>
Industry	More efficient end-use electrical equipment; heat and power recovery; material recycling and substitution; control of non-CO ₂ gas emissions; and a wide array of process-specific technologies; <i>Advanced energy efficiency; CCS for cement, ammonia, and iron manufacture; inert electrodes for aluminium manufacture</i>	Provision of benchmark information; Performance standards; Subsidies, tax credits	<i>May be appropriate to stimulate technology uptake.</i> Stability of national policy important in view of international competitiveness
		Tradable permits	Predictable allocation mechanisms and stable price signals important for investments

Sector	Key mitigation technologies and practices currently commercially available. <i>Key mitigation technologies and practices projected to be commercialised before 2030 shown in italics.</i>	Policies, measures and instruments shown to be environmentally effective	Key constraints or opportunities (Normal font = constraints; <i>italics = opportunities</i>)
		Voluntary agreements	Success factors include: clear targets, a baseline scenario, third party involvement in design and review and formal provisions of monitoring, close co-operation between government and industry
Agriculture	Improved crop and grazing land management to increase soil carbon storage; restoration of cultivated peaty soils and degraded lands; improved rice cultivation techniques and livestock and manure management to reduce CH ₄ emissions; improved nitrogen fertiliser application techniques to reduce N ₂ O emissions; dedicated energy crops to replace fossil fuel use; improved energy efficiency; <i>Improvements of crop yields</i>	Financial incentives and regulations for improved land management, maintaining soil carbon content, efficient use of fertilisers and irrigation	<i>May encourage synergy with sustainable development and with reducing vulnerability to climate change, thereby overcoming barriers to implementation</i>
Forestry/ forests	Afforestation; reforestation; forest management; reduced deforestation; harvested wood product management; use of forestry products for bioenergy to replace fossil fuel use; <i>Tree species improvement to increase biomass productivity and carbon sequestration. Improved remote sensing technologies for analysis of vegetation/ soil carbon sequestration potential and mapping land use change</i>	Financial incentives (national and international) to increase forest area, to reduce deforestation, and to maintain and manage forests; Land-use regulation and enforcement	Constraints include lack of investment capital and land tenure issues. <i>Can help poverty alleviation.</i>

Sector	Key mitigation technologies and practices currently commercially available. <i>Key mitigation technologies and practices projected to be commercialised before 2030 shown in italics.</i>	Policies, measures and instruments shown to be environmentally effective	Key constraints or opportunities (Normal font = constraints; <i>italics</i> = opportunities)
Waste	Landfill CH ₄ recovery; waste incineration with energy recovery; composting of organic waste; controlled waste water treatment; recycling and waste minimisation; <i>biocovers and biofilters to optimise CH₄ oxidation</i>	Financial incentives for improved waste and wastewater management	<i>May stimulate technology diffusion</i>
		Renewable energy incentives or obligations	Local availability of low-cost fuel
		Waste management regulations	Most effectively applied at national level with enforcement strategies

Source: IPCC 2007a (Table SPM-5)

ANNEXE II. Selected examples of planned adaptation by sector

Sector	Adaptation option/strategy	Underlying policy framework	Key constraints and opportunities to implementation (Normal font = constraints; <i>italics</i> = opportunities)
Water	Expanded rainwater harvesting; water storage and conservation techniques; water re-use; desalination; water-use and irrigation efficiency	National water policies and integrated water resources management; water-related hazards management	Financial, human resources and physical barriers; <i>integrated water resources management; synergies with other sectors</i>
Agriculture	Adjustment of planting dates and crop variety; crop relocation; improved land management, e.g. erosion control and soil protection through tree planting	R&D policies; institutional reform; land tenure and land reform; training; capacity building; crop insurance; financial incentives, e.g. subsidies and tax credits	Technological & financial constraints; access to new varieties; markets; <i>longer growing season in higher latitudes; revenues from 'new' products</i>
Infrastructure/ settlement (including coastal zones)	Relocation; seawalls and storm surge barriers; dune reinforcement; land acquisition and creation of marshlands/wetlands as buffer against sea level rise and flooding; protection of existing natural barriers	Standards and regulations that integrate climate change considerations into design; land use policies; building codes; insurance	Financial and technological barriers; availability of relocation space; <i>integrated policies and managements; synergies with sustainable development goals</i>

Sector	Adaptation option/strategy	Underlying policy framework	Key constraints and opportunities to implementation (Normal font = constraints; <i>italics</i> = opportunities)
Human health	Heat-health action plans; emergency medical services; improved climate-sensitive disease surveillance and control; safe water and improved sanitation	Public health policies that recognise climate risk; strengthened health services; regional and international co-operation	Limits to human tolerance (vulnerable groups); knowledge limitations; financial capacity; <i>upgraded health services; improved quality of life</i>
Tourism	Diversification of tourism attractions & revenues; shifting ski slopes to higher altitudes and glaciers; artificial snow-making	Integrated planning (e.g. carrying capacity; linkages with other sectors); financial incentives, e.g. subsidies and tax credits	Appeal/marketing of new attractions; financial and logistical challenges; potential adverse impact on other sectors (e.g. artificial snow-making may increase energy use); <i>revenues from 'new' attractions; involvement of wider group of stakeholders</i>
Transport	Realignment/relocation; design standards and planning for roads, rail, and other infrastructure to cope with warming and drainage	Integrating climate change considerations into national transport policy; investment in R&D for special situations, e.g. permafrost areas	Financial & technological barriers; availability of less vulnerable routes; <i>improved technologies and integration with key sectors (e.g. energy)</i>

Sector	Adaptation option/strategy	Underlying policy framework	Key constraints and opportunities to implementation (Normal font = constraints; <i>italics</i> = opportunities)
Energy	Strengthening of overhead transmission and distribution infrastructure; underground cabling for utilities; energy efficiency; use of renewable sources; reduced dependence on single sources of energy	National energy policies, regulations, and fiscal and financial incentives to encourage use of alternative sources; incorporating climate change in design standards	Access to viable alternatives; financial and technological barriers; acceptance of new technologies; <i>stimulation of new technologies; use of local resources</i>
Forestry/ forests	Afforestation; reforestation; forest management; reduced deforestation; harvested wood product management; use of forestry products for bioenergy to replace fossil fuel use; <i>Tree species improvement to increase biomass productivity and carbon sequestration. Improved remote sensing technologies for analysis of vegetation/ soil carbon sequestration potential and mapping land use change</i>	Financial incentives (national and international) to increase forest area, to reduce deforestation, and to maintain and manage forests; Land-use regulation and enforcement	Constraints include lack of investment capital and land tenure issues. <i>Can help poverty alleviation.</i>
Waste	Landfill CH ₄ recovery; waste incineration with energy recovery; composting of organic waste; controlled waste water treatment; recycling and waste minimisation; <i>biocovers and biofilters to optimise CH₄ oxidation</i>	Financial incentives for improved waste and wastewater management	<i>May stimulate technology diffusion</i>
		Renewable energy incentives or obligations	Local availability of low-cost fuel
		Waste management regulations	Most effectively applied at national level with enforcement strategies

Source: IPCC 2007a (Table SPM-4)

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- Support the transition to a sustainable energy future by providing relevant stakeholders in different policy processes with innovative analysis regarding opportunities and challenges in the trade and sustainable energy nexus;
- Generate policy-oriented and solutions-focused knowledge on the interface between the multilateral trading system and various regimes and initiatives promoting the transition to a sustainable energy future;
- Expand the knowledge community on trade and sustainable energy by including non-traditional actors and view-points in the debate, including oil producers, climate scientists, agricultural economists, specialists in services trade, labour and consumer organisations; and
- Support existing capacity-building efforts through knowledge outputs and dialogues, particularly for poor countries and disadvantaged communities.

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Founded in 1996, the International Centre for Trade and Sustainable Development (ICTSD) is an independent non-profit and non-governmental organization based in Geneva. By empowering stakeholders in trade policy through information, networking, dialogue, well-targeted research and capacity building, the centre aims to influence the international trade system such that it advances the goal of sustainable development.