DEEPENING GLOBAL COLLABORATION

10

Key points

International trade in permits lowers the global cost of abatement, and provides incentives for developing countries to accept commitments.

Trade in emissions rights is greatly to be preferred to trade in offset credits, which should be restricted.

A global agreement on minimum commitments to investment in low-emissions new technologies is required to ensure an adequate level of funding of research, development and commercialisation. Australia's commitment to support of research, development and commercialisation of low-emissions technology would be about $2.8 billion.

An International Adaptation Assistance Commitment would provide new adaptation assistance to developing countries that join the mitigation effort.

Early sectoral agreements would seek to ensure that the main trade-exposed, emissions-intensive industries face comparable carbon prices across the world, including metals and international civil aviation and shipping.

A WTO agreement is required to support international mitigation agreements and to establish rules for trade measures against countries thought to be doing too little on mitigation.

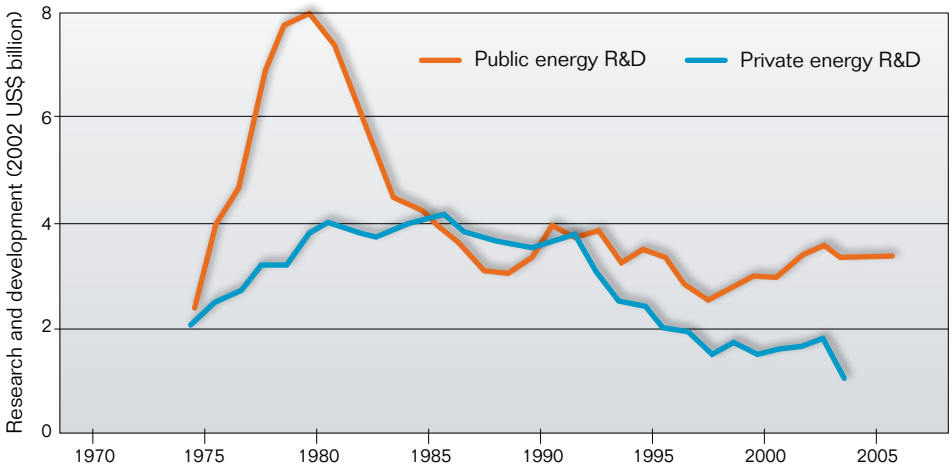
It would be neither desirable nor feasible for each country separately to pursue national emissions-reduction targets. It would not be desirable because lower-cost abatement options would be forgone, and higher-cost options accepted. It would not be feasible, for there would be no financial incentive for developing countries to participate in strong mitigation, and they would not do so. These are two fatal flaws.

No ambitious system of emissions allocation among nations will work unless it allocates entitlements rather than actual emissions. And mitigation efforts will not succeed without international public funding to develop new technology and to transfer it as quickly and widely as possible. This chapter covers key aspects of international collaboration, from international public funding for research and development to emissions trading, to policy frameworks for particular sectors, trade rules and enforcement mechanisms.

10.1 International public funding for mitigation

One of the weaknesses of the world's response to climate change to date has been the limited extent of global public funding for mitigation. Levels of energy research and development, critical to enable the world to make the transition to a low-emissions future, have fallen over time.[1] Figure 10.1 illustrates the case of the United States, the world's largest investor in research and development. The low levels of energy research and development can be explained partly by the limited mitigation efforts so far. Nor has the issue been an important part of the public discussion. Research and development are barely mentioned in either the United Nations Framework Convention on Climate Change (UNFCCC) or the Kyoto Protocol.

Figure 10.1 Energy research and development expenditure by the public and private sectors in the United States



Source: Kammen & Nemet (2005a).

Unlike research and development, technology transfer features prominently under the UNFCCC and Kyoto Protocol. However, the unquantified assurances given in these treaties have not been translated into action. Some technology transfer has occurred under the Kyoto Protocol's Clean Development Mechanism, but nothing on the scale required to underpin broad-based mitigation in developing countries. The Global Environment Facility, a multilateral agency that has been designated as the 'financial mechanism' for the UNFCCC and a number of other environmental conventions, has been an active player in technology transfer, but on a limited scale; on average less than US$1 billion a year (including co-financing) was allocated to climate change projects between 1991 and 2004 (IPCC 2007).

More recently, low-emissions technology research and transfer have received increased attention, with support from prominent economists[2] and political leaders.

Venture capital funds are also starting to invest heavily in renewable energy (Pontin 2007). In February 2008, the US, UK and Japanese governments announced the establishment of 'a multibillion-dollar fund to accelerate the deployment of clean technologies and help the developing world deal with climate change' (Paulson et al. 2008). The three countries have committed about US$1–2 billion each to what is now called the Clean Technology Fund, to be administered by the World Bank. The G7[3] has issued a call to 'scale up investment in developing countries to support them in joining international efforts to address climate change' (AFP 2008). In the last few years, a number of collaborative initiatives have been launched to develop and transfer clean technologies (Box 10.1). The World Bank and regional banks have announced a new focus on energy efficiency and clean technologies, including renewable energy, with commitments to lend US$1–2 billion a year each (IPCC 2007). Australian governments have started investing in research and development on carbon capture and storage, and to a lesser extent in research on renewables. A number of Australian companies are investing large amounts of risk capital raised for the purpose in deep geothermal technologies.

Box 10.1 International research and development and technology transfer initiatives

In recent years, a number of international technology-related initiatives have been launched. Many of them are in need of additional funding. They would all be eligible for funding under the Review's proposed International Low-Emissions Technology Commitment.

- The Generation IV International Forum is a multilateral partnership fostering international cooperation in research and development for the next generation of nuclear energy systems.
- The Carbon Sequestration Leadership Forum is focused on the development of improved technologies for the separation and capture of carbon dioxide for transport and long-term safe storage.
- The Methane to Markets Partnership focuses on advancing near-term methane recovery and use of methane as a clean energy source.
- The International Partnership for the Hydrogen Economy provides a forum for its member countries for advancing policies, common codes and standards, as well as developing demonstration and commercial utilisation activities related to hydrogen and fuel cell technologies.
- The mission of the Renewable Energy and Energy Efficiency Partnership is to 'contribute to the expansion of the global market for renewable energy and energy efficiency' (REEEP 2008). The partnership's broad membership includes national governments, business, development banks and non-government organisations.
- The Asia–Pacific Partnership on Clean Development and Climate brings together governments and companies from Australia, Canada, China, India, Japan, the Republic of Korea and the United States to collaborate on the development, deployment and transfer of cleaner and more efficient technologies.

Widespread adoption of national emissions goals, as advocated in Chapter 9, would not obviate the need for international public funding for research and development related to mitigation. This follows from the external benefits generated by private investment in this area (Chapter 18). Provision of such funding will be critical to the global endeavour to live within a tightening carbon constraint to correct for international market failures relating to public goods and missing markets:

- Expenditure on the research, development and commercialisation of low-emissions technologies has international public good characteristics, as it can benefit all nations and its rewards cannot be fully captured by private investors. Delivering this international public good will be critical for lowering abatement costs and increasing confidence that the mitigation task is a feasible one. Indeed, some have argued that international climate change mitigation policy should be predominantly about the development and provision of low-emissions technologies (Schelling 2002; Barrett 2003). This view underestimates the importance of price signals for providing incentives for change, and for inducing technological change (Köhler et al. 2006). No amount of technological innovation will make some potentially important emissions-reducing technologies competitive with unmitigated release of emissions to the atmosphere. Geosequestration of emissions from fossil fuel combustion is an important example: coal-fired generation will always be more expensive with geosequestration than without it. Nevertheless, deep cuts in global emissions will require the development of new energy technologies, and international externalities in research and development provision will require international public funding.
- International trade in emissions rights will be critical for providing incentives for developing countries to participate, but it will take several years even after a new international agreement is reached for the necessary international markets to develop. In the interim, developing countries will face a problem of 'missing markets.' Developed country governments and international development finance institutions will need to provide developing countries with financing to kick-start the move to a low-emissions future (Carmody & Ritchie 2007). Such financing would provide critical technology—existing and new—to support the transition to a low-carbon economy, but could extend beyond the energy markets to other areas such as reducing deforestation.

How much public funding would be required? One estimate of global energy research and development needs for a stabilisation goal of 550 ppm carbon dioxide equivalent is in the order of US$30–100 billion per year until stabilisation (Kammen & Nemet 2005b). Another estimate for the same stabilisation level calls for annual spending of US$50 billion per year by 2050 compared to an estimated US$10 billion today (Bosetti et al. 2007).[4] Although some of this research and development will be provided by the private sector, in general these estimates understate the required public funding. They only cover energy research and

development, and neglect technology transfer or other public financing for developing country mitigation. These estimates model requirements for stabilisation at 550 ppm carbon dioxide equivalent, a level that may not do enough to reduce the risk of dangerous climate change. Stabilisation at a lower concentration level will require faster and greater development and uptake of new technology, and thus larger, earlier expenditure. The International Energy Agency (2008) examined the energy technology requirements for reducing global emissions by 50 per cent by 2050. It concluded that 'a massive increase of energy technology Research, Development and Demonstration … is needed in the coming 15 years, in the order of US$10–100 billion per year' (IEA 2008: 1).

Looking beyond research and development to the financing needs of developing countries, the UNFCCC estimates that by 2030 additional global investment and financial flows of US$200 billion annually would be needed, with flows to developing countries in the order of US$100 billion annually to finance mitigation that leads to constraining emissions at 2030 to current levels (UNFCCC 2007a). While the bulk of these investment flows are expected to come from the private sector, until international carbon markets are established there will be greater reliance on public sector funding. The Group of 77 developing countries together with China have recently proposed that developed countries set aside 0.5 to 1 per cent of GNP 'to support action on mitigation and adaptation and technology development and transfer' (G-77 & China 2008).

Encouraging adequate global funding, ensuring equitable burden sharing, and deterring free-riding all contribute to making a strong case for embedding commitments to the international funding of climate change mitigation in an international agreement.

Such a commitment would apply only to high-income countries. This is consistent with the UNFCCC principle of 'common but differentiated responsibility'. It would reflect the burden the UNFCCC places on developed countries to meet mitigation costs in developing countries, and also the Bali agreement to scale up developing country mitigation action on the back of increased incentives from developed countries.

The Review therefore proposes that high-income countries support an **International Low-Emissions Technology Commitment**. This would require high-income countries to allocate a small proportion of GDP above a threshold to such purposes. They would commit to a specified funding level, but would retain flexibility in the use of funds. Funds could be spent domestically or abroad, through national or collaborative ventures.

Eligible expenditures under the Commitment would include public funding on low-emissions research and development; public funding on technology commercialisation (at a discount of, say, 2:1); and public funding to kick-start the mitigation efforts of developing countries, for example through technology transfer and support for reduction in forestry emissions. Much of the spending will be in high-income countries since that is where the technological breakthroughs are

more likely to be made. A significant portion would be in developing countries, for reasons of both equity and efficiency. Research and development, and especially commercialisation of new technologies, will sometimes be less expensive in developing countries, and private investors will sometimes choose a developing country location on cost grounds. A commitment to expend some minimum portion of the funding in developing countries, perhaps up to 50 per cent, but again with flexibility over modalities and priority areas, would help accelerate technological transfer, and strengthen the incentives for mitigation in developing countries.

Funding commitments would apply as a percentage of GDP above a certain threshold level of per capita income. The threshold for funding commitments could coincide with the threshold for classification in the high-income group of countries, so that a country just entering the group would initially have only minimal funding commitments.

The size of the International Low-Emissions Technology Commitment will need to be of the order of US$100 billion to accommodate both research and development requirements, and to finance commercialisation of low-emissions technologies in developing countries. As a broad illustration, take an annual global amount of US$100 billion and the World Bank high-income threshold of US$11 000 per capita. Then for 2007 GDP levels (at then current exchange rates) under this formula, the 50 richest countries (accounting for two-thirds of global GDP) would have contributed on average 0.24 per cent of their GDP to the Commitment.

Australia's 2007 share under the above formulation would have been $2.8 billion, or 0.26 per cent of GDP. Australia would commit the public sector (federal or state) to spend at least this amount on research, development and commercialisation of new low-emissions technologies. It could acquit the commitments at home or abroad. Expenditures abroad would help developing countries finance the technologies they need to contain emissions growth.

There is a strong argument for a steep ramping up of funding for low-emissions technology, given the urgency of mitigation, the fact that research and technology transfer will bring about a permanent reduction in mitigation costs, and the need to induce developing countries to participate. Commitments might come down in future years as and when market mechanisms become effective and technological breakthroughs are made.

Developing countries would need to agree to and comply with the commitments that would be expected from them under the next climate agreement in order to qualify as recipients of funds under the Commitment.[5] For the least developed countries, the expectation would only be to put in place a carbon penalty comparable to carbon pricing in developed countries on large emissions-intensive export industries. Most other developing countries would be expected in addition to take on one-sided targets.

How funding for the Commitment is secured would be left to individual governments. Countries with an emissions trading scheme or carbon tax could choose to earmark a portion of permit sales revenue or tax revenue towards this commitment.[6]

Expenditures under the Commitment would not be restricted to the stationary energy sector. It would also cover transport, and various forms of biosequestration: research into increasing carbon content of soils, forestry management, and the use of algae for biosequestration. It would also cover research into geo-engineering.

Of particular strategic interest to Australia is the development of near-zero emissions coal technologies and their transfer to developing countries. Australia should lead a global effort to develop and implement near-zero emissions coal technologies, such as carbon capture and storage, both building on our comparative advantage and addressing key national interest concerns. First, there will be direct economic implications for Australia, through reduced demand for coal, if these technologies are not developed and commercialised in a global low-emissions future (see Chapter 20). Australia will also be affected indirectly, through reduced demand for exports in general, if our trading partners, such as China, are unable to reduce emissions without reducing their own economic growth. Second, effective participation of major developing countries such as China, Indonesia and India is critical to the success of global mitigation. The participation of these countries would be made easier by the development of such technologies. Third, such technological development has important domestic effects, as it will not only obviate the need for structural adjustment packages to coal-dependent sectors or industries, but will also greatly ease Australia's own transition to a low-emissions economy.

10.2 International public funding for adaptation

Countries will experience climate change impacts differently, and hence adaptation will mean different things for different countries. For most poor countries, an important response to the adaptation challenge is economic growth (Schelling 1997), which will put greater resources at the disposal of both citizens and governments to respond to climate change. Along with education, economic growth will take people out of the sector that is most vulnerable to climate change—agriculture. Trade liberalisation will help countries adjust to shifting production opportunities. All of these are core development assistance objectives that would benefit developing countries even if there were no climate change, but that will also help them adapt to climate change.

Given the range of potential impacts and adaptive responses, it is difficult to calculate the costs and benefits of adapting to climate change in one country, let alone across the world. There is a wide range of estimates of required expenditure on adaptation in the literature, from $4 billion to $100 billion per annum (World Bank 2006b; Stern 2007; UNDP 2007; Oxfam 2007).

The similarities between the adaptation and development agendas mean that it makes no sense to force a division between the two.

The first adaptation requirement in all of Australia's developing country neighbours is basic scientific research on potential impacts. Elementary mapping of possible impacts and vulnerability has hardly begun in any of these countries. Some

aspects of the established development agenda will require an enhanced priority. For example, with projected increases in intensity of severe weather events, such as storm surges and cyclones, developing countries will need to improve their disaster mitigation and management capacities. In different contexts this may include developing building standards, early-warning systems or emergency response capacity. However, there is no need for a new adaptation architecture. The challenge is rather to make the existing aid architecture work better and to fully incorporate climate change adaptation considerations into decision making by including climate change information and impacts assessments in established development processes.

A number of funds have been established under the UNFCCC and the Kyoto Protocol that can support adaptation measures (Box 10.2), but they are small and are yet to prove themselves.

Box 10.2 Adaptation funds under the UNFCCC and the Kyoto Protocol

The **Least Developed Countries Fund** was established to assist least developed countries (as defined by the United Nations), of which there are 49, to design and implement National Adaptation Programmes of Action. It is funded through voluntary contributions, and pledges amount to US$120 million (GEF 2008a). Australia contributed $7.5 million to the fund in 2007.

The **Special Climate Change Fund** is designed to complement other funding and, while mitigation activities are within its scope, its top priority is adaptation. It is funded through voluntary contributions, and pledges currently total US$60 million (GEF 2008b). Australia is not currently a contributor to this fund.

The **Adaptation Fund** was established under the Kyoto Protocol. This fund has only just become operational. It is financed through a 2 per cent levy on certified emissions reductions (CERs) traded through the Clean Development Mechanism. The fund receives secretariat services from the Global Environment Facility, and the World Bank has been invited to become the trustee. The majority of its board members come from developing countries. Initial funding is unlikely to be available before 2010 (World Bank 2008b), when it is estimated that revenue from the levy will total US$80–300 million per year (UNFCCC 2007a). Projects in least developed countries are exempt from the levy.

The Review recommends that developed countries make a quantified commitment to providing adaptation support to developing countries. An **International Adaptation Assistance Commitment** would provide developing countries with an assurance that they will receive support in adapting, while allowing developed countries to retain flexibility over the delivery of their adaptation assistance.

Although adaptation assistance would, by its nature, be categorised as official development assistance, developed countries would need to ensure that funding

to meet their shares of the International Adaptation Assistance Commitment was additional and did not displace current and planned levels of development funding.

Adaptation funding requirements, while impossible to predict and quantify, will be significant. They are likely to increase steadily over time as impacts themselves develop over time. Australia and other developed countries should be prepared to increase their development assistance significantly as the understanding of impacts improves.

The new mitigation and adaptation commitments proposed by the Review would give developing countries incentives to participate more fully in the international climate change regime. Access to such funding should be conditional on developing countries fulfilling reasonable expectations on their contribution to mitigation efforts. Note that, as set out in Chapter 9, participation conditions would be minimal for the least developed countries.

Australia's development assistance has traditionally been focused on our immediate region, and in particular our near neighbours, through the South Pacific, Papua New Guinea, Timor-Leste and Indonesia. For the same geopolitical, humanitarian and historical reasons, Australia's adaptation assistance should retain this geographic focus. Australia should remain engaged in the broader region of Southeast Asia, China and South Asia, but there and globally an indirect role will often be more appropriate, such as through funding multilateral organisations. More generally, the Review recommends that Australia retain flexibility over the deployment of its adaptation support, and consider the full range of bilateral and multilateral channels. Australia should make its decisions on funding mechanisms based on which channels can most effectively deliver adaptation services, particularly to Australia's neighbours. Australia will need to improve its own international disaster response capacity, as we are likely to be increasingly called upon to respond to major natural disasters in the region that surpass local capacities.

The non-aid policies of developed countries are also important for helping developing countries adapt. For example, developed country policies that promote free trade, especially but not only in food, and the flow of unskilled labour, can assist adaptation. Developed country policies on security, peacekeeping and disaster response will also be important to help developing countries adapt if, as some predict (Collier et al. 2008), climate change leads to increased civil conflict.

The movement of people resulting from climate change could eventually be massive. While most of it is likely to be internal, it could spill over national borders. Australia's Pacific island neighbours are already seeking assistance for moving sections of their populations that are experiencing sea-level rise and saltwater inundation. It is too early to say whether at some future point in time it might be necessary for developed countries to create special classes of entry for residents of such climate-affected nations (so-called 'climate refugees'). A more immediate response would be to increase the adaptive capacity of small developing countries. For example, countries such as Australia and New Zealand have a role to play in helping to improve labour mobility in the region. This would strengthen international

private sector networks (diasporas), which in turn would help the Pacific island countries to grow and to diversify their risk. There is also likely to be an increased need for humanitarian assistance in response to projected increases in severe weather events, especially around the densely populated mega-deltas of South and Southeast Asia.

10.3 Promoting collaborative research to assist developing countries

While a price or cap on emissions will drive innovation in mitigation, and improved climate science will promote adaptation, developing countries often do not have the research capacity to turn these incentives into action. The importance of research for effective mitigation and adaptation suggests that a priority for international and Australian funding should be a collaborative research endeavour. An appropriate focus for such an effort would be the intersection between climate change, sustainable development and agriculture—for three reasons. First, agriculture is one of the sectors most vulnerable to climate change. Second, it is one of the most important sectors for developing countries. And finally, there is also significant mitigation potential in changed agricultural practices.

The Australian Centre for International Agricultural Research (ACIAR) (see Box 10.3) currently provides targeted funding to promote development-relevant agricultural research (including research on crops, livestock, fisheries, forestry, post-harvest technologies, agricultural development policy and the management of natural resources underpinning agriculture). Most of ACIAR's projects are bilateral—that is, they involve researchers from Australia and developing countries working together to solve problems of shared priority. ACIAR also funds multilateral research as part of an international research network. The coordinating body of the international research network, the Consultative Group for International Agricultural Research, recently began a process of expanding its research agenda to include climate change adaptation and mitigation. The Review recommends that the mandate of ACIAR be explicitly expanded to encompass climate change, in its biological, biophysical and social science dimensions. This would include research into, for example, the development of drought-resistant cultivars and biosequestration and could also extend to research into disaster response, and insurance. There are potential benefits in expanding the remit of ACIAR to include broader environmental issues, such as air quality and waste management, and the expansion should be reviewed by the ACIAR Commission.

Currently, a core objective of ACIAR is the development of local scientific capacity in developing countries, through collaborative research and pilot development projects with Australian scientific institutions. This should continue to be a strong focus, and the centre should consider future partnerships with other Australian research centres, such as the CSIRO Adaptation Flagship, the Climate Change Adaptation Research Facility based at Griffith University and the proposed Australian climate policy research institute (see Chapter 15).

ACIAR may also assist in translating climate projections into forms meaningful to local decision makers.

Impact assessments provide the foundation for effective adaptation planning and action. Many countries have established processes for medium- to long-term development planning, such as poverty reduction plans, and climate projections will need to be incorporated into these frameworks, and converted into policy options. Such planning should inform any research agenda. Research programs with a clear adaptation focus could be counted towards Australia's International Adaptation Assistance Commitment. Programs with a clear mitigation focus could be counted towards Australia's International Low-Emissions Technology Commitment.

The Consultative Group for International Agricultural Research is also proposing a number of governance and structural reforms. Such reforms should maintain the independence and decentralised nature of the group, while minimising bureaucracy and maximising collaboration.

Box 10.3 The Australian Centre for International Agricultural Research and the Consultative Group for International Agricultural Research

The Australian Centre for International Agricultural Research is a statutory authority that forms part of, and is funded by, Australia's aid program. ACIAR is a funding body, developing and managing bilateral and multilateral research projects relating to agriculture (including fisheries and forestry), with the goal of poverty reduction and sustainable development. The centre is also involved in the communication of research results. Its mandate includes a focus on the following five regions: Papua New Guinea and the Pacific Islands, Southeast Asia, North Asia, South Asia and Southern Africa.

ACIAR is the vehicle through which Australia funds its contribution to the Consultative Group for International Agricultural Research, an international network of 15 specialist agricultural and rural research organisations, established in 1971. The international network facilitates cross-border learning and utilises economies of scale in research.

10.4 International trade in emissions rights

10.4.1 Benefits and risks

Trading between countries in emissions rights is an integral part of the Review's proposed approach to mitigation. The agreed emissions targets would need only to hold in aggregate for the world, not at the level of each country. Some countries could emit above their allocations, buying emissions rights from other countries that in turn remain below their allocations. Indeed, it would be a natural development for countries with comparative advantage, after taking the external costs of emissions

into account, in production of emissions-intensive goods, to purchase permits in international markets alongside exporting large amounts of the goods.

International trading in emissions entitlements has several advantages:

- It reduces global abatement costs by ensuring that the cheapest abatement opportunities are sought out first, wherever they occur. Cost savings are greater when there are wide differences between participants' target commitments and abatement options, as in a scheme with broad international coverage. Estimates of aggregate cost reductions from global trade are in the range of 20–80 per cent (Stern 2008).
- A broader market can reduce price volatility, dilute country-specific shocks and provide greater certainty on the domestic costs of meeting a target.
- Trade will lead to a convergence of emissions prices across countries and provide a level playing field for trade-exposed, emissions-intensive industries.
- The revenues from international trade provide financial incentives for developing country commitments. Developing countries, with some lower-cost abatement options, can expect to reduce their emissions below their allocations, and sell the freed-up emissions rights. This is the principal direct incentive for developing countries to take on national targets, with developed countries acting as purchasers.[7]

International emissions trading also carries risks. Linking internationally is a form of shared sovereignty, which will imply some loss of control over aspects of mitigation policy. Fully linking into international markets means that the speed and amount of domestic economic adjustment are determined to a significant degree by the international price. Small and medium-sized countries, such as Australia, would lose control of the domestic price of carbon. While in general free trade is welfare promoting, for a government-created market, the resulting price might be too high or low relative to domestic perceptions of the optimal rate of mitigation. Linking can also be a cause of price volatility, for example if there were external policy instability. Risks can be reduced by limiting trading, as discussed below.

From these considerations, it is clear that the spread of international emissions trading offers great opportunities, but needs to be managed in a judicious and calibrated manner. Fully linked international markets are likely to emerge only over time.

Bilateral and regional trading and other forms of cooperation are natural stepping stones towards greater international integration. Such links are already being considered between existing and proposed emissions trading systems in Europe, North America, Australia, New Zealand and Japan, but could also occur between developed and developing countries. Links between individual developed and developing countries, or among groups of countries, will be easier to achieve than comprehensive global integration, and can build on established relationships. Developed countries will need to show leadership in their regions (see Box 10.4 in section 10.8 for potential for links between Australia, Papua New Guinea and Indonesia).

10.4.2 International trading options

Imposing restrictions on trading allows countries to retain greater control over domestic prices and abatement, although with higher overall costs of complying with a given commitment. Rules for allocating trading opportunities and the profit from price differentials have to be devised in this context. Under the Kyoto Protocol, there are unquantified limits on international trade under the supplementarity principle of Article 17. The greater the trust a country has in the international system, the less it will want to resort to limits. As a result, in Chapter 14, the Review suggests limits in the Australian emissions trading scheme on the use of international offsets, but not emissions permits, from markets that meet quality standards.

Direct trading through private firms provides flexibility and is likely to lower transaction costs, especially when trade involves firms from countries with national emissions trading systems. But trading can also occur through government gateways, which would introduce the option to impose conditions on the use of international payments. For example, to make financial transfers more acceptable in permit-buying countries, buyers could require that the revenue be used for climate- and development-related purposes in permit-selling developing countries. Any such arrangements would be negotiated between the parties involved in trade.

A fundamental prerequisite for selling permits is transparent monitoring that complies with standards accepted by the international community and in particular by the main permit buyers. With international trading, incentives to under-report emissions are heightened. An international authority, possibly under the auspices of the UNFCCC, would have to assess whether minimum standards are met, similar to existing procedures under the Kyoto Protocol.

Each country would be able to determine the countries with which it would trade, to protect the integrity of its own domestic system. The scope for selectivity, however, is limited by indirect linking. For example, if Australia links to New Zealand, and New Zealand links to other countries, then Australia's market is effectively also linked to all of New Zealand's partners. Indirect linking will accelerate the tendency towards a similar permit price across countries.

Specific recommendations for how Australia should go about international linking based on consideration of these general options are provided in Chapter 14.[8]

10.4.3 International offset credits

International trading can also occur in offset credits. These involve credits for emissions reductions claimed where no overall national commitment applies. Under the Kyoto Protocol, most international trading is in offset credits derived from the Clean Development Mechanism (CDM).

The CDM has facilitated some developing country engagement in mitigation, but suffers from important limitations. Expanding the CDM beyond its project-by-project basis is currently being considered in the UN process. As discussed in Chapter 9, broad coverage of emissions sources with a safeguard for developing

countries is achieved better through one-sided targets than through an expanded CDM. A one-sided target allows the quantitative commitment to be set according to agreed principles, without arbitrarily determining counterfactual baselines. One-sided targets allow for commitments below business-as-usual emissions that can nevertheless benefit developing countries through sales of emissions rights, while providing the safeguard of opting out.

Strong global mitigation will require emissions containment in developing countries in addition to (rather than in substitution for) emissions reduction in developed countries. This can only be provided by developing countries accepting national targets, and not through sales of permits within the CDM. This is increasingly recognised internationally, including by the European Union, to date the principal backer of the CDM.[9]

If this framework were adopted, offset mechanisms would only have a role where there were no national commitments. The CDM would be left as a transitional mechanism to apply in countries without one-sided targets. To remove disincentives for taking on national commitments, no new CDM projects should be accepted from countries that are expected to take on targets (see Chapter 14). In addition, implementation rules for the CDM would need to be strengthened to ensure a high standard of environmental integrity. Countries purchasing CDM credits may also decide to place quantitative or qualitative limits on purchases.

10.5 Price-based sectoral agreements for the trade-exposed, emissions-intensive sectors

Unless large producers the world over face a similar emissions price, there is a danger of artificial movement of production in emissions-intensive industries producing tradable goods from countries applying strong mitigation measures to others. This could have adverse environmental and economic effects. The fear of 'carbon leakage'—a loss of competitiveness and relocation of trade-exposed, emissions-intensive industries as a result of carbon penalties applying in some countries but not others—has been a powerful obstacle to domestic mitigation policies in many countries.

This fear can be exaggerated. Firms in different countries face very different cost structures already, in part due to differing government policies. To the extent that firms enjoy rents—and many have recently seen large increases in output prices—firms will be able to absorb carbon penalties without any adjustment (Lockwood & Whalley 2008). One country's imposition of carbon taxes or an emissions trading scheme without exclusion or compensation for trade-exposed, emissions-intensive industries would tend to lower its real effective exchange rate, offsetting the initial impact on competitiveness for some firms, and absolutely improving competitiveness relative to the prior position for others.

Australian producers of liquefied natural gas have drawn attention to the distortion that might arise from Australia but not its developing country competitors applying a price to carbon. This potential distortion would be substantially less than

many differential features of fiscal regimes, for as far into the future as we can see. For example, differences in royalty-like charges affecting costs at the margin, and favourable to Australian producers, would generally be larger than any likely effects of carbon pricing.

Nevertheless, carbon leakage can be a real problem, and one that creates powerful domestic opposition to attempts to impose economy-wide carbon prices.

Countries implementing domestic policies are considering various ways to offset competitive disadvantages to their trade-exposed, emissions-intensive industries—for example, by allocating free emissions permits under emissions trading, or by applying border taxes.[10] Domestic compensation causes difficulties in implementation of domestic climate policies. Chapter 14 describes an optimal arrangement for avoiding carbon leakage without introducing new sources of distortion. This is recommended for Australia, and could usefully be applied elsewhere.

There is a good deal of current interest in developed countries in border tax adjustments. Even if compliant with World Trade Organization rules developed for the purpose (section 10.6), these can only ever be a backstop to international climate change agreements.

To avoid the need for potentially distorting domestic and trade solutions in response to the carbon leakage problem, comparable emissions pricing needs to apply to most or all of the main producers in trade-exposed, emissions-intensive industries. Effective economy-wide emissions pricing commitments for all relevant countries would be the best solution. But not all relevant countries will take on such commitments for some time. The next most straightforward mechanism to achieve a comparable carbon price is sectoral agreements that cause each government to subject the main producers in each industry producing emissions-intensive tradable goods to a carbon tax, until the country has an effective national emissions limit.[11]

An agreement about taxes does not itself allow differentiation of commitments between countries. This is not necessary in the case of the trade-exposed, emissions-intensive sectors. Producers are part of a global market. Domestic governments would keep the revenue, giving them a fiscal incentive to implement the agreement. Access to global climate funds for developing countries could be made conditional on their taking part in relevant international sectoral agreements.

Only a small number of countries would need to be involved in the key industrial sectors to achieve broad coverage. Industries that are often mentioned in the international discussion as candidates for sectoral agreements include iron and steel, aluminium, chemicals, cement, and paper and pulp. The bulk of emissions from developing countries in these sectors arise from just a few countries. To cover 80 per cent or more of developing country emissions in each sector, just three developing countries would need to be involved in iron and steel; four each in aluminium smelting and pulp and paper making; seven in cement production; and nine in chemicals and petrochemicals (Schmidt et al. 2006).[12] From Australia's perspective, additional sectors of interest are non-ferrous metals beyond aluminium, alumina, liquefied natural gas, and the products of sheep and cattle.

Price-based agreements would require agreement on the tax rate for countries not operating under UN-compliant economy-wide commitments. The tax rate would be set as an average of a basket of domestic emissions trading systems; or pegged to the price prevailing in one of the major developed country emissions trading markets (such as the European Union, Australian, or in future North American or East Asian markets).

In some industries, notably aluminium smelting and some steel production, indirect emissions in generating electricity would need to be taken into account. These emissions could be assessed according to a simple and robust approximation, based on the emissions intensity of the systems from which they draw their power, and made subject to the sectoral emissions tax. Indirect or embodied emissions that fell below a threshold would not be considered, in the interest of simplicity.

Appropriate regulatory and governance structures would need to be agreed, starting with a small number of the most important producing countries. Provisions would have to be reviewed periodically and implementation monitored by an international body.

Effective sectoral agreements could and should be struck quickly, as they are relatively straightforward and are important to help facilitate strong mitigation policies in many countries including Australia. A 2013 start date for sectoral agreements should be the goal, directly following the Kyoto Protocol's first commitment period. If coordination among candidate countries begins immediately, there is a good chance to have some agreements in place by then.

It would naturally fall to the large producing countries, in particular developed countries including Australia, to take leadership in crafting agreements among the major producers in each industry sector. To motivate the case for sectoral agreements, policy makers the world over need to understand that comprehensive emissions pricing for trade-exposed industries does not distort the optimal economic location of production of emissions-intensive tradable goods, once environmental externalities have been taken into account. If production moves elsewhere because doing so is cheaper after carbon is priced, this is economically and environmentally efficient restructuring, and should not be discouraged.

10.6 Climate change and trade policy

The links between climate and trade policy are receiving increasing attention. In December 2007, the Indonesian Government convened the first meeting on climate change of trade ministers from major economies in conjunction with the Bali Climate Change Conference.

Trade barriers to the diffusion of low-emissions technologies, and of goods and services embodying them, reduce the technologies' impact. Liberalisation of low-emissions technologies markets can be pursued unilaterally and through multilateral channels (World Bank 2008a). In December 2007, the European Union and the United States introduced a proposal to give priority in the World Trade

Organization negotiations to liberalisation of climate-friendly goods and to services linked to addressing climate change (WTO 2008). The principle is a sound one. The proposal would have been better if it had been comprehensive. The EU–US list does not include ethanol, an important exclusion, as ethanol production receives large domestic subsidies or protection in many countries, including Australia, as well as the European Union and the United States. Neither does it include motor vehicles, despite the interest that all countries have in rapid diffusion of low-emissions innovations in this sector.

The most contentious climate change issue in trade policy is whether countries should be allowed to impose border adjustments if they introduce carbon pricing ahead of others. Two rationales are suggested for such action. The first is to compensate domestic industries for a loss of competitiveness. The second is to apply pressure to other countries to impose similar policies.

The European Union proposal for the post-2012 EU emissions trading scheme and several of the climate change legislative drafts in the United States have flagged provisions for countervailing tariff measures. Economist Joseph Stiglitz (2006) has endorsed this line of action. The Review shares the concern of those who note that such moves may open the doors to protectionism and trade disputes (Bhagwati & Mavroidis 2007).

As the Director-General of the WTO, Pascal Lamy, recently commented, imposing taxes on imports to penalise countries with looser emissions controls would be a 'distant second-best to an international solution' on climate change (Point Carbon 2008). The global community has a strong interest in avoiding pressures for border taxes by moving sooner rather than later to the international agreements that avoid distortions in investment and production in trade-exposed, emissions-intensive industries. Nevertheless, if an international solution is not forthcoming, the pressure, and indeed the case, for border adjustments will grow.

Border adjustments could be imposed unilaterally. It is likely that the WTO would be open to the use of certain trade measures in support of climate change objectives (WTO 2008). Any unilateral adjustments would, however, certainly be appealed and lead to a 'long period of uncertainty and trade frictions' (Hufbauer & Kim 2008: 35).

The alternative course of action, recommended by the Review, is to work for a new WTO code on the subject (Hufbauer & Kim 2008). Such a code would provide a framework within which countries could impose border adjustments, and would greatly reduce the likelihood of the imposition of climate change–justified border adjustments degenerating into a trade war. It would give countries the right to impose adjustments on products in relation to competitors that do not impose comparable mitigation regimes (either economy-wide through national targets, or sector-specific through price-based sectoral agreements). Support for such a code would need to be unanimous. Developing countries have resisted modifications to WTO provisions on environmental grounds, but, given combined EU–US leadership, the credible threat of unilateral responses if no agreement were reached, the other incentives for cooperation on climate change, and the strong United Nations role

in the emerging international mitigation regime, an agreement may be possible, though it would probably take several years to forge.

Pending such a global agreement, it would be undesirable for border adjustments to be imposed unilaterally by any country, because of the risks that they would pose to global trade. Rather, if there were a need for unilateral adjustment (due to an absence of global agreements), it would be better to provide domestic payments in WTO-consistent forms to firms.

10.7 International aviation and shipping

Emissions from international air traffic and maritime transport, or 'bunker fuel' emissions, constitute a relatively small share of global fossil fuel emissions (about 1.5 per cent and 2 per cent respectively). But emissions from international aviation grew by 2.7 per cent annually over 2000–05, and shipping emissions, though harder to measure, are estimated to have grown by 3.1 per cent per year (IEA 2007). Both, and especially civil aviation, are expected to increase rapidly their shares of global emissions as incomes and international movements of goods and people rise under business as usual. At present, emissions from the international aviation and maritime transport sectors are not regulated under the UNFCCC or the Kyoto Protocol, due to difficulties of attribution and concerns about competitiveness.

The simplest way to incorporate these two sectors into an international mitigation regime would be to treat them as emissions-intensive, trade-exposed sectors. Emissions from these two sectors should be included against national limits[13] or subject to a comparable carbon tax.[14] Emissions would be attributed to countries on the basis of fuel purchase, and the fuel-supplying country would retain the revenue raised from the tax.

Most freight ships are registered in developing countries but owned by companies in developed countries (UNFCCC 2007b). This makes a sectoral agreement particularly important for shipping. Getting broad coverage may be harder than for aviation, as ships can bunker large amounts of fuel, and have manifold options to refuel. Allowing countries to retain the revenue from any tax would give a positive incentive for enforcement.

For aviation, imposition of a fuel tax might require an amendment to the Convention on International Civil Aviation. Aviation has a range of non-carbon dioxide climate impacts, such as the emission of nitrogen oxides and the formation of condensation trails and cirrus clouds. The IPCC (1999) estimated that total radiative forcing effects from aviation are about two to four times greater than those of the carbon dioxide from burning jet fuel alone. Measurement is complex and uncertain, and this issue may best be addressed after the establishment of an initial sectoral agreement.

10.8 Land-use change and forestry

Emissions from land-use change and forestry (LUCF) include emissions from the removal of forests (deforestation) and their creation (afforestation and reforestation), as well as emissions from the management of forests (for example, through forest degradation or thickening). LUCF emissions differ in a number of ways from energy and industrial emissions. They are concentrated in the developing world because of deforestation, are difficult to estimate, and can be negative (when a forest grows and carbon is sequestered) as well as positive.

In the last few years emissions from tropical deforestation have received increased attention as a potentially important element of global mitigation, spawning interest in mechanisms for reducing emissions from deforestation and degradation (REDD).

- LUCF emissions are larger than earlier thought. The IPCC (2007) roughly estimates annual global LUCF emissions to be some 17 per cent of total emissions—more than the entire global transport sector.
- Reducing LUCF emissions in many instances would be relatively inexpensive. The Stern Review (2007: 245) found that the cost of halting deforestation in eight countries responsible for 70 per cent of LUCF emissions 'would amount to around US$5–10 billion annually (approximately US$1–2/t$CO_2$ on average)'. The World Bank (2006a) also found very low potential abatement costs, with dense tropical forests in Latin America cleared for economic gain amounting to just US$1–3 per ton of CO_2 released. Not all studies suggest such low costs. The opportunity cost of preserving forests varies greatly between sites, and is increasing with rising food and energy prices where conversion to food crops or oil palm plantations is the competing land use. However, the message that 'forestry can make a very significant contribution to a low-cost global mitigation portfolio' (IPCC 2007: 543) is sound.
- The current international regime gives limited rewards for reductions in LUCF emissions, and does little to foster sequestration. Developed countries are required to include emissions from deforestation, reforestation and afforestation (under Article 3.3 of the Kyoto Protocol) and can include other changes in land-based carbon stocks (under Article 3.4) if they choose. But most LUCF emissions are in developing countries. The CDM has no scope for credits gained by reducing deforestation. Credits can be received for establishing forests, but the rules around these are restrictive, and few forest-related CDM projects have been undertaken.

A number of proposals have been put on the table. They take either a national, a sectoral or a project-based approach.

- The simplest framework for reducing LUCF emissions in developing countries would be for those countries, like developed countries, to take on national emissions reduction commitments, and include LUCF emissions in that commitment. If developing countries bring emissions below target, as they would be expected to do, they would be able to trade their excess permits on world markets.
- The sectoral approach would establish separate baselines only for LUCF emissions. There are a large number of proposals that take such a sectoral approach to reduce LUCF emissions in developing countries (see Terrestrial Carbon Group (2008) for a recent proposal from an Australian group, and Hare and Macey (2007) for a survey). As with the national approach, countries would be rewarded if they achieved or came under their LUCF targets. The financial payments could be through either a market mechanism or public funding.
- The project approach would work along the lines of the CDM and reward developing countries for reductions in emissions from a baseline at the project level. For example, if a particular at-risk forest were conserved, an attempt would be made to calculate the saving in emissions.

The many arguments against the efficacy of the CDM approach all apply with greater force in the case of forestry (Forner et al. 2006). It appears neither desirable nor likely for such credits to gain widespread acceptance in international markets.

Sectoral approaches could be attractive to developing countries opposed to country-wide commitments. The quarantining of LUCF from other emissions is attractive given the uncertainties around reducing emissions from deforestation, but comes at the price of additional complexity. It is also far from clear which, if any, of the various competing sectoral approaches could command a consensus.

The national approach would require minimal institutional innovation, and is consistent with a simple, comprehensive approach to abatement. Chapter 9 argued that most developing countries should be given one-sided targets. Opt-out provisions could be particularly important for countries that have large LUCF emissions, and which present large but very uncertain abatement options. Bilateral or regional agreements might be required on the use of trading revenue, for example to allay concerns about displacing rural livelihoods. Averaging over time, and perhaps insurance mechanisms, would be needed to allow smoothing over base periods and commitment periods.

Note that a national approach would not commit developing country governments to introduce a domestic emissions trading scheme. Indeed, applying an emissions trading scheme to the forestry sector would probably not be appropriate for most developing countries. Instead, countries would be well advised to use a mix of regulatory and fiscal measures to help maintain or increase forest cover.

Whichever approach were taken, any serious national effort to reduce LUCF emissions would have to overcome three main challenges.

- **LUCF emissions are difficult to measure**—Measuring emissions from forest management and degradation is particularly difficult. Transparent monitoring systems would be essential if claimed emissions reductions were to provide the basis for financial flows. Ongoing emissions from cleared land (such as from the burning of dried-out peat) can also be large, but even more difficult to measure.
- **Many developing country governments lack the policy mechanisms to reduce LUCF emissions**—In many countries the government's control over the forestry sector is limited. Deforestation might be driven by subsistence agriculture or by illegal logging (for a survey of global forestry policy issues and mechanisms, see World Bank 2006a). Governments will need to develop realistic and implementable strategies for increasing forest cover, including through better forest management as well as reduced land clearing, and reforestation.
- **Logging is an export business subject to carbon leakage**—Reducing logging and LUCF emissions in one country could lead to increased logging and emissions in another. Ultimately, for success, a comprehensive approach covering all major forestry emitters is required.

Although most LUCF emissions are in developing countries, developed countries have a critical role to play. Apart from increasing sequestration within their own borders, they can help with emissions monitoring, and can provide funding to developing countries. Most importantly, they can kick-start action on a bilateral basis. Given the contentious and complex nature of the issue, it is possible that a satisfactory agreement on forest-related emissions will be several years in the making. In the interim, bilateral initiatives and regional cooperation will be particularly important. Given its neighbourhood, Australia's regional initiatives will have a focus, albeit not exclusive, on forestry (Box 10.4). Progress will require developed countries, including Australia, to commit significant resources for emissions reductions that may have no formal international status for the time being.

Box 10.4 Regional partnerships for Australia: the potential for links with Papua New Guinea and Indonesia

Chapter 8 outlined the important role regional partnerships could play in promoting international action on climate change and especially how they could build trust and confidence between developed and developing countries.

Australia has the opportunity to develop such an approach with its neighbours, in particular Indonesia and Papua New Guinea. Both have expressed interest at the highest level in cooperation with Australia on climate change policy.

Box 10.4 Regional partnerships for Australia: the potential for links with Papua New Guinea and Indonesia *(continued)*

While there is a high level of uncertainty around the data, Indonesia's emissions are thought to amount to as much as two Gt CO_2 per year, around five times Australia's total CO_2 emissions, with over three-quarters of that from deforestation (WRI 2008). According to one source, emissions from fires in peat land in Indonesia alone are estimated to be about 1800 Mt per year, about three times Australia's total emissions (Hooijer et al. 2006: 29). Papua New Guinea's annual LUCF emissions may exceed 100 Mt CO_2 (WRI 2008), a quarter of Australia's total CO_2 emissions. Both countries would have a strong interest in reducing emissions from deforestation, provided they were compensated for the loss of economic opportunity such as through the sale of rights on an international market.

Ultimately, it is desirable for both Indonesia and Papua New Guinea to be linked to Australia's emissions trading scheme and to be able to trade any reduction in emissions below their national target levels with the Australian Government or market participants. This would benefit both sides: the financial flows would benefit Indonesia and Papua New Guinea, while Australia would benefit from access to low-cost abatement options. For Indonesia, such deep integration with a large emitting country would be achieved best within larger regional arrangements involving other developed countries, with Japan and New Zealand the obvious first candidates. For such a link to become a reality, important preparatory work has to be completed. Work in several of these areas is already under way under Australia's International Forest Carbon Initiative.

- **Emissions estimation**—Current estimates of LUCF emissions are often highly contested. More accurate estimation of LUCF emissions is needed, not only from land clearing but also from forest management (and degradation) and from post-forest-clearance (for example, emissions from dried-out peat lands).
- **LUCF emissions-reduction strategies**—Reducing LUCF emissions will be a challenging task. The drivers of LUCF emissions include subsistence farming, illegal logging and poor governance. Developing a strategy that will tackle these drivers, bring benefits to local communities and promote forest regeneration and reforestation will not be straightforward.
- **Other low-emissions options**—Reducing LUCF emissions would be central to the Australia–Indonesia and Australia – Papua New Guinea partnerships, but should not be the sole goal of the partnerships. Papua New Guinea has excellent hydro potential, for example.

10.9 Enforcement mechanisms

The Kyoto Protocol has an enforcement mechanism that can be activated for breaches of greenhouse gas accounting or emissions target obligations. If a country does not meet its target, it has to make up the shortfall in the next commitment period with a 30 per cent penalty. This is a weak enforcement mechanism if subsequent commitment period targets are not defined in advance.

The problem of enforcing commitments is part of a more general problem of encouraging effective participation, regarded by some as the Achilles' heel of international efforts. In a world of sovereign states, countries cannot be forced to sign agreements, or to meet their commitments. In order to get countries to participate meaningfully, incentives must be designed so that participation is in the self-interest of each nation. All countries share an interest in reducing the risks of dangerous climate change. Several other sorts of incentives will be important.

- International trade in permits and offsets and access to international public mitigation and adaptation financing (under the proposed International Low-Emissions Technology Commitment and International Adaptation Assistance Commitment) will provide financial incentives for developing countries.
- Trade sanctions have been proposed by some as an enforcement mechanism. As discussed above (section 10.6), border adjustments to take into account differential mitigation regimes have a role to play in a world where some countries are moving faster than others on mitigation, but only once a framework has been developed and agreed under the World Trade Organization.

Enforcement requires monitoring. Under the UNFCCC and Kyoto Protocol, countries are required to produce reliable accounting (annual inventories) of their greenhouse gas emissions. Countries must also have a national registry to account for their emission credits. Teams of experts, selected from a roster of individuals nominated by the Protocol parties, check annual inventories for accuracy and completeness. If there is a dispute between the team and the party, the Protocol's Compliance Committee may intervene. The current system provides a solid foundation on which to build. As the number of countries subject to national emissions goals increases, the need for rigorous and robust monitoring will grow.

Notes

1 The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007: 20) found: 'Government funding in real absolute terms for most energy research programmes has been flat or declining for nearly two decades (even after the UNFCCC came into force) and is now about half of the 1980 level'. The IPCC (2007: Chapter 13) reports that OECD energy research and development has been below US$10 billion per year since the early 1990s (in 2004 prices and exchange rates) and that research and development budgets for renewable energy exceeded US$2 billion (in 2004 prices and exchange rates) in the late 1970s and early 1980s but have been well below US$1 billion since the mid-1980s.

2 Jagdish Bhagwati (2006) has called for 'subsidising the purchase of environment-friendly technologies by the developing countries'. Larry Summers (2007) has recommended 'the provision of subsidised capital for projects that have environmental benefits that go beyond national borders'.

3 The G7 comprises Canada, France, Germany, Italy, Japan, the United Kingdom and the United States.

4 Popp (2004) estimates annual energy efficiency research and development requirements at only US$13 billion in 2005, rising to US$33 billion in 2055, but the mitigation strategy he models is mild. It allows global temperatures to increase by more than 3°C.

5 The February 2008 statement by the UK, US and Japan governments indicated that the World Bank funding would support 'developing countries that undertake energy sector and climate related policy actions consistent with a low carbon growth trajectory' (Paulson et al. 2008). More explicitly, the United States has stated that it 'believes countries seeking access to the fund should be undertaking credible national plans to limit greenhouse gases and have those plans reflected in a post-2012 climate change agreement' (White House 2008).

6 It has been proposed that technology transfer commitments should be eligible for offsets (Forsyth 1999). Quite aside from its complexity, such an approach would miss the point that this commitment is in addition to an emissions reduction commitment.

7 A similar argument goes for the issue of excess Kyoto permits from Russia and some Eastern European countries, sometimes referred to as 'hot air'. Targets for these countries were negotiated knowing that emissions had fallen dramatically as a result of economic collapse and industrial restructuring in the 1990s, and were an incentive for Russia and others to join the Kyoto Protocol. Trading units from these countries for compliance elsewhere is in the logic of the agreement.

8 See Appendix 2 of Garnaut (2008) for a fuller exposition of these options.

9 The EU's Head of Emissions Trading, Yvon Slingenberg, recently signaled that the European Union wants a 'gradual shift from offsetting to cap and trade', with emissions cuts becoming 'more the contributions of developing countries' (Wynn 2008).

10 The European Union attempts to solve the problem by allocating free permits. Under the post-2012 phase III of the EU emissions trading scheme, it is proposed that affected sectors receive up to 100 per cent of their allowances for free, depending on the extent to which the industries are covered by an international agreement. The European Union has also flagged the possibility that tariffs may be used to neutralise any distorting effects from imports (European Commission 2008).

11 Sectoral agreements have received greatly increased attention recently and are explicitly mentioned in the Bali Roadmap. The various approaches raised in the international discussion (for example, Baron et al. 2007; Bradley et al. 2007; Egenhofer & Fujiwara 2008; Schmidt et al. 2006) are for more complex and less comprehensive schemes. Many revolve around best practice or technology standards, and therefore result in incentives applying only to low-efficiency operations within each technology. Choosing the benchmarks and how they should develop through time is fraught with difficulty. Other proposals are for offset credits from specific sectors, but they present the same problems as the CDM. Comprehensive coverage could be achieved by separate international emissions trading schemes for specific sectors, but this would require negotiating targets in the absence of any obvious principles for allocating them and determining what each sector's cap should be.

12 The actual analysis is in terms of countries that are not in Annex I of the UNFCCC.

13 The European Union has proposed bringing aviation into its emissions trading scheme, with coverage of emissions from flights within as well as from and to the EU. Many non-EU states, however, are opposed to this proposal. An approach agreed to by a number of countries through international negotiations would have a greater chance of success.

14 Such an approach is likely to be more achievable in the short term than negotiating the sector's own version of a trading scheme, not least because of the lack of basis for setting targets. The International Civil Aviation Organization is, however, working on an emissions trading system for international civil aviation (ICAO 2008).

References

AFP 2008, 'G7 calls for investment to fight climate change', AFP, 9 February, Tokyo, <http://afp.google.com/article/ALeqM5gc8JEW4bcoTUnJcCKemRD-iJprWg>.

Baron, R., Reinaud, J., Genasci, M. & Philibert, C. 2007, *Sectoral Approaches to Greenhouse Gas Mitigation: Exploring issues for heavy industry*, IEA Information Paper, IEA, Paris.

Barrett, S. 2003, *Environment and Statecraft: The strategy of environmental treaty-making*, Oxford University Press, New York.

Bhagwati, J. 2006, 'A global warming fund could succeed where Kyoto failed', *Financial Times*, 16 August.

Bhagwati, J. & Mavroidis, P.C. 2007, 'Is action against US exports for failure to sign Kyoto Protocol WTO-legal?' *World Trade Review* 6(2): 299–310.

Bosetti, V., Carraro, C., Massetti, E. & Tavoni, M. 2007, *Optimal Energy Investment and R&D Strategies to Stabilise Greenhouse Gas Atmospheric Concentrations*, Fondazione Eni Enrico Mattei, Milan.

Bradley, R., Baumert, K.A., Childs, B., Herzog, T. & Pershing, J. 2007, *WRI Report—Slicing the pie: sector-based approaches to international climate agreements—issues and options,* World Resources Institute, Washington DC.

Carmody, J. & Ritchie, D. 2007, 'Investing in clean energy and low carbon alternatives in Asia', Asian Development Bank, Philippines, <www.adb.org/Documents/Studies/Clean-Energy-and-Low-Carbon-Alternatives-in-Asia/clean-energy-low-carbon-alternatives-in-asia.pdf>.

Collier, P., Conway, G. & Venables, T. 2008, *Climate Change and Africa*, Oxford University, <http://users.ox.ac.uk/~econpco/research/pdfs/ClimateChangeandAfrica.pdf>.

Egenhofer, C. & Fujiwara, N. 2008, *Global Sectoral Industry Approaches to Climate Change: The way forward*, Centre for European Policy Studies, Brussels.

European Commission 2008, 'Questions and answers on the Commission's proposal to revise the EU emissions trading system', press release dated 23 January.

Forner, C., Blaser, J., Jotzo, F. & Robledo, C. 2006, 'Keeping the forest for the climate's sake: avoiding deforestation in developing countries under the UNFCCC', *Climate Policy* 6: 275–94.

Forsyth, T. 1999, 'Flexible mechanisms of climate technology transfer', *Journal of Environment and Development* 8(3): 238–57.

Garnaut, R. 2008, *Emissions Trading Scheme Discussion Paper*, <www.garnautreview.org.au>.

GEF (Global Environment Facility) 2008a, 'The Least Developed Countries Fund', <www.gefweb.org/interior.aspx?id=194&terms=ldcf>.

GEF 2008b, 'The Special Climate Change Fund (SCCF)', <www.gefweb.org/interior.aspx?id=194&terms=ldcf#id=192&ekmensel=c57dfa7b_48_60_btnlink>.

G-77 & China 2008, 'Financial mechanism for meeting financial commitments under the Convention', submission to the Third Session of the Ad Hoc Working Group on Long-term Cooperative Action under the UNFCCC, Accra, 21 August to 27 August, <http://unfccc.int/files/kyoto_protocol/application/pdf/g77_china_financing_1.pdf>.

Hare, B. & Macey, K. 2007, *Tropical Deforestation Emission Reduction Mechanism: A discussion paper*, Greenpeace.

Hooijer, A., Silvius, M., Wösten, H. & Page, S. 2006, *PEAT-CO_2: Assessment of CO_2 emissions from drained peatlands in SE Asia*, Delft Hydraulics Report Q3943.

Hufbauer, G.C. & Kim, J. 2008, 'Reconciling GHG Limits with the Global Trading System (draft)', Peterson Institute for International Economics, Washington DC.

ICAO (International Civil Aviation Organization) 2008, 'Environment', Environmental Unit: Air Transport Bureau, <www.icao.int/icao/en/env/index.html>.

IEA (International Energy Agency) 2007, *World Energy Outlook 2007: China and India insights*, IEA, Paris.

IEA 2008, *Energy Technology Perspectives 2008: Fact sheet—the blue scenario*, IEA, Paris.

IPCC (Intergovernmental Panel on Climate Change) 1999, *Aviation and the Global Atmosphere*, J.E. Penner, D.H. Lister, D.J. Griggs, D.J. Dokken & M. McFarland (eds), Cambridge University Press, Cambridge.

IPCC 2007, *Climate Change 2007: Mitigation of climate change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, B. Metz, O.R. Davidson, P.R. Bosch, R. Dave & L.A. Meyer (eds), Cambridge University Press, Cambridge and New York.

Kammen, D.M. & Nemet, G.F. 2005a, 'Real numbers: reversing the incredible shrinking energy R&D budget', *Issues in Science and Technology*, National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and University of Texas at Dallas, Dallas, pp. 84–8.

Kammen, D.M & Nemet, G.F. 2005b, 'Supplement: estimating energy R&D investments required for climate stabilization', <www.climatetechnology.gov/stratplan/comments/Kammen-1.pdf>.

Köhler, J., Grubb, M., Popp, D. & Edenhofer, O. 2006, 'The transition to endogenous technical change in climate–economy models: a technical overview to the innovation modeling comparison project', *Energy Journal: Special issue*, <www.econ.cam.ac.uk/research/imcp/technicaloverview.pdf>.

Lockwood, B. & Whalley, J. 2008, *Carbon Motivated Border Tax Adjustments: Old wine in green bottles*, Working Paper 14025, National Bureau of Economic Research, Cambridge, Massachusetts.

Oxfam 2007, *Adapting to Climate Change: What's needed in poor countries, and who should pay*, Oxfam Briefing Paper.

Paulson, H., Darling, A. & Nukaga, F. 2008, 'Financial bridge from dirty to clean energy', *Financial Times*, 7 February.

Point Carbon 2008, 'EU border tax "a distant second" to global deal: WTO chief', <www.pointcarbon.com/news/1.931067>.

Pontin, J. 2007, 'Vinod Khosla: a veteran venture capitalist's new energy', *MIT Technology Review*, March/April, <www.technologyreview.com/Energy/18299/>.

Popp, D. 2004, *R&D Subsidies and Climate Policy: Is there a 'free lunch'?* Working Paper 10880, National Bureau of Economic Research, Cambridge, Massachusetts.

REEEP (Renewable Energy and Efficiency Partnership) 2008, 'Mission', REEEP, Vienna, <www.reeep.org/511/mission.htm>.

Schelling, T.C. 1997, 'The cost of combating global warming: facing the tradeoffs', *Foreign Affairs* 76(6): 8–14.

Schelling, T.C. 2002, 'What makes greenhouse sense?' *Foreign Affairs* 81(3): 2–9.

Schmidt, J., Helme, N., Lee, J. & Houdashelt, M. 2006, *Sector-Based Approach to the Post-2012 Climate Change Policy Architecture*, Future Actions Dialogue Working Paper, Center for Clean Air Policy, Washington DC.

Stern, N. 2007, *The Economics of Climate Change: The Stern Review*, Cambridge University Press, Cambridge.

Stern, N. 2008, *Key Elements of a Global Deal on Climate Change*, LSE, London.

Stiglitz, J. 2006, 'A new agenda for global warming', *Economist's Voice*, <www.bepress.com/ev>.

Summers, L. 2007, 'Practical steps to climate control', *Financial Times*, 28 May.

Terrestrial Carbon Group 2008, *How to Include Terrestrial Carbon in Developing Nations in the Overall Climate Change Solution*, <www.terrestrialcarbon.org>.

UNDP (United Nations Development Programme) 2007, *Human Development Report 2007/2008. Fighting Climate Change: Human solidarity in a divided world*, Palgrave Macmillan, New York.

UNFCCC (United Nations Framework Convention on Climate Change) 2007a, *Investment and Financial Flows Relevant to the Development of an Effective and Appropriate International Response to Climate Change*, UNFCCC, Bonn.

UNFCCC 2007b, *Submission from Government of Norway on Emissions from Fuel Used for International Aviation and Maritime Transport*, UNFCCC, Bonn.

White House 2008, 'Increasing our energy security and confronting climate change through investment in renewable technologies', White House fact sheet, 5 March, <www.whitehouse.gov/news/releases/2008/03/20080305-2.html>.

World Bank 2006a, *At Loggerheads? Agricultural expansion, poverty reduction, and environment in the tropical forests*, Policy Research Report, World Bank, Washington DC.

World Bank 2006b, 'Clean energy and development: towards an investment framework', paper produced for the Development Committee Meeting, DC2006–0002, 23 April.

World Bank 2008a, *International Trade and Climate Change: Economic, legal and institutional perspectives*, World Bank, Washington DC.

World Bank 2008b, 'Proposal for a Strategic Climate Fund (draft)', <http://siteresources.worldbank.org/INTCC/Resources/Proposal_for_a_Strategic_Climate_Fund_April_28_2008.pdf>.

WRI (World Resources Institute) 2008, *Climate Analysis Indicators Tool (CAIT) Version 5.0*, WRI, Washington DC.

WTO (World Trade Organization) 2008, *The Multilateral Trading System and Climate Change,* <www.wto.org>.

Wynn, G. 2008, 'EU wants developing nations to do more on climate', *Reuters News Service*, 11 March.