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Policies, Instruments and Co-operative Arrangements

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EXECUTIVE SUMMARY

This chapter synthesizes information from the relevant literature on policies, instruments and co-operative arrangements, focusing mainly on new information that has emerged since the Third Assessment Report (TAR). It reviews national policies, international agreements and initiatives of sub-national governments, corporations and non-governmental organizations (NGOs).

National policies

The literature on climate change continues to reflect the wide variety of national policies and measures that are available to governments to limit or reduce greenhouse gas (GHG) emissions. These include regulations and standards, taxes and charges, tradable permits, voluntary agreements, subsidies, financial incentives, research and development programmes and information instruments. Other policies, such as those affecting trade, foreign direct investment, consumption and social development goals, can also affect GHG emissions. Climate change policies, if integrated with other government polices, can contribute to sustainable development in developed and developing countries alike.

Reducing emissions across all sectors and gases requires a portfolio of policies tailored to fit specific national circumstances. While the advantages and disadvantages of any one given instrument can be found in the literature, four main criteria are widely used by policymakers to select and evaluate policies: environmental effectiveness, cost-effectiveness, distributional effects (including equity) and institutional feasibility. Other more specific criteria, such as effects on competitiveness and administrative feasibility, are generally subsumed within these four.

The literature provides a great deal of information for assessing how well different instruments meet these criteria, although it should be kept in mind that all instruments can be designed well or poorly and to be stringent or lax and politically attractive or unattractive. In addition, all instruments must be monitored and enforced to be effective. The general conclusions that can be drawn from the literature are that:

- Regulatory measures and standards generally provide some certainty of emissions levels, but their environmental effectiveness depends on their stringency. They may be preferable when information or other barriers prevent firms and consumers from responding to price signals (*high agreement/much evidence*).
- Taxes and charges are generally cost-effective, but they cannot guarantee a particular level of emissions, and they may be politically difficult to implement and, if necessary, adjust. As with regulations, their environmental effectiveness depends on stringency (*high agreement/much evidence*).
- Tradable permits can establish a carbon price. The volume of allowed emissions determines the carbon price and the environmental effectiveness of this instrument, while the distribution of allowances can affect cost-effectiveness and competitiveness. Experience has shown that banking provisions can provide significant temporal flexibility (*high agreement/much evidence*). Uncertainty in the price of carbon makes it difficult to estimate the total cost of meeting emission reduction targets.

Voluntary agreements (VAs) between industry and governments, which vary considerably in scope and stringency, are politically attractive, raise awareness among stakeholders and have played a role in the evolution of many national policies. A few have accelerated the application of best available technology and led to measurable reductions of emissions compared to the baseline, particularly in countries with traditions of close cooperation between government and industry. However, there is little evidence that VAs have achieved significant reductions in emissions beyond business as usual (*high agreement/much evidence*). The successful programmes all include clear targets, a baseline scenario, third party involvement in design and review and formal provisions for monitoring.

- Financial incentives are frequently used by governments to stimulate the diffusion of new, less GHG-emitting technologies. While economic costs are generally higher for these than for other instruments, financial incentives are often critical to overcoming the barriers to the penetration of new technologies (*high agreement/much evidence*). Direct and indirect subsidies for fossil fuel use and agriculture remain common practice, although those for coal have declined over the past decade in many Organization for Economic Co-operation and Development (OECD) and in some developing countries.
- Government support through financial contributions, taxation measures, standard setting and market creation is important to the promotion of technology development, innovations and transfer. However, government funding for many energy research programmes has fallen off since the oil shock in the 1970s and stayed constant at this lower level, even after the United Nations Framework Convention on Climate Change (UNFCCC) was ratified. Substantial additional investments in – and policies for – Research and Development (R&D) are needed to ensure that technologies are ready for commercialization in order to arrive at a stabilization of GHGs in the atmosphere (see Chapter 3), as are economic and regulatory instruments to promote their deployment and diffusion (*high agreement/much evidence*).
- Information instruments, including public disclosure requirements, may affect environmental quality by promoting better-informed choices and lead to support for government policy. There is only limited evidence that the provision of information can achieve emissions reductions, but it can improve the effectiveness of other policies (*high agreement/medium evidence*).

In practice, climate-related policies are seldom applied in complete isolation, as they overlap with other national polices relating to the environment, forestry, agriculture, waste management, transport and energy and, therefore, in many cases require more than one instrument. For an environmentally effective and cost-effective instrument mix to be applied, there must be a good understanding of the environmental issue to be addressed, the links with other policy areas and the interactions between the different instruments in the mix. Applicability in specific countries, sectors and circumstances – particularly developing countries and economies in transition – can vary greatly, but may be enhanced when instruments are adapted to local circumstances (*high agreement/much evidence*).

International agreements

As precedents, the UNFCCC and Kyoto Protocol have been significant in providing a means to solve a long-term international environmental problem, but they are only first steps towards the implementation of an international response strategy to combat climate change. The Kyoto Protocol's most notable achievements are the stimulation of an array of national policies, the creation of a carbon market and the establishment of new institutional mechanisms. Its economic impacts on the participating countries are yet to be demonstrated. The Clean Development Mechanism (CDM), in particular, has created a large project pipeline and mobilized substantial financial resources, but it has faced methodological challenges in terms of determining baselines and additionality. The Protocol has also stimulated the development of emissions trading systems, but a fully global system has not been implemented. The Kyoto Protocol is currently constrained by the modest emission limits. It would be more effective if the first commitment period is followed-up by measures to achieve deeper reductions and the implementation of policy instruments covering a higher share of global emissions (*high agreement/much evidence*).

New literature highlights the options for achieving emission reductions both under and outside of the Convention and its Kyoto Protocol by, for example, revising the form and stringency of emission targets, expanding the scope of sectoral and sub-national agreements, developing and adopting common policies, enhancing international Research, Development and Demonstration (RD&D) technology programmes, implementing development-oriented actions and expanding financing instruments (*high agreement/much evidence*). An integration of diverse elements, such as international R&D co-operation and cap and trade programmes, within an agreement is possible, but any comparison of the efforts made by different countries would be complex and resource-intensive (*medium agreement/medium evidence*).

Recent publications examining future international agreements in terms of potential structure and substance report that because climate change is a global problem, any approach that does not include a larger share of global emissions will have a higher global cost or be less environmentally effective (*high agreement/much evidence*). The design of a future regime will have significant implications for global costs and the distribution of cost among regions at different points in time There is a broad consensus in the literature that a successful agreement will have to be environmentally effective and cost-effective, incorporate distributional considerations and equity and be institutionally feasible (*high agreement/much evidence*). Agreements are more likely to be effective if they include goals, specific actions, timetables, participation and institutional arrangements and provisions for reporting and compliance (*high agreement/much evidence*).

Goals determine the extent of participation, the stringency of the measures and the timing of the actions. For example, to limit the temperature increase to 2°C above pre-industrial levels, developed countries would need to reduce emissions in 2020 by 10–40% below 1990 levels and in 2050 by approximately 40–95%. Emissions in developing countries would need to deviate below their current path by 2020, and emissions in all countries would need to deviate substantially below their current path by 2050. A temperature goal of less than 2°C requires earlier reductions and greater participation (and vice versa) (*high agreement/much evidence*). Abatement costs depend on the goal, vary by region and depend on the allocation of emission allowances among regions and the level of participation.

Initiatives of local and regional authorities, corporations, and non-governmental organizations

Corporations, local and regional authorities and NGOs are adopting a variety of actions to reduce GHG emissions. Corporate actions range from voluntary initiatives to emissions targets and, in a few cases, internal trading systems. The reasons corporations undertake independent actions include the desire to influence or pre-empt government action, to create financial value, and to differentiate a company and its products. Actions by regional, state, provincial and local governments include renewable energy portfolio standards, energy efficiency programmes, emission registries and sectoral cap and trade mechanisms. These actions are undertaken to influence national policies, address stakeholder concerns, create incentives for new industries and/or to create environmental co-benefits. Non-government organizations promote programmes that reduce emissions through public advocacy, litigation and stakeholder dialogue. Many of the above actions may limit GHG emissions, stimulate innovative policies, encourage the deployment of new technologies and spur experimentation with new institutions, but they generally have limited impact on their own. To achieve significant emission reductions, these actions must lead to changes in national policies (*high agreement/medium evidence*).

Implications for global climate change policy

Climate change mitigation policies and actions taken by national governments, the private sector and other areas of civil society are inherently interlinked. For example, significant emissions reductions have occurred as a result of actions by governments to address energy security or other national needs (e.g. the switch in the UK to gas, the energy efficiency programmes of China and India, the Brazilian development of a transport fleet driven by bio-fuel or the trend in the 1970s and 1980s toward nuclear power). However, non-climate policy priorities can overwhelm climate mitigation efforts (e.g. decisions in Canada to develop the tar sands reserves, those in Brazil to clear forests for agriculture and in the USA to promote coal power to enhance energy security) and lead to increased emissions. New research to assess the interlinkages between climate change and other national policies and actions might lead to more politically feasible, economically attractive and environmentally beneficial outcomes and international agreements.

13.1 Introduction

Article 4 of the United Nations Framework Convention on climate change (UNFCCC) commits all Parties – taking into account their common but differentiated responsibilities and their specific national and regional priorities, objectives and circumstances – to formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures that will result in the mitigation of climate change by addressing anthropogenic emissions of greenhouse gases (GHGs) by sources and removals by sinks. The main purpose of this chapter is to discuss national policy instruments and their implementation, international agreements and other arrangements and initiatives of the private sector, local governments and non-governmental organizations (NGOs). This chapter expands on the literature that has emerged since the Third Assessment Report (TAR) – in particular, on aspects covered in Chapters 6 and l0 of the TAR. There is a relatively heavier focus given to publications proposing new approaches to possible future international agreements, alternative options for international cooperation and initiatives of local governments and the private sector. Wherever feasible, these agreements and arrangements are discussed in the context of criteria such as environmental effectiveness, cost-effectiveness, distributional considerations, institutional feasibility, among others. This chapter does not discuss in detail either sectoral policies, which can be found in other chapters of this report, or adaptation policies, as those may be found in IPCC (2007b).

13.1.1 Types of policies, measures, instruments and co-operative arrangements

A variety of policies, measures, instruments and approaches are available to national governments to limit the emission of GHGs; these include regulations and standards, taxes and charges, tradable permits, voluntary agreements (VAs), informational instruments, subsidies and incentives, research and development and trade and development assistance. Box 13.1 provides a brief definition of each instrument (Hahn, 2001; Sterner, 2003). Depending on the legal framework within which each individual country must operate, these may be implemented at the national level, sub-national level or through bi-lateral or multi-lateral arrangements, and they may be either legally binding or voluntary and either fixed or changeable (dynamic).

Box 13.1 Definitions of selected GHGs abatement policy instruments

Note: The instruments defined below to directly control GHG emissions; instruments may also be used to manage activities that indirectly lead to GHG emissions, such as energy consumption.

Regulations and Standards: These specify the abatement technologies (technology standard) or minimum requirements for pollution output (performance standard) that are necessary for reducing emissions.

Taxes and Charges: A levy imposed on each unit of undesirable activity by a source.

Tradable Permits: These are also known as marketable permits or cap-and-trade systems. This instrument establishes a limit on aggregate emissions by specified sources, requires each source to hold permits equal to its actual emissions and allows permits to be traded among sources.

Voluntary Agreements: An agreement between a government authority and one or more private parties with the aim of achieving environmental objectives or improving environmental performance beyond compliance to regulated obligations. Not all VAs are truly voluntary; some include rewards and/or penalties associated with participating in the agreement or achieving the commitments.[1]

Subsidies and Incentives: Direct payments, tax reductions, price supports or the equivalent thereof from a government to an entity for implementing a practice or performing a specified action.

Information Instruments: Required public disclosure of environmentally related information, generally by industry to consumers. These include labelling programmes and rating and certification systems.

Research and Development (R&D): Activities that involve direct government funding and investment aimed at generating innovative approaches to mitigation and/or the physical and social infrastructure to reduce emissions. Examples of these are prizes and incentives for technological advances.

Non-Climate Policies: Other policies not specifically directed at emissions reduction but which may have significant climate-related effects.

1 Voluntary Agreements (VAs) should not be confused with voluntary actions which are undertaken by govern-ment agencies at the sub-national level, corporations, NGOs and other organizations independent of national government authorities. See Section 13.4.

13.1.2 Criteria for policy choice

Four principal criteria for evaluating environmental policy instruments are reported in the literature; these are:

- Environmental effectiveness – the extent to which a policy meets its intended environmental objective or realizes positive environmental outcomes.
- Cost-effectiveness – the extent to which the policy can achieve its objectives at a minimum cost to society.
- Distributional considerations – the incidence or distributional consequences of a policy, which includes dimensions such as fairness and equity, although there are others.
- Institutional feasibility – the extent to which a policy instrument is likely to be viewed as legitimate, gain acceptance, adopted and implemented.

It has to be mentioned, however, that literature in the fields of economics and political science does not provide much guidance in terms of determing which evaluative criteria are the most appropriate for an analysis of environmental policy. However, many authors employ criteria similar to the ones listed above, and although other criteria may also be important in evaluating policies, the analysis presented in this chapter is limited to these four criteria. Criteria may be applied by governments in making ex ante choices among instruments and in ex post evaluation of the performance of instruments.

13.1.2.1 Environmental effectiveness

The main goal of environmental policy instruments and international agreements is to reduce the negative impact of human action on the environment. Policies that achieve specific environmental quality goals better than alternative policies can be said to have a higher degree of environmental effectiveness. It should be noted that although climate protection is the ostensible environmental goal for any climate policy, there may be ancillary environmental benefits (for example, those demonstrated by Burtraw *et al*. (2001a) for air pollution benefits; see also Section 4.5.2. for air quality co-benefits).

The environmental effectiveness of any policy is contingent on its design, implementation, participation, stringency and compliance. For example, a policy that seeks to fully address the climate problem while dealing with only some of the GHGs or some of the sectors will be relatively less effective than one that aims at addressing all gases and all sectors.

The environmental effectiveness of an instrument can only be determined by estimating how well it is likely to perform. Harrington *et al*. (2004) distinguish between estimating how effective an environmental instrument will be ex ante and evaluating its performance ex post. These researchers were able to find or recreate ex ante estimates of expected emissions reductions in a series of U.S. and European case studies. Their comparison of the ex ante and ex post observations suggests a reasonable degree of accuracy in the estimates, with those cases in which emissions reductions were greater than expected involving incentive-based instruments, while the cases in which reductions fell short of expectations involved regulatory approaches.

There are situations in which standards are proven to be effective. Regulators may be unduly pessimistic about the environmental performance of incentive-based instruments or unduly optimistic about the performance of regulatory approaches, or perhaps both. Recent evidence suggests that market-based approaches can provide equal if not superior environmental quality improvements over regulatory approaches (see Ellerman, 2006). As we discuss below, however, institutional constraints may alter the relative efficacy of market- and standards-based instruments.

13.1.2.2 Cost-effectiveness

The cost-effectiveness of a policy is a key decision parameter in a world with scarce resources. Given a particular environmental quality goal, the most cost-effective policy is the one which achieves the desired goal at the least cost. There are many components of cost, and these include both the direct costs of administering and implementing the policy as well as indirect costs, such as how the policy drives cost-reducing technological change.

Cost-effectiveness is distinct from general economic efficiency. Whereas cost-effectiveness takes an environmental goal as given, efficiency involves the process of selecting a specific goal according to economic criteria (Sterner, 2003). Consequently, the choice of a particular environmental goal will likely have dramatic impacts on the overall cost of a policy, even if that policy is implemented using the most cost-effective instrument.

Policies are likely to vary considerably in terms of cost-effectiveness, and any estimation of the costs involved can be challenging (Michaelowa, 2003b). While cost-effectiveness estimates traditionally include the direct expenditures incurred as a result of implementing any specific policy, the policy may also impose indirect social costs, which are more difficult to measure (Davies and Mazurek, 1998). Moreover, costs for which data are limited are often ignored. Harrington *et al*. (2000) provide a summary of commonly excluded costs as well as examples of efforts to estimate these.

Cost-effectiveness can be enhanced with low transaction costs for compliance. This implies limiting the creation of new institutions and keeping implementation procedures as simple as possible while still ensuring system integrity. Studies reported in the literature can be divided into two categories in terms of the economic impacts of the timing of reductions. While some researchers argue that reductions should be postponed until low-cost technologies are available, others argue that necessary decisions have to be made today to avoid a 'lock-in' to an emission intensive pathway that would be expensive to leave at a later time point (see also Chapter 11).

A common concern is that ex ante cost estimates may not reflect the actual costs of a policy when it is assessed from an ex post perspective. Harrington *et al*. (2000) show that the discrepancy between the actual and estimated total costs of 28 environmental regulations in the USA is relatively low and, if anything, that ex ante estimates tend to overstate total costs. While these authors do not systematically evaluate specific environmental instruments, they do find that estimates for market-based instruments tend to overstate unit costs, while unit-costs estimates for other instruments are neither under- nor overestimates.

13.1.2.3 Distributional considerations

Policies rarely apportion environmental benefits and costs evenly across stakeholders. Even if a policy meets an environmental goal at least cost, it may face political opposition if it disproportionately impacts – or benefits – certain groups within a society, across societies or across generations. From an economic perspective, a policy is considered to be beneficial if it improves social welfare overall. However, this criterion does not require that the implementation of that policy actually improves the specific situation of any one individual. Consequently, as Keohane *et al*. (1998) argue, distributional considerations may be more important than aggregate cost effectiveness when policymakers evaluate an instrument.

The distributional considerations of climate change policies relate largely to equity. Equity can be defined in a number of ways within the climate context (see IPCC, 2001). Equity and fairness may be perceived differently by different people, depending on the cultural background of the observer. For example, Ringius *et al*. (2002) view responsibility, capacity and need as the basic principles of fairness that seem to be sufficiently widely recognized to serve as a normative basis for a climate policy regime. These three principles have been used in the evaluation of potential international climate agreements (e.g. Torvanger *et al*., 2004).

A regulation that is perceived as being unfair or for which the incidence is unbalanced may have a difficult time making it through the political process.[2] However, distributional considerations are fundamentally subjective, and the most equitable policy may not be the most politically popular one. For example, a policy that focuses the regulatory burden on a low-income subpopulation or country but directs the benefits to a wealthy interest group may sail with ease through the political process. While highly inequitable in costs and benefits, such an instrument is occasionally attractive to politicians. Bulkeley (2001) describes the different interests in the Australian climate policy debate and suggests that industrial emitters managed to steer the country away from ambitious reduction target – and toward an emissions increase – at the third Conference of the Parties in Kyoto.

Due to the fact that there is little consensus as to what constitutes optimal distribution, it can be difficult to compare – let alone rank – environmental policies based on distributional criteria (Revesz and Stavins, 2006). One exception is provided by Asheim *et al*. (2001), who construct an axiom of equity which, they argue, can be used to evaluate sustainability.[3] However, while sustainability may be important when evaluating environmental policies, it only captures the inter-generational dimension of distribution and is imperfectly related to political acceptability.

13.1.2.4 Institutional feasibility

Institutional realities inevitably constrain environmental policy decisions. Environmental policies that are well adapted to existing institutional constraints have a high degree of institutional feasibility. Economists traditionally evaluate instruments for environmental policy under ideal theoretical conditions; however, those conditions are rarely met in practice, and instrument design and implementation must take political realities into account. In reality, policy choices must be both acceptable to a wide range of stakeholders and supported by institutions, notably the legal system. Other important considerations include human capital and infrastructure as well as the dominant culture and traditions. The decision-making style of each nation is therefore a function of its unique political heritage. Box 13.2 provides an example for one country, taken largely from OECD (2005c).

Certain policies may also be popular due to institutional familiarity. Although market-based instruments are becoming more common, they have often met with resistance from environmental groups. Market-based instruments continue to face strong political opposition, even in the developed world, as demonstrated by environmental taxes in the USA or Europe. Regulatory policies that are outside of the norm of society will always be more difficult to put into effect (e.g. speed limits in Germany, or private sector participation in water services in Bolivia).

Another important dimension of institutional feasibility deals with implementing policies once they have been designed and adopted. Even if a policy receives political support, it may be difficult to implement under certain bureaucratic structures.

2 The United States has acknowledged the role of distribution explicitly through Executive Order 12878 (1994), which requires federal agencies to address environmental justice in their missions and activities.
3 For a summary of the economic literature on sustainability and intergenerational equity, see Pezzey and Toman (2002).

Box 13.2 The UK climate change levy: a study in political economy

The UK has a tradition of action on climate change that dates from the early acceptance of the problem by the Conservative Prime Minister Margaret Thatcher in 1988. The Labour government in 1997 reaffirmed the commitment to act and to use market-based instruments wherever possible; however, it voiced concerns on two aspects of this commitment: Firstly, that such measures might have a disproportionate effect on the poor which, in turn, might affect the coal mining communities (an important constituency) and, secondly, that this commitment might perpetuate a perception that the Labour government was committed to high taxes.

A key element of the UK's climate policy is a climate levy. The levy is paid by energy users – not extractors or generators – is levied on industry only and aims to encourage renewable energy. An 80% discount can be secured if the industry in question participates in a negotiated 'climate change agreement' to reduce emissions relative to an established baseline. Any one company over-complying with its agreement can trade the resulting credits in the UK emissions trading scheme, along with renewable energy certificates under a separate renewable energy constraint on generators. However, a number of industrial emitters wanted a heavier discount and, through lobbying, they managed to have a voluntary emissions trading scheme established that enables companies with annual emissions above 10,000 tCO_2-eq to bid for allocation of subsidies. The "auction" offered payments of 360 million €and yielded a de-facto payment of 27 € per tonne of CO_2. Thus, the trading part of the scheme has design elements that strongly reflect the interest groups involved (Michaelowa, 2004). The levy itself has limited coverage and, consequently, households, and energy extractors and generators have no incentive to switch to low carbon fuels. However, its design does take household vulnerability, competitiveness concerns and the sensitivity of some sectoral interests into account. Thus, while the levy has contributed to emission reduction, it has not been as effective as a pure tax; a pure tax may not have been institutionally feasible.

13.2 National policy instruments, their implementation and interactions

The policy-making process of almost all governments consists of complex choices involving many stakeholders, including the potential regulated industry, suppliers, producers of complementary products, labour organizations, consumer groups and environmental organizations. The choice and design of virtually any instrument has the potential to benefit some of these stakeholders and to harm others. For example, permits allocated free to existing firms represent a valuable asset transferred from the government to industry, while auctioned permits and taxes generally impose heavier burdens on polluters. As a result, it is likely that a candidate instrument will likely face both support and opposition from the stakeholders. Voluntary measures are often favoured by industry because of their flexibility and potentially lower costs, but these are often opposed by environment groups because of their lack of accountability and enforcement. In practice, policies may be complementary or opposing; moreover, the political calculus used to choose a particular instrument differs for each government.[4]

In formulating a domestic climate policy programme, a combination of policy instruments may work better in practice than reliance on a single instrument. Furthermore, an instrument that works well in one country may not work well in another country with different social norms and institutions. When instruments are to be compared, it is important that the different levels of stringency be taken into consideration and adjusted, for all of the instruments described herein may be set at different levels of stringency. Regulations will also undoubtedly need to be adjusted over time. All instruments must be supplemented with a workable system of monitoring and enforcement. Furthermore, instruments may interact with existing institutions and regulations in other sectors of society.

13.2.1 Climate change and other related policies

In this section we consider a number of instruments that have been used to manage environmental problems in different parts of the world. Some of these tools have been used for climate policy, while others have not; however, experience from dealing with other pollutants suggests their applicability to climate. Mitigation options can range from the purely technological (such as fuel switching) to the purely behavioural (such as reducing vehicle kilometres travelled) as well as innumerable combinations of both technological and behavioural options. Policies, measures and instruments are tools to trigger the implementation of these options.

13.2.1.1 Regulations and standards

Regulatory standards are the most common form of environmental regulation, and they cover a wide variety of

4 The design of most instruments assumes effective compliance and penalty provisions.

approaches. A regulatory standard specifies with a certain degree of precision the action(s) that a firm or individual must undertake to achieve environmental objectives and can consist of such actions as specifying technologies or products to use or not use and/or more general standards of performance as well as proclaiming dictates on acceptable and unacceptable behaviour. Two broad classes of regulatory standards are technology and performance standards. Technology standards mandate specific pollution abatement technologies or production methods, while performance standards mandate specific environmental outcomes per unit of product. In this context, where a technology standard might mandate specific CO_2 capture and storage methods on a power plant, a performance standard would limit emissions to a certain number of grams of CO_2 per kilowatt-hour of electricity generated. A product standard would, for example, be the requirement that refrigerators operate minimally at a specified level of efficiency, while a technology-forcing standard would involve setting the refrigerator efficiency requirement slightly beyond present-day technological feasibility but announcing that the efficiency requirement will not go into effect until a number of years following the announcement.

The primary advantage of a regulatory standard is that it may be tailored to an industry or firm, taking into account the specific circumstances of that industry or firm. There is also a more direct connection between the regulatory requirement and the environmental outcome, which can provide some degree of certainty.

Technology standards involve the regulator stipulating the specific technology or equipment that the polluter must use. Technology standards are best used when there are few options open to the polluter for controlling emissions; in this case, the regulator is able to specify the technological steps that a firm should take to control pollution. The information requirements for technology standards are high: the regulator must have good and reliable information on the abatement costs and options open to each firm. Losses in cost effectiveness arise when regulators are less well informed; technology standards may then be applied uniformly to a variety of firms, rather than tailoring the standard to the actual circumstance of the firm. This raises costs without improving environmental effectiveness and is one of the main drawbacks to regulatory standards.

Performance standards can reduce these potential problems with technology standards by providing more flexibility (IPCC, 2001). Costs can generally be lower whenever a firm is given some discretion in how it meets an environmental target. Performance standards expand compliance options beyond a single mandated technology and may include process changes, reduction in output, changes in fuels or other inputs and alternative technologies. Despite this increased flexibility, performance standards also require well-informed and responsive regulators.

One problem with regulatory standards is that they do not provide polluters with the incentive(s) to search for better approaches to reducing pollution. Thus, they may not perform well in inducing innovation and technological change (Jaffe *et al*., 2003; Sterner, 2003). If a government mandates a certain technology, there is no economic incentive for firms to develop more effective technologies. Moreover, there may be a ‘regulatory ratchet’ whereby firms are discouraged from developing more effective technologies out of fear that standards will be tightened yet again (Harrington *et al*., 2004). Finally, although it may be possible to force some technological change through technology mandates, it is difficult for regulators to determine the amount of change that is possible at a reasonable economic cost. This raises the possibility of implementing either costly, overly stringent requirements or, alternatively, weak, unambitious requirements (Jaffe *et al*., 2003). Nevertheless, there are examples in the literature of technology innovations spurred by regulatory standards. For example, Wätzold (2004) reported innovative responses from pollution control vendors in Germany in response to standards for SO_2 control.

Although relatively few regulatory standards have been adopted with the sole aim of reducing GHG emissions, standards have been adopted that reduce these gases as a co-benefit. For example, there has been extensive use of standards to increase energy efficiency in over 50 nations (IPCC, 2001). Energy efficiency applications include fuel economy standards for automobiles, appliance standards, and building codes.[5] These types of policies are discussed in more detail in Chapters 5 and 6 of this report. Standards to reduce methane and other emissions from solid waste landfills have been adopted in Europe, the USA and other countries (see Chapter 10) and are often driven by multiple factors, including the reduction of volatile organic compound (VOC) emissions, improved safety by reducing the potential for explosions and reduced odours for local communities (Hershkowitz, 1998).

There are a number of documented situations in which regulatory standards have worked well (see Freeman and Kolstad, 2006; Sterner, 2003). Sterner (2003) reports several cases of such situations, including those in which firms are not responsive to price signals (e.g. in non-competitive settings or with state enterprises) and where monitoring emissions is difficult but tracking the installation of technology is easy. In situations where there is imperfect monitoring and homogeneous abatement costs between firms, Montero (2005) finds that standards may lead to lower emissions and may be economically more efficient than market-based instruments. Based on an analysis of the German SO_2 abatement programme, Wätzold (2004) concludes that a technology standard may be acceptable

5 For example, the Green Building Council in the United States of America.

Box 13.3 China mandates energy efficiency standard in urban construction

Approximately 2 billion m^2 of floor space is being built annually in China, or one half of the world's total. Based on the growing pace of its needs, China will see another 20–30 billion m^2 of floor space built between the present and 2020. Buildings consume more than one third of all final energy in China, including biomass fuels (IEA, 2006). China's recognition of the need for energy efficiency in the building sector started as early as the 1980s but was impeded due to the lack of feasible technology and funding. Boosted by a nationwide real estate boom, huge investment has flowed into the building construction sector in recent years.

On 1 January, 2006, China introduced a new building construction statute that includes clauses on a mandatory energy efficiency standard for buildings. The Designing Standard for Energy Conservation in Civil Building requires construction contractors to use energy efficient building materials and to adopt energy-saving technology in heating, air conditioning, ventilation and lighting systems in civil buildings. Energy efficiency in building construction has also been written into China's 11th Five-Year National Development Programme (2006–2010), which aims for a 50% reduction in energy use (compared with the current level) and a 65% decrease for municipalities such as Beijing, Shanghai, Tianjin and Chongqing as well as other major cities in the northern parts of the country. Whether future buildings will be able to comply with the requirements in the new statute will be a significant factor in determining whether the country will be able to realize the ambitious energy conservation target of a 20% reduction in energy per gross domestic product (GDP) intensity during the 11th Five-Year Plan of 2005–2010.

when only one technology exists to achieve an environmental result and, therefore, firms do not face differential abatement costs. Finally, standards may be desirable where there are informational barriers that prevent firms or individuals from responding solely to price signals. This may be particularly relevant for energy efficiency standards for household appliances and other similar applications (OECD, 2003d). Chapter 6 provides additional information on this subject.

A growing body of literature is focusing on whether regulatory standards or market-based instruments are preferable for developing countries. One common view is that technology standards may be more appropriate for building the initial capacity for emissions reduction because economic incentive programmes require more specific and greater institutional capacity, have more stringent monitoring requirements and may require fully developed market economies to be effective (IPCC, 2001; Bell and Russell, 2002). Willems and Baumert (2003) support this approach but also note that technology approaches, policies and measures may have greater applicability to the general capacity needs of developing countries interested in pursuing sustainable development strategies (See Box 13.3). Russell and Vaughan (2003) suggest that a transitional strategy is the appropriate approach for developing countries, whereby technology standards are introduced first, followed by performance standards and finally by experimentation with market-based instruments. An alternative view is that, in some cases, a performance standard at the facility level and an overall emissions cap could provide a more a more effective structure (Ellerman, 2002; Kruger *et al*., 2003). This type of approach could also facilitate a transition to a tradable permits programme as the institutions and economies develop over time.

13.2.1.2 Taxes and charges

An emission tax on GHG emissions requires individual emitters to pay a fee, charge or tax[6] for every tonne of GHG released into the atmosphere.[7] An emitter must pay this per-unit tax or fee regardless of how much emission reduction is being undertaken.[8] Each emitter weighs the cost of emissions control against the cost of emitting and paying the tax; the end result is that polluters undertake to implement those emission reductions that are cheaper than paying the tax, but they do not implement those that are more expensive, (IPCC, 1996, Section 11.5.1; IPCC, 2001, Section 6.2.2.2; Kolstad, 2000). Since every emitter faces a uniform tax on emissions per tonne of GHG (if energy, equipment and product markets are perfectly competitive), emitters will undertake the least expensive reductions throughout the economy, thereby equalizing the marginal cost of abatement (a condition for cost-effectiveness). Taxes and charges are commonly levelled on commodities that are closely related to emissions, such as energy or road use.

An emissions tax provides some assurance in terms of the marginal cost of pollution control, but it does not ensure a particular level of emissions. Therefore, it may be necessary to

6 No distinction is made here among the terms taxes, fees or charges. In actuality, the revenue from taxes may go into the general government coffers, whereas the revenue from fees or charges may be earmarked for specific purposes.

7 Because GHGs have different effects on atmospheric warming per unit of emissions, the use of carbon dioxide equivalents (CO_2-eq) is one way of measuring relative impact.

8 An alternative is the idea of threshold taxes, where the tax per unit of emissions is only assessed on emissions greater than a set threshold (Pezzey 2003). In other words, infra-marginal emissions would be tax-exempt. This type of tax would generate less revenue but could be more politically acceptable.

adjust the tax level to meet an internationally agreed emissions commitment (depending on the structure of the international agreement). Over time, an emissions tax needs to be adjusted for changes in external circumstances, such as inflation, technological progress and new emissions sources (Tietenberg, 2000). Fixed emissions charges in the transition economies of Eastern Europe, for example, have been significantly eroded by the high inflation of the past decade (Bluffstone and Larson, 1997). Innovation and invention generally have the opposite effect by reducing the cost of emissions reductions and increasing the level of reductions implemented. If the tax is intended to achieve a given overall emissions limit, the tax rate will need to be increased to offset the impact of new sources (Tietenberg, 2000).

Most environmentally related taxes with implications for GHG emissions in OECD countries are levied on energy products (150 taxes) and on motor vehicles (125 taxes), rather than on CO_2 emission directly. There is also a significant number of waste-related taxes in OECD countries (about 50 taxes in all), levied either on particular products that can cause particular problems for waste management (about 35 taxes) or on various forms of final waste disposal, including those on incineration and/or land-filling (15 taxes in all). A very significant share of all the revenues from environmentally related taxes originates from taxes on motor fuels. Such taxes were introduced in all member countries many decades ago – primarily as a means to raise revenue. Irregardless of the underlying reasoning for their implementation, however, they do impact on the prices (potential) car users are confronted with and thus have important environmental impacts.

However, there is some experience with the direct taxation of CO_2 emissions. The Nordic Council of Ministers (2002) notes that CO_2 emissions in Denmark decreased by 6% during the period 1988–1997 while the economy grew by 20%, but that they also decreased by 5% in a single year – between 1996 and 1997 – when the tax rate was raised. Bruvoll and Larsen (2004) analysed the specific effect of carbon taxes in Norway. Although total emissions did increase, these researchers found a significant reduction in emissions per unit of GDP over the period due to reduced energy intensity, changes in the energy mix and reduced process emissions. The overall effect of the carbon tax was, however, modest, which may be explained by the extensive tax exemptions and relatively inelastic demand in those sectors in which the tax was actually implemented. Cambridge Econometrics (2005) analysed the impacts of the Climate Change Levy in the UK and found that total CO_2 emissions were reduced by 3.1 MtC – or 2.0% – in 2002 and by 3.6 MtC in 2003 compared to the reference case. The reduction is estimated to grow to 3.7 MtC – or 2.3% – in 2010.

To implement a domestic emissions tax, governments must consider a number of issues, such as the level at which the tax should be set, particularly in the case of pre-existing taxes (e.g. taxes which already exist on energy), or other potential distortions (e.g. subsidies to certain industries or fuels). Consideration must also be given to how the tax is used, with such options as whether it goes directly into general government coffers, is used to offset other taxes (i.e. the double-dividend effect), is transferred across national boundaries to an international body, is earmarked for specific abatement projects, such as renewable energy, or is allocated to those most adversely impacted by either the costs of emission reduction or damage from climate change. Another important issue is the point at which the tax is should be levied. A tax on gasoline may be levied at the pump and collected directly from consumers or it may be levied on wholesale gasoline production and collected from oil companies. In either case, the final consumer ultimately pays most of this cost, but the administrative and monitoring costs may differ dramatically in the two cases.

Emission taxes do well in both cost effectiveness and environmental effectiveness. The real obstacles facing the use of emission taxes and charges are distributional and, in some countries, institutional. At the best of times, new taxes are not politically popular. Furthermore, emissions or energy taxes often fall disproportionately on lower income classes, thereby creating negative distributional consequences. In developing countries, institutions may be insufficiently developed for the collection of emission fees from a wide variety of dispersed sources. In many countries, state enterprises play a significant role; such public or quasi-private entities may not respond adequately to the incentive effects of a tax or charge.

13.2.1.3 Tradable permits

A steadily increasing amount of research is focusing on tradable permits in terms of, among others, efficiency and equity issues associated with the distribution of permits, implications of economy-wide versus sectoral programmes, mechanisms for handling price uncertainties, different forms of targets and compliance and enforcement issues.

Tradable permit systems can be designed to cover either emissions from a few sectors of the economy or those from virtually the entire economy.[9] A number of analyses have found that economy-wide approaches are superior to sectoral coverage because they equalize marginal costs across the entire economy. Using a variety of models, Pizer *et al*. (2006) report that in the USA significant cost savings are linked to an economy-wide programme when compared to a sectoral programme coupled with non-market-based policies.[10] Researchers have found similar results for the European Union

9 Thus far, emissions trading programmes, such as those for SO_2 and NO_x in the USA and that of the EU Emis-sions Trading System (EU ETS) for CO_2 have only covered certain sectors. In the case of the EU ETS, Chris-tiansen and Wettestad (2003) write that the EU restricted the sectors involved to ease implementation during the first phase of the programme.

Box 13.4 The EU Emission Trading System

The EU Emissions Trading System (EU ETS) is the world's largest tradable permits programme. The programme was initiated on January 1, 2005, and it applies to approximately 11,500 installations across the EU's 25 Member States. The system covers about 45% of the EU's total CO_2 emissions and includes facilities from the electric power sector and other major industrial sectors.

The first phase of the EU ETS runs from 2005 until 2007. The second phase will begin in 2008 and continue through to 2012, coinciding with the 5-year Kyoto compliance period. Member States develop National Allocation Plans, which describe in detail how allowances will be distributed to different sectors and installations. During the first phase, Member States may auction off up to 5% of their allowances; during the second phase, up to 10% of allowances may be auctioned off.

Market development and prices: A number of factors affect allowance prices in the EU ETS, including the overall size of the allocation, relative fuel prices, weather and the availability of certified emission reductions (CERs) from the Clean Development Mechanism (CDM) (Christiansen *et al*., 2005). The EU ETS experienced significant price volatility during its start-up period, and for a brief period in April 2006 prices rose to nearly 30 per tonne; however, prices subsequently dropped dramatically when the first plant-level emissions data from Member States were released. The sharp decline in prices focused attention on the size of the initial Phase I allocation. Analysts have concluded that this initial allocation was a small reduction from business as usual emissions (Grubb *et al*., 2005; Betz *et al*., 2004).

Consistency in national allocation plans: Several studies have documented differences in the allocation plans and methodologies of Member States (Betz *et al*., 2004; Zetterberg *et al*. 2004; Baron and Philibert, 2005; DEHSt, 2005). Researchers have looked at the impact on innovation and investment incentives of different aspects of allocation rules (Matthes *et al*., 2005; Schleich and Betz, 2005) and have found that these rules can affect technology choices and investment decisions. Ahman *et al*. (2006), Neuhoff *et al*. (2006) and Betz *et al*., (2004) find that when Member States' policies require the confiscation of allowances following the closure of facilities, this creates a subsidy for continued operation of older facilities and a disincentive to build new facilities. They further find that different formulas for new entrants can impact on the market.

Implications of free allocation on electricity prices: Sijm *et al*. (2006) report that a significant percentage of the value of allowances allocated to the power sector was passed on to consumers in the price of electricity and that this pass-through of costs could result in substantially increased profits by some companies. The authors suggest that auctioning a larger share of allowances could address these distributional issues. In a report for the UK government, IPA Energy Consulting found a similar cost pass-through for the UK and other EU Member States (IPA Energy Consulting, 2005).

and the EU ETS. (Babiker *et al*., 2003; Betz *et al*., 2004; Klepper and Peterson, 2004; Bohringer and Löschel, 2005).

Not only the coverage of sectors may vary in a tradable permits programme, but also the point of obligation. The responsibility for holding permits may be assigned directly to emitters, such as energy-using industrial facilities (downstream), to producers or processors of fuels (upstream) or to some combination of the two (a 'hybrid system').[11] The upstream system would require permits to be held at the level of fossil fuel wholesalers and importers (Cramton and Kerr, 2002).[12]

There are two basic options for the initial distribution of permits: (1) free distribution of permits to existing polluters or (2) auctions. Cramton and Kerr (2002) describe a number of equity benefits of auctions, including providing a source of revenue that could potentially address inequities brought about by a carbon policy, creating equal opportunity for new entrants and avoiding the potential for "windfall profits" that might accrue to emissions sources if allowances are allocated at no charge.[13] (See Box 13.4 for a discussion of this issue).

Goulder *et al*. (1999) and Dinan and Rogers (2002) find that recycling revenues from auctioned allowances can have economy-wide efficiency benefits if they are used to reduce certain types of taxes. Dinan and Rogers (2002) and Parry (2004) argue that free allocation of tradable permits may be regressive because this type of allowance distribution leads to income

10 However, they also find that the exclusion of certain sectors, such as residential and commercial direct use of fossil fuels, does not noticeably affect the cost of an otherwise economy-wide tradable permit system covering electricity production, industry and transportation.

11 See IPCC (2001b), Baron and Bygrave (2002), UNEP/UNCTAD (2002), and Baron and Philibert (2005) for a discussion of the advantages and disadvantages of these different approaches.

12 As the discussion below notes, the point of obligation is not necessarily the point at which all permits need be allocated.

13 A hybrid of free allocation and auctioning or emissions taxes is also possible (Pezzey 2003). Bovenburg and Goulder (2001) and Burtraw *et al*. (2002) find that allocating only a small portion of permits at no cost while auctioning the remainder can compensate industry for losses due to a carbon policy.

transfers towards higher income groups (i.e. shareholders) at the expense of households. In contrast, these authors find that government revenues from auctions may be used to address equity issues through reductions in taxes or other distributions to low-income households. Ahman *et al*. (2006) argue that a gradual transition from free allocation to auctioning might be a politically feasible manner to develop a fairer distribution of allowances.

To date, most emissions trading programmes have distributed emissions allowances almost entirely through free allocations.[14] Experience with the US SO_2 programme shows that the no-cost allocation of allowances was critical for gaining political acceptance for the emissions trading concept (Ellerman, 2005). Christiansen and Wettestad (2003) and Markussen and Svendsen (2005) discuss how interest group pressures led to a largely free allocation of allowances in the EU ETS. In a broader sense, the rationale for a policy allowing some free allocation of allowances based on historic emissions is based on the desire to compensate incumbent installations that are affected by the regulation (Tietenberg, 2003; Harrison and Radov, 2002, Ahman *et al*. 2006).

The number of publications exploring the efficiency, equity and competitiveness implications of allowance allocation approaches is continuing to grow. For example, Burtraw *et al*. (2001b) and Fischer (2001) found that periodic updates of allocations on the basis of production are economically inefficient. In an analysis of a potential emissions trading programme in Alberta, Canada, Haites (2003b) found that this type of periodic updating of allocations based on each source's output may reduce the decline in production for some sectors that may arise from an emissions cap but that it may also reduce profits and raise overall costs when compared to a fixed allocation. Demailly and Quirion (2006) find that under certain assumptions, an output-based allocation in the European cement industry would reduce leakage with limited impacts on production. See Chapter 11, Section 11.7.4 for a more extensive discussion on competitiveness issues.

A final issue associated with the distribution of allowances is whether excessive market power can distort prices. Maeda (2003) examines how the initial distribution of permits affects the potential emergence of firms with market power. Tietenberg (2006) summarizes research on market power, including studies on whether different auction designs or initial permit allocation can lead to price manipulation by dominant firms. He concludes that in practice, market power 'typically has not been a problem in emissions trading.' There has yet to be an overall assessment of market power in the EU ETS.

Several authors have compared the advantages and disadvantages of absolute targets (i.e., mass emissions limits on a sector or economy) to those of intensity targets (i.e. limits on emission per unit of GDP).[15] Ellerman and Wing (2003) and Kolstad (2006) find that intensity targets can reduce the uncertainties associated with the cost of emission reduction under uncertain economic growth levels. Pizer (2005b) finds that intensity targets may be more appropriate if the short-term objective is to slow, rather than halt, emissions growth, while Ellerman and Wing (2003) show that an intensity target may be set so stringently that it can halt or reverse growth. Dudek and Golub (2003) argue that absolute targets have more certain environmental results and lower transaction costs for emissions trading, thereby creating stronger incentives for technological change. Kuik and Mulder (2004) find that, for the EU, an intensity or relative target would avoid negative effects on competitiveness but would not reduce emissions at the lowest costs. In contrast, an absolute target combined with permit trading leads to efficient emissions reduction, but its overall macroeconomic costs may be significant. Finally, Quirion (2005) argues that, in the most plausible cases, an emissions tax and an absolute target are superior to an intensity target and that the welfare gaps between the two types of targets are very small. Overall, intensity targets are less effective than absolute targets if the goal is to achieve a certain level of emissions reduction, but they may be more effective at addressing costs when economic growth is uncertain.

Although a tradable permits approach can ensure that a certain quantity of emissions will be reduced, it does not provide any certainty of price. Price uncertainty may be addressed by a 'price cap' or 'safety valve' mechanism, which guarantees that the government will sell additional permits if the market price of allowances hits a certain price (Pizer, 2002; McKibbon and Wilcoxen; 2002, Jacoby and Ellerman; 2004).[16] The underlying reasoning is that GHGs become the focus of concern as they accumulate over an extended period in the atmosphere. There may therefore be less concern about short-term increases in CO_2 as long as the overall trajectory of CO_2 emissions is downward over an extended period (Newell and Pizer, 2003). While the safety valve mechanism shares some advantages with price-based mechanisms, such as a tax, the former may have the added political advantage of providing emitters with an additional allocation of allowances (Pizer, 2005a). A safety valve mechanism does not provide any certainty that a particular emissions level will be met, and it requires additional administrative complexity to link a domestic programme with a safety valve to a programme without a safety valve or with a different safety valve price.

14 The US SO_2 trading programme contains a small reserve auction, which was valuable for price discovery during the early years of the programme (Ellerman *et al*., 2000). Revenue from this auction was returned to the companies affected in the programme. Only four EU Member States (Denmark, 5%; Hungary, 2.5%; Ireland, 0.75%; Lithuania, 1.5%) decided to auction off parts of their ET budget in the first phase of the EU ETS scheme (Betz *et al*., 2004).

15 Intensity targets are also known as "rate-based", "dynamic," "indexed," and "relative" targets.

16 It is also possible to have a "price floor" to ensure that prices don't go below a certain level. For example, Hepburn *et al*. (2006) discuss how a coordinated auction measure for the EU ETS could be used to support a minimum price.

Experience with trading programmes in the USA has shown significant benefits can be derived from the temporal flexibility provided by banking provisions in cases where the exact timing of emission reductions is not critical to environmental effectiveness (Ellerman *et al*., 2000; Stavins, 2003). Allowance banking can create a cushion that will prevent price spikes and can hedge uncertainty in allowance prices (Jacoby and Ellerman, 2004).[17] A banking provision allows the arbitrage between actual marginal abatement costs in one phase of a programme and the expected abatement costs in a future phase of a programme. The temporal flexibility of banking is particularly useful for companies facing large capital expenditures because it provides some flexibility in the timing of those expenditures (Tietenberg, 2003). In some emission markets in the USA, banking has been restricted where there was concern about short-term increases in emissions (Tietenberg, 2006). Banking was also restricted between Phase I and Phase 2 in the EU ETS to avoid a large bank that would make it more difficult to meet Kyoto targets.

Several critical elements of an effective enforcement regime for emissions trading have been described in the literature. First, if the goal is strict adherence to the emission limits implied by the number of permits, then excess emissions penalties should be set at levels substantially higher than the prevailing permit price in order to create the appropriate incentives for compliance (Swift, 2001; Stranland *et al*., 2002).[18] A second component of an enforcement regime is reasonably accurate emissions monitoring (Stranland *et al*., 2002; Stavins, 2003). San Martin (2003) and Montero (2005) report that incomplete monitoring can undermine the efficiency of trading programmes. Tietenberg (2003) and Kruger *et al*. (2000) emphasize that public access to emissions and trading data provides an additional incentive for compliance.

Finally, there have been several experiments with tradable permits for conventional pollution control in developing countries and economies in transition (Bygrave, 2004; US EPA, 2004). For example, Montero *et al*. (2002) evaluate an experiment with tradable permits for total suspended particulates (TSP) in Santiago, Chile and find that permit markets are underdeveloped due to high transaction costs, uncertainty and poor enforcement. However, they also find an improved documentation of historic emissions inventories and an increased flexibility to address changing market conditions. S. Gupta (2003b) and Wang *et al*. (2004) suggest strengthening the monitoring and enforcement capacity that would be required to implement conventional pollution trading programmes in India and China, respectively. Several authors have concluded that tradable permit programmes may be less appropriate for developing countries due to their lack of appropriate market or enforcement institutions. (Blackman and Harrington, 2000, Bell and Russell, 2002)

13.2.1.4 Voluntary agreements

Voluntary agreements are agreements between a government authority and one or more private parties to achieve environmental objectives or to improve environmental performance beyond compliance to regulated obligations. Voluntary agreements are playing an increasingly important role in many countries as a means to achieve environmental and social objectives. They tend to be popular with those directly affected and can be used when other instruments face strong political opposition (Thalmann and Baranzini, 2005). Box 13.5 provides examples of VAs. See Chapter 7, Section 7.9.2 for additional information.

Voluntary agreements can take on many forms with varying levels of stringency. While all VAs are ‘voluntary’ insofar as firms are not compelled to join, some may involve incentives (rewards or penalties) for participation. Firms may agree to direct emissions reductions or to indirect reductions through changes in product design (see Chapter 6, Section 6.8.2.2.). Agreements may be stand-alone, but they are often used in conjunction with other policy instruments. Voluntary agreements are also a subset of a larger set of ‘voluntary approaches’ in which industry may first negotiate standards of behaviour with other firms or private groups and then allow third parties to monitor compliance. This larger set also includes unilateral voluntary actions by industry. See Section 13.4, Box 13.5, and Chapter 7, Section 7.9.2 for more information on voluntary actions.

The benefits of VAs for individual companies and for society may be significant. Firms may enjoy lower legal costs, enhance their reputation and improve their relationships with society on a whole and shareholders in particular. Societies gain to the extent that firms translate goals into concrete business practices and persuade other firms to follow their example. The negotiations involved to develop VAs raise awareness of climate change issues and potential mitigative actions within industry (Kågeström *et al*., 2000), establish a dialogue between industry and government and help shift industries towards best practices.

Evaluating the effectiveness of VAs is not easy. The standard approach is first to measure the environmental performance of a group of firms participating in a VA and then to compare the performance to that of a typical non-participating firm or firms. One problem with this approach is selection bias: it is often the best-performing firms that enter into a VA. A second and related problem is the counterfactual: it is difficult to know what a firm might have done had they not entered into the VA. Very few studies have attempted to evaluate VAs by taking into account both of these issues. Studies which do not take these factors into account can produce an overly optimistic view of the performance of a VA.

17 Price uncertainty may also be addressed by “borrowing” of allowances, i.e. using allowance allocations from future years.

18 The addition of a “make good” provision – that is, the requirement stating that allowances from a subsequent compliance year or period are surrendered for any excess emissions – is a further design element used to ensure that an absolute emissions target is met (Betz and MacGill, 2005).

The environmental effectiveness of VAs is the subject of much discussion. Some governments – as well as industry – believe that VAs are effective in reducing GHG emissions (IAI, 2002; OECD, 2003c). Rietbergen *et al*. (2002) investigated whether the voluntary agreements in The Netherlands have resulted in improvements in energy efficiency beyond what would have occurred in the absence of such agreements. They estimate that, on average, between 25% and 50% of the energy savings in the Dutch manufacturing industry can be attributed to the policy mix of the agreements and supporting measures.

Others are more sceptical about the efficacy of VAs in reducing emissions. Independent assessments of VAs – while acknowledging that investments in cleaner technologies have resulted in absolute emission improvements – indicate that there is little improvement over business-as-usual (BAU) scenarios, as these investments would have probably happened anyway (Harrison, 1999; King and Lenox, 2000; Rietbergen and Blok, 2000; OECD, 2003e; Rivera and deLeon, 2004). The economic efficiency of VAs can also be low, as they seldom incorporate mechanisms to equalize marginal abatement costs between different emitters (Braathen, 2005).

There are a limited, although increasing, number of comprehensive reviews of the effectiveness of VAs, but any comparison of these reviews and assessments is difficult because of the different metrics and evaluative criteria employed (Price, 2005). In general, studies of the design and efficacy of VAs assess only a single programme (e.g. Arora and Cason, 1996; Khanna and Damon, 1999; King and Lenox, 2000; Welch *et al*., 2000; Rivera, 2002; Croci, 2005). Based on her evaluation of the French experience, Chidiak (2002) suggests that the reductions in GHG emissions cannot necessarily be seen as a direct consequence of the commitments within the agreements and argues that, in actual fact, these improvements have been triggered largely as a result of other environmental regulations and cost reduction efforts. Johannsen (2002) and Helby (2002) present similar results for programmes in Denmark and Sweden, respectively. They note that reductions in specific emissions correspond with industry's BAU behaviour, thereby suggesting that the stated objectives in the agreements were not sufficiently ambitious. In particular, Helby concludes that EKO-Energi, which sought to highlight a new level of best practice and thus pose a challenge to other firms, was 'at best a very modest success,' resulting in a small overall direct effect on total industrial energy consumption. Interestingly, Chidiak also finds that the agreements did not foster intra-industry networking and information exchange on energy management and suggests that their failure to achieve more ambitious goals is a result of the lack of a well-articulated policy-mix. Other analyses indicate that VAs work best as part of a policy package, rather than as a stand-alone instrument (Krarup and Ramesohl, 2002; Torvanger and Skodvin, 2002). OECD (2003e) and Braathen (2005) note that many of the current VAs would perform better if there were a real threat of other instruments being used if targets are not met.

The US Government Accountability Office (2006), in its review of the US Climate Vision and Leaders Programmes, which are supported by the Environmental Protection Agency (EPA) and Department of Energy (DOE), finds that emission reduction goals were set for only 38 of 74 participants, that some goals are intensity-based and others emission-based and that programmes vary in terms of how they are measured, the time periods covered, the requirements for reporting and the means of tracking progress. Brouhle *et al*. (2005) note that the difficulties in evaluating US programmes is associated to the many different programmes and their goals that need be sorted, the availability of adequate data and the measuring of achievement relative to a baseline. Jaccard *et al*. (2006) review various Canadian voluntary programmes that have been in existence for 15 years and report that during that period emissions have grown by 25%.

Darnall and Carmin (2003) review 61 governmental, industry and third-party general environmental agreements, mainly in the USA (see also Lyon and Maxwell, 2000). Overall, their results demonstrate that the voluntary programmes had low programme rigour in that they had limited levels of administrative, environmental and performance requirements. For example, two thirds did not require participants to create environmental targets and to demonstrate that the targets were met. Similarly, almost 50% of the programmes had no monitoring requirements. Compared to government programmes, industry programmes had stronger administrative requirements and third party programmes had yet even slightly stronger requirements. According to Hanks (2002) and OECD (2003e), the best VAs include: a clear goal and baseline scenario; third party participation in the design of the agreement; a description of the parties and their obligations; a defined relationship within the legal and regulatory framework; formal provisions for monitoring, reporting and independent verification of results at the plant level; a clear statement of the responsibilities expected to be self-financed by industry; commitments in terms of individual companies, rather than as sectoral commitments; references to sanctions or incentives in the case of non-compliance.

It must be acknowledged that VAs fit into the cultural traditions of some countries better than others. Japan, for example, has a history of co-operation between government and industry that facilitates the operation of "voluntary" programmes. Some examples of VAs in various countries are provided in Box 13.5.

13.2.1.5 Subsidies and incentives

Direct and indirect subsidies can be important environmental policy instruments, but they have strong market implications and may increase or decrease emissions, depending on their nature. Subsidies aimed at reducing emissions can take different forms, ranging from support for Research and Development

Box 13.5 Examples of national voluntary agreements

- **The Netherlands Voluntary Agreement on Energy Efficiency:** A series of legally binding long-term agreements based on annual improvement targets and benchmarking covenants between 30 industrial sectors and the government with the objective to improve energy efficiency.
- **Australia "Greenhouse Challenge Plus" programme:** An agreement between the government and an enterprise/ industry association to reduce GHG emissions, accelerate the uptake of energy efficiency, integrate GHG issues into business decision making and provide consistent reporting.[19] See http://www.greenhouse.gov.au/challenge.
- European Automobile Agreement: An agreement between the European Commission and European, Korean and Japanese car manufacturing associations to reduce average emissions from new cars to 140 gCO_2/km by 2008–2009. See http://ec.europa.eu/environment/CO2/CO2_agreements.htm.
- **Canadian Automobile Agreement:** An agreement between the Canadian government and representatives of the domestic automobile industry to a reduce emissions from cars and light-duty trucks by 5.3 $MtCO_2$-eq by 2010. The agreement also contains provisions relating to research and development and interim reduction goals.
- **Climate Leaders:** An agreement between US companies and the government to develop GHG inventories, set corporate emission reduction targets and report emissions annually to the US EPA. See: http://www.epa.gov/climateleaders/.
- **Keidaren Voluntary Action Plan:** An agreement between the Japanese government and 34 industrial and energy-converting sectors to reduce GHG emissions. A third party evaluation committee reviews the results annually and makes recommendations for adjustments.[20] See http://www.keidanren.or.jp

(R&D), investment tax credit, and price supports (such as feed-in tariffs for renewable electricity).[21] Subsidies that increase emissions typically involve support for fossil fuel production and consumption. They tend to expand the subsidized industry, relative to the non-subsidy case. If the subsidized industry is a source of GHG emissions, subsidies may result in higher emissions. Subsidies to the fossil fuel sector result in over-use of these fuels with resulting higher emissions; subsidies to agriculture can result in the expansion of agriculture into marginal lands and corresponding increases in emissions. Conversely, incentives to encourage the diffusion of new technologies, such as those for renewables or nuclear power, may promote emissions reductions.

One of the significant advantages of subsidies is that they have politically positive distributional consequences. The costs of subsidies are often spread broadly through an economy, whereas the benefits are more concentrated. This means that subsidies may be easier to implement politically than many other forms of regulatory instruments. Subsidies do tend to take on a life of their own, which makes it difficult to eliminate or reduce them, should that be desired.

The International Energy Agency (IEA) estimates that in 2001 energy subsidies in OECD countries alone were approximately 20–80 billion US$ (IEA, 2001). The level of subsidies in developing and transition economy countries is generally considered to be much higher. One example is low domestic energy prices that are intended to benefit the poor, but which often benefit high users of energy. The result is increased consumption and delayed investments in energy-efficient technologies. In India, kerosene and liquefied petroleum gas (LPG) subsidies are generally intended to shift consumption from biomass to modern fuels, reduce deforestation and improve indoor air quality, particularly in poor rural areas. In reality, these subsidies are largely used by higher expenditure groups in urban areas, thus having little effect on the use of biomass. Nevertheless, removal of subsidies would need to be done cautiously, in the absence of substitutes, as some rural households use kerosene for lighting (Gangopadhyay *et al*., 2005).

OECD countries are slowly reducing their subsidies to energy production or fuel (such as coal) or changing the structure of their support to reduce the negative effects on trade, the economy and the environment. Coal subsidies in OECD countries fell by 55% between 1991 and 2000 (IEA, 2001).[22] (See Chapter 7 for additional information.)[23] About 460 billion US$ is spent on agricultural subsidies, excluding water and fisheries (Humphreys *et al*., 2003), with OECD

19 As of 1 July 2006, participation in the programme is a requirement for Australian companies receiving fuel tax credits of more than 3 million US$.
20 This programme is a cross between a mandatory and voluntary programme; see Saito (2001), Yamaguchi (2003) and Tanikawa (2004) for additional information. The special relationship between the government and industry as well as unique societal norms make this voluntary initiative unique. In the context of Japan there is de facto enforcement.
21 One way of promoting the use of renewable sources of electricity is for the government to require electric power producers to purchase such electricity at favourable prices. The US Public Utility Regulatory Policy Act of 1978 required electric utilities to buy renewable energy at "avoided cost". In Europe, specific prices have been set at which utilities must purchase renewable electricity – these are referred to as "feed-in tariffs." These tariffs have been effective at promoting the development of renewable sources of electricity (Ackermann *et al*., 2001; Menanteau *et al*., 2003).
22 Calculated using producer subsidy equivalents.
23 It should be noted that a comprehensive analysis of subsidies requires the net effect of subsidies and taxes, including their point of allocation, to be considered.

countries accounting for about 318 billion US$ or 1.2% of the GDP. These subsidies result in the expansion of this sector with associated GHG implications (OECD, 2001, 2002).

Many countries provide financial incentives, such as tax credits for energy-efficient equipment and price supports for renewable energy, to stimulate the diffusion of technologies. In the USA, for example, the Energy Policy Act of 2005 contains an array of financial incentives for various advanced technologies; these financial incentives have been estimated at 11.4 billion US$ over a 10-year period.

One of the most effective incentives for fostering GHG reductions are the price supports associated with the production of renewable electricity, which tend to be set at attractive levels. These price supports have resulted in the significant expansion of the renewable energy sector in OECD countries due to the requirement that electric power producers purchase such electricity at favourable prices. The US Public Utility Regulatory Policy Act of 1978 requires electric utilities to buy renewable energy at "avoided cost". In Europe, specific prices have been set at which utilities must purchase renewable electricity – these are referred to as 'feed-in tariffs'. These tariffs have been effective at promoting the development of renewable sources of electricity (Ackermann *et al*., 2001; Menanteau *et al*., 2003). As long as renewables remain a relatively small portion of overall electricity production, consumers see only a small increase in their electricity rates. Incentives therefore have attractive properties in terms of environmental effectiveness, distributional implications and institutional feasibility. The main problem with them is cost-effectiveness: They are costly instruments, particularly in the long-run as interests and industries grow to expect the continuation of subsidy programmes. See Chapter 4.5 for a more extensive discussion.

13.2.1.6 Research and Development[24]

The role of R&D in changing the trajectory of energy economy is unquestionable – new technologies have played a large role in the evolution of the energy sector over the last century. Moreover, the rate at which low emission technologies will improve during the next 20–30 years will be an important determinant of whether low emission paths can be achieved in the long term.

Policy uncertainties, however, often hinder investment in R&D and the dissemination of new technology, although different types of polices may be needed to address different types of investment. Hamilton (2005) notes that investors prefer a policy environment which is 'loud, long and legal'. A number of authors note that long-term policy targets or clear foresight on carbon taxes can overcome social inertia and reduce uncertainty for investors in R&D (Blyth and Yang, 2006; Edenhofer *et al*., 2006; Reedman, Graham and Coombes, 2006).

Nearly 600 billion US$ was expended worldwide on R&D in all sectors in 2000, with approximately 85% of that amount being spent in only seven countries.[25] Over the last 20 years, the percentage of government-funded R&D has generally declined, while industry-funded R&D has increased in these countries. In a historic context, R&D expenditures as a percentage of GDP have gone up and down in cycles as government priorities have changed over the last 50 years, although in some instances comparisons over time are difficult (US-NSF, 2003; OECD, 2005a; US-GAO, 2005).

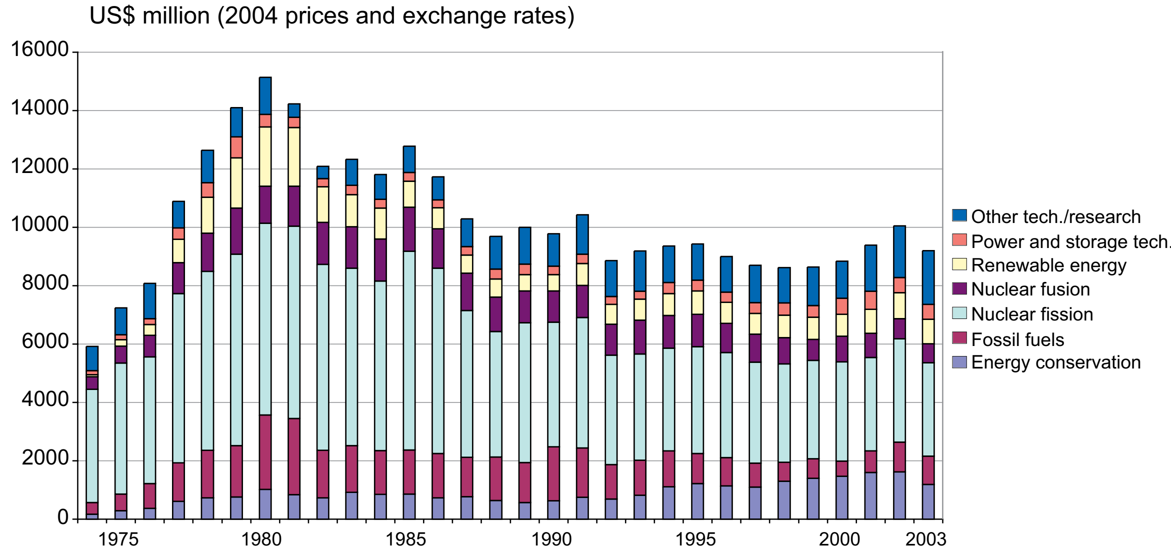
Total public funding for energy technologies in IEA countries during the period 1987–2002 was 291 billion US$, with 50% of this allocated to nuclear fission and fusion, 12.3% to fossil fuels and 7.7% to renewable energy technologies (IEA, 2004; see Figure 13.1).[26] Funding has dropped after the initial interest created through the oil shock in the 1970s and has stayed constant, even after the UNFCCC was ratified. Nemet and Kammen (2006) suggest that for the USA a change in direction is warranted and that a five- to tenfold increase in public funding is feasible.

The USA and Japan, the two largest investors in energy R&D, spent on average of 3.38 and 2.45 billion US$, respectively, between 1975 and 1999. However, such figures mask important underlying trends. For example, a large percentage of the funding designated for energy R&D has gone into nuclear power – nearly 75% in the case of Japan (Sagar and van der Zwaan 2006). The support of the US government for R&D declined by 1 billion US$ from 1994 to 2003, with reductions implemented in nearly all energy technologies, while R&D investments in other areas grew by 6% per year. Between the 1980s and 2003, private sector energy R&D declined from nearly 50% of that of government funding to about 25% (Nemet and Kammen, 2006).

Many countries pursue technological (R&D) advancements as a national policy for a variety of different reasons: for example, to foster the development of innovative technologies or to assist domestic industries in being competitive. Countries also chose to co-operate with each other in order to share costs, spread risks, avoid duplication, access facilities, enhance domestic capabilities, support specific economic and political objectives, harmonize standards, accelerate market learning and create goodwill. Cooperation, however, may increase

24 As used in this section, the term R&D generally refers to research, development and demonstration.
25 Canada, France, Germany, Italy, Japan, the UK and the USA.
26 In year-2000 US$ and exchange rates.

13.1 (a). RD&D budgets for energy



13.1(b). RD&D budgets for renewable energy

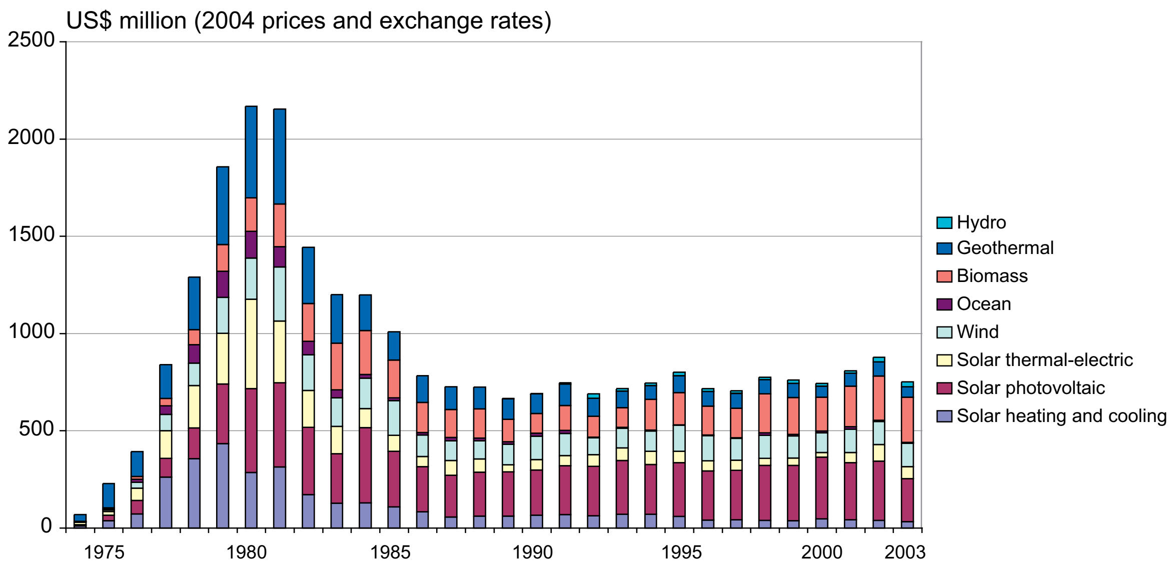


Figure 13.1: *Public funded Research and Development (R&D) expenditures for energy (A) and renewable energy technologies (B) by International Energy Agency (IEA) member countries.*

Source: IEA, 2004, 2005.

transaction costs, require extensive coordination, raise concerns over intellectual property rights and foreclose other technology pathways (Fritsche and Lukas, 2001; Sakakibara, 2001; Ekboir, 2003; Justice and Philibert, 2005). Governments use a number of tools to support R&D, such as grants, contracts, tax credits and allowances and public/private partnerships. The effect of these tools on public budgets and their effectiveness in stimulating innovation will vary as a function of how they are structured and targeted. For example, in the USA, R&D tax credits to industry totalled an estimated 6.4 billion US$ in 2001; however, industries associated with high GHG emissions did not take advantage of this opportunity in that the utility industry received only 23 million US$.[27]

There are different views on the role of R&D, its links to the overall energy innovation system and processes underlying effective learning. Sagar and van der Zwaan (2006) examined the trends in major industrialized countries and report that public R&D spending does not correlate with changes in national energy intensity or carbon emissions per unit of energy

27 http://www.nsf.gov/statistics/inbrief/nsf/nst05316

consumption. For a more extensive discussion of technological learning, energy supply models and the link to R&D, see Chapter 3, Section 3.4.2 and Chapter 11, Section 11.3.3. Watanabe (1999) argues that government R&D can play a role in achieving breakthroughs in some areas, induce investments by industry in R&D and generate trans-sectoral spill over effects. Others have noted, however, that the benefits of R&D may not be realized for two to three decades, which is beyond the planning horizons of even the most forward-looking companies (Anderson and Bird, 1992) and that, for a variety of reasons, industry can only appropriate a fraction of the benefits of R&D investments (Margolis and Kammen ,1999). In the energy sector in particular, technology 'spill over' to competitors is large; as a result, firms under-invest in R&D (Azar and Dowlatabadi 1999) and face difficulties in evaluating intangible R&D outputs (Alic *et al*. 2003).[28] In addition, regulatory interventions can cap profits in the case of path-breaking research success (Foxon and Kemp, 2004; Grubb, 2004).[29] Goulder and Schneider (1999) argue that increasing R&D expenditures in carbon-free technologies could crowd out R&D in the rest of the economy and therefore reduce overall growth rates. However, Azar and Dowlatabadi (1999) counter that radical technological change will trigger more research overall and therefore increase economy-wide productivity rates.

The OECD (2005b) finds that obligations/quotas, price guarantees and tax preferences have had the most influence on innovation and patent activities in the renewable energy sector and that while public subsidies for R&D have not played a role, the overall level of investment in R&D within the economy of a country has been important. Sathaye *et al*. (2005) observe that government-funded research at government-owned facilities, private companies and universities may help identify patentable technologies and processes. They reviewed the process of allocating patent rights in four OECD countries and found that intellectual property rights (IPR) regimes have changed since the ratification of the UNFCCC, with diffusion typically taking place along a pathway of licensing or royalty payments rather than unrestricted use in the public domain. Popp (2002) also examined patent citations and found that the level of energy-saving R&D depends not only on energy prices, but also on the quality of the accumulated knowledge available to inventors. He finds evidence for diminishing returns to research inputs – both across time and within a given year – and notes that government patents filed in or after 1981 are more likely to be cited. Popp (2004) notes that when in terms of the potential for technology to help solve the climate problem, two market failures lead to underinvestment in climate-friendly R&D: environmental externalities and the public goods nature of the new knowledge. As a result, government subsidies to climate-friendly R&D projects are often proposed as part of a policy solution.

Policies that directly affect the environmental externality have a much larger impact on both atmospheric temperature and economic welfare. Fischer and Newell (2004) examine several policy options to promote renewables and indicate that research subsidies are the most expensive approach to achieve emission reductions – in the absence of higher prices. They note that the process of technological change is less important than the implementation of direct incentives to reduce emission intensity or overall energy use. A more specific example arises from the Danish experience with wind technologies. Meyer (2004) notes that despite significant support for wind energy R&D during the 1980s, wind power only boomed in Denmark when favourable feed-in tariffs were introduced, procedures for construction allowances were simplified and priority was given for green electricity. This is supported by Nemet (2005), who found that the ability to raise capital and take risks has played a much larger role in the recent expansion of the photovoltaic industry than other factors, such as learning by experience.

In summary, national programmes and international cooperation relating to R&D are essential long-term measures to stimulate technological advances. Substantial additional investments in and policies for R&D are needed, depending on the specific goals: for example, if high stabilization levels are desired (e.g. 750 ppmv CO_2-eq, which is scenario category D of Chapter 3 of this report), a technology-focused approach that defers emissions reduction to the future would be sufficient; for low stabilization goals (e.g. 450 ppmv CO_2-eq, which is category A1, or 550 ppmv CO_2-eq, which is category B), strong incentives for short-term emission reductions would be necessary in addition to technological development and deployment programmes. See Section 13.3 for a discussion of goals.

13.2.1.7 Information instruments

Information instruments – such as public disclosure requirements and awareness/education campaigns – may positively affect environmental quality by allowing consumers to make better-informed choices. When firms or consumers lack the necessary information about the environmental consequences of their actions, they may act inefficiently. While some research indicates an information provision can be an effective environmental policy instrument, we know less about its efficacy in the context of climate change. Examples of information instruments include labelling programmes for consumer products, information disclosure programmes for firms and public awareness campaigns.

Article 6 of the UNFCCC on Education, Training and Public Awareness calls on governments to promote the development

28 An assessment of private public research partnership under the Advanced Technology Programme in the USA indicates that 'Time lags, along with the difficulty inherent in retrospective evaluation of factors affecting the timing and character of innovations, make it difficult to attribute specific commercial advantages to funding awarded much earlier.' In general, companies shift funds away from basic research towards product modifications and extensions.

29 Renewable energy technologies compete in electricity wholesale markets that are frequently exposed to regulations, such as price caps, which reduce incentives for private investment in long-term R&D.

and implementation of educational and public awareness programmes, promote public access to information and public participation and promote the training of scientific, technical and managerial personnel. With decision 11/CP.8, the Conference of the Parties (COP) launched a 5-year country-driven work programme to engage stakeholders in information/education activities. The UNFCCC secretariat notes that there is a general lack of resources, limited technical skill and poor regional coordination relating to information and education campaigns (UNFCCC 2006a).

Information instruments can often be used to improve the effectiveness of other instruments. Another feature common to all information instruments that makes them unique from other environmental policies is that they do not impose penalties for environmentally harmful behaviour per se. A disclosure programme, such as the Toxics Release Inventory (TRI), requires only that firms document and report their emissions; it does not place limits on how much pollution they can emit.

Kennedy *et al*. (1994) demonstrate that environmental externalities can be at least partially corrected through information provision. However, they also point out that when other corrective instruments, such as taxes, are available, these measures are preferable to information policies. Based on a recent theoretical study, Petrtakis *et al*. (2005) reports that information provision can be more effective than tax instruments, especially when the information can be provided at low cost. Osgood (2002) provides limited empirical support in the context of weather information programmes in Mexico and California.

Evidence-to-date suggests that while disclosure mandates may be effective at changing a firm's environmental practices, other information instruments, such as advisory programmes, have less effect on consumer behaviour (Konar and Cohen, 1997). Firms whose stock price declined significantly when pollution data became publicly available reduced their emissions more than other firms in the same industry. Firms may view information policies as overly burdensome and argue that voluntarily provided information is sufficient (Sterner, 2003). Certainly, there is a cost to disclosure and labelling policies, and costs depend on the level of information required by a policy (Beierle, 2004). A firm may have to collect and disseminate information they would not otherwise have gathered, and government agencies must be able to verify that the information is accurate.

13.2.1.8 Non-climate policies

There are a number of non-climate national policies that can have an important influence on GHG emissions. These include policies focused on poverty, land use and land use change, energy supply and security; international trade, air pollution, structural reforms and population policies. Only a few types of 'non-climate policies' are touched upon in this section.

The literature available on this topic indicates that poverty reduces the resilience of vulnerable populations and makes them more at risk to the potential impacts of climate change, but it also leads communities to take measures that may increase emissions. Heemst and Bayangos (2004) note that if poverty can be reduced without raising emissions, then a strategy to reduce poverty can be seen as a way to reduce emissions as well as enhance resilience. Typical areas of synergy include small-scale renewables (Richards, 2003) and community forestry (Smith and Scherr, 2002), both of which may benefit the poor.

Land use policies (or the lack thereof), whether terrestrial (agriculture, forestry, nature), aquatic (wetlands) or urban, can lead to enhanced emissions. Verhagen *et al*. (2004) note that policies aimed at integrating climate change concerns with the specific concerns of local people may yield major synergies. For example, within the Netherlands, a major programme is currently underway to understand how spatial planning and climate change policy can be effectively linked. Regional (acid rain abatement), local and indoor air pollution policies can also have climate change co-benefits (Bakker *et al*., 2004).

The consumption of natural resources varies significantly between developed and developing countries and is ultimately one of the major drivers of global emissions. The global population and income levels affect the consumption of natural resources, particularly those of energy, food and fibre, and hence can also affect GHG emissions. Policies that increase consumption of natural resources have implications for GHG emissions.

13.2.2 Linking national policies

13.2.2.1 National policy interactions/linkages and packages

Single instruments are unlikely to be sufficient for climate change mitigation, and it is more likely that a portfolio of policies will be required (see IPCC, 2001). Examples of areas where there are potential synergies include water management strategies, farm practices, forest management strategies and residential building standards. Instruments that maximize potential synergies could become socially and economically efficient and may offer opportunities for countries to achieve sustainable development targets, even in the face of uncertainties. This is especially important given the limited financial and human resources in developing countries (Dang *et al*., 2003). Climate change considerations also provide both developing and developed countries with an opportunity to look closely at their respective development strategies from a new perspective. Fulfilling development goals through policy reforms in such areas as energy efficiency, renewable energy, sustainable land use and/or agriculture will often also generate benefits related to climate change objectives.

A key synergy is that between adaptation and mitigation policies. Climate policy options can include both mitigation and adaptation (see Chapter 17 of IPCC (2007b) for a discussion on adaptation policies and Chapter 18 for a detailed analysis of interaction between mitigation and adaptation). Many adaptation options are consistent with pathways towards effective and long-term mitigation and, in turn, several mitigation options can facilitate planned adaptation.

In theory, a perfectly functioning market would need only one instrument (e.g. a tax) to address a single environmental problem, such as climate change. In such a situation, the application of two or more overlapping instruments could diminish economic efficiency while increasing administrative costs. In practice, however, there are market failures that may make a mix of instruments desirable. This section describes some of these cases and addresses situations in which multiple or overlapping objectives might justify a mix of policies.

Climate-related policies are seldom applied in complete isolation: in a large number of cases one or more instruments will be applied. The mere existence of an instrument mix, however, is clearly not 'proof' of its environmental effectiveness and economic efficiency. A rather obvious first requirement for applying an environmentally and economically effective instrument mix is to have a good understanding of the environmental issue to be addressed. In practice, many environmental issues can be complex. While a tax can affect the total demand for a product and the choice between different product varieties, it is less suited to address, for example, how a given product is used and when it is used. Hence, other instruments could be needed. A second requirement for designing efficient and effective policies is to have a good understanding of the links with other policy areas: not only do different environmental policies need to be co-ordinated, but co-ordination with other related policies is also necessary. A third requirement is to have a good understanding of the interactions between the different instruments in the mix.

Several authors describe situations in which a combination of policies might be desirable. Johnstone (2002) argues that the price signal from a tradable permits or tax system may not be sufficient to overcome barriers to technological development and diffusion and that additional policies may be warranted. These barriers include: (1) credit market failures that discourage lenders from providing capital to firms for high-risk investments associated with R&D and even the implementation of new technologies and (2) reduced incentives for private investment in R&D if firms can not prevent other firms from benefiting from their investments (i.e. 'spill-over' effects).[30] Fischer and Newell (2004) find that the combination of a technology policy, such as government sponsored R&D, with a tax or tradable permit instrument could help overcome this type of market imperfection.

A second market failure that may require more than one instrument is the lack of information among consumers on the environmental or economic attributes of a technology. In such a case, a price signal alone may not sufficiently spur the diffusion of these types of technologies. One solution to this type of barrier is an eco-labelling system, which can help increase the effectiveness of a price instrument by providing better information on relevant characteristics of the product (OECD, 2003b; Braathen, 2005). Sijm (2005) notes that this type of market failure may exist for households who may lack the relevant information to invest in energy efficiency measures and may not respond to a price signal. Another market failure in the residential sector may be caused by split incentives where neither the landlord nor tenant has an incentive to invest in energy efficiency measures (Sorrell and Sijm, 2003).

With the implementation of the EU ETS, particular attention has been given to the interaction between a tradable permits mechanism and other policies. Sijm (2005) and Sorrell and Sijm (2003) argue that an emissions trading scheme can co-exist with other instruments as long as these other instruments improve the efficiency of the trading mechanism by addressing market failures or contributing to some other policy objective. However, they argue that the combination of an emissions trading scheme with other instruments could also lead to "double regulation", reduced efficiency and increased costs if policies are not designed carefully. NERA (2005) and Morthorst (2001) assess the interaction of renewable energy policies with tradable permits programmes and conclude that if not designed properly, these policies can lower allowance prices but raise the overall costs of the programme.

There may be cases where a package of CO_2 mitigation policies is justified if these policies serve multiple policy objectives. Sijm (2005) gives several examples of policies and objectives that may be compatible with the EU ETS, including direct regulation that also reduces local environmental effects from other pollutants. Renewable energy policies can be used to expand energy supply, increase rural income and reduce conventional pollutants. Policies that encourage bio-fuel production and automobile fuel efficiency have also been advocated for their advantages in encouraging energy security and fuel diversity as well as GHG mitigation. In the USA, these types of energy policies have been proposed in conjunction with a tradable permits system as part of a package to address energy, security and environmental objectives (NCEP, 2004).

13.2.2.2 Criteria assessment

Any evaluation of the instruments based on the criteria discussed herein is challenging for two reasons. First, practitioners must be able to compare potential instruments based on each of the evaluative criteria. Unfortunately, in many cases it can be difficult if not impossible to rank instruments in an objective manner. For example, Fischer *et al*. (2003) conclude that it is not possible to rank environmental policy

30 For a more extensive discussion of these issues, see Jaffe *et al*., 2003.

Table 13.1: *National environmental policy instruments and evaluative criteria* [a]

Instrument	Criteria			
	Environmental effectiveness	**Cost-effectiveness**	**Meets distributional considerations**	**Institutional feasibility**
Regulations and standards	Emissions level set directly, though subject to exceptions. Depends on deferrals and compliance.	Depends on design; uniform application often leads to higher overall compliance costs.	Depends on level playing field. Small/new actors may be disadvantaged.	Depends on technical capacity; popular with regulators in countries with weakly functioning markets.
Taxes and charges	Depends on ability to set tax at a level that induces behavioural change.	Better with broad application; higher administrative costs where institutions are weak.	Regressive; can be ameliorated with revenue recycling.	Often politically unpopular; may be difficult to enforce with underdeveloped institutions.
Tradable permits	Depends on emissions cap, participation and compliance.	Decreases with limited participation and fewer sectors.	Depends on initial permit allocation. May pose difficulties for small emitters.	Requires well functioning markets and complementary institutions.
Voluntary agreements	Depends on programme design, including clear targets, a baseline scenario, third party involvement in design and review and monitoring provisions.	Depends on flexibility and extent of government incentives, rewards and penalties.	Benefits accrue only to participants.	Often politically popular; requires significant number of administrative staff.
Subsidies and other incentives	Depends on programme design; less certain than regulations/standards.	Depends on level and programme design; can be market distorting.	Benefits selected participants, possibly some that do not need it.	Popular with recipients; potential resistance from vested interests. Can be difficult to phase out.
Research and development	Depends on consistent funding; when technologies are developed and polices for diffusion. May have high benefits in the long term.	Depends on programme design and the degree of risk.	Benefits initially selected participants; potentially easy for funds to be misallocated.	Requires many separate decisions. Depends on research capacity and long-term funding.
Information policies	Depends on how consumers use the information; most effective in combination with other policies.	Potentially low cost, but depends on programme design.	May be less effective for groups (e.g. low-income) that lack access to information.	Depends on cooperation from special interest groups.

Note:
[a] Evaluations are predicated on assumptions that instruments are representative of best practice rather than theoretically perfect. This assessment is based primarily on experiences and published reports from developed countries, as the number of peer reviewed articles on the effectiveness of instruments in other countries is limited. Applicability in specific countries, sectors and circumstances – particularly developing countries and economies in transition – may differ greatly. Environmental and cost effectiveness may be enhanced when instruments are strategically combined and adapted to local circumstances.

instruments based on their technology-stimulating effects. Consequently, it will be difficult to determine which of the available instruments is the most cost-effective. Distributional considerations are also particularly difficult to evaluate. Revesz and Stavins (2006) provide a discussion of the difficulties involved in evaluating instruments based on distribution or equity. They also cite a number of authors that propose different approaches to evaluating policies.

Nevertheless, it is possible to make general statements about each instrument according to the criteria we have selected. For example, it is generally believed that market-based instruments will be more cost effective than regulations and standards (Wiener, 1999). However, this belief implicitly assumes that a country has well-functioning institutions, the lack of which can result in a market-based instrument being more costly to implement (Blackman and Harrington, 2000). Table 13.1 summarizes the seven instruments presented in this chapter for each of the four criteria we discuss. Sterner (2003) and Harrington *et al*. (2004) provide similar summaries for other instruments.

Second, policymakers must determine how much weight to assign each of the evaluative criteria. Consider two instruments that are equally environmentally effective and both institutionally feasible, but one has unfavourable distributional implications while the other is less cost-effective. In order to choose one instrument over the other, one must assess the relative importance of distribution versus cost-effectiveness. However, the determination of just what weight should be given to each evaluative criterium is a subjective question and one left to policymakers to decide. Some authors do provide some guidelines on how policymakers can determine which evaluative criteria are the most important. Sterner (2003) argues that distributional considerations will likely be less important in an economy with relatively less inequality than in countries with large income disparities and also provides additional guidance on other criteria, including institutional flexibility and incentive compatibility. Bell (2003) and Bell and Russell (2002) argue that institutional feasibility is of critical importance in developing countries, where environmental effectiveness and cost-effectiveness may be determined in large part by a government's institutional capacity. In general, the criteria that receive the most weight will be those that are assessed to be the most important in terms of each country's specific circumstances.

13.3 International climate change agreements and other arrangements

The context of and reasons for an international agreement were relatively well covered in IPCC (2001). The authors of more recent reports cite the reasons presented in older publications for the necessity of agreements – namely, the global nature of the problem and the fact that no single country emits more than approximately 20% of global emissions. This situation means that successful solutions will need to engage multiple countries. Similarly, the fact that no one sector is responsible for more than about 25% of global emissions (the largest sector is that of electricity generation and heat production at 24% of the global, six-gas total; see Baumert *et al*., 2005a) implies that no single sector will be uniquely required to act.

13.3.1 Evaluations of existing climate change agreements

In contrast, the more recent publications have devoted considerable attention to the limitations of existing international agreements in addressing the climate change. In fact, there are no authoritative assessments of the UNFCCC or its Kyoto Protocol that assert that these agreements have succeeded – or will succeed without changes – in fully solving the climate problem. As its name implies, the UNFCCC was designed as a broad framework, and the Kyoto Protocol's first commitment period for 2008–2012 has been its first detailed step. Both the Convention and the Kyoto Protocol include provisions for further steps as necessary.

A number of limitations and gaps in existing agreements are cited in the literature, namely:

- The lack of an explicit long-term goal means countries do not have a clear direction for national and international policy (see, for example, Corfee-Morlot and Höhne, 2003);
- The targets are inadequately stringent (Den Elzen and Meinshausen, 2005, who argue for more stringent targets);
- The agreements do not engage an adequate complement of countries (see Baumert *et al*. 1999, who suggest a need to engage developing as well as developed countries, or Bohringer and Welsch 2006, who suggest that with the US withdrawal, the Kyoto Protocol's effect is reduced to zero);
- The agreements are too expensive (Pizer, 1999, 2002);
- The agreements do not have adequately robust compliance provisions (Victor, 2001; Aldy *et al*., 2003);
- The agreements do not adequately promote the development and/or transfer of technology (Barrett, 2003);
- The agreements, as one consequence of failing to solve the problem, do not adequately propose solutions that will facilitate adaption to the forthcoming changes (Muller, 2002).

Reviews of the current agreements take several forms. Some (e.g. Depledge, 2000) provide detailed article-by-article reviews of the existing agreements, seeking to interpret the legal language as well as to provide a better understanding of their historical derivations. In this manner, they offer insight into how future agreements might be developed. Other studies assess the effect of the emission reductions required by the Kyoto Protocol on global GHG concentrations and conclude that although the effect is currently small (Manne and Richels, 1999), it may be large in the future as present-day emission reductions set the stage for future reduction efforts, which would not have happened otherwise (Höhne and Blok, 2006). Some researchers (e.g. Cooper, 2001; Michaelowa *et al*., 2005a) evaluate the basic underpinnings of the two climate agreements, looking at problems associated with establishing binding targets and differentiating between countries as well as difficulties in operationalizing the concept of emissions markets. These kinds of assessments – by far the most common – not only assess current limitations but usually proceed to put forth counter-arguments, outline improvements that should be made and propose alternative mechanisms for addressing the climate problem. See the following sections for responses and alternatives to solving the climate problem.

13.3.2 Elements of international agreements and related instruments

The majority of elements identified in the literature draw on existing multilateral agreements, in particular, the UNFCCC and its Kyoto Protocol. Agreements related to climate change, but not specifically focused on GHG mitigation, are less extensively analysed in the climate literature. These include energy policy and technology agreements (see, for example, publications the IEA evaluating their "Implementing Agreements") and the evaluation of VAs with the auto sector (see, for example, Sauer *et al*., 2005 on the European Automobile Manufacturers Association (ACEA) agreement between the European, Japanese and Korean auto manufacturers). Based on the literature in Table 13.2, it is possible to derive some common elements of international climate change agreements. These are listed in Box 13.6, and expanded upon in the section below.

13.3.3 Proposals for climate change agreements

The literature on climate change contains a large number of proposals on possible future international agreements. Table 13.2 provides a summary review of recent proposals for international climate agreements as reported in the literature (see also Bodansky, 2004; Kameyama, 2004; Philibert, 2005a), although not all proposals cover all elements that are necessary

Box 13.6 Elements for climate change agreements[31]

A number of elements are commonly incorporated in existing – and proposals for new – international climate change agreements. These include:

Goals: Most agreements establish objectives that implementation is supposed to achieve. In the climate context, a variety of goals have been proposed, including those related to emissions reductions, stabilization of GHG concentrations, avoiding "dangerous" interference with climate, technology transfer and sustainable development. Goals can be set at varying degrees of specificity.

Participation: All agreements are undertaken between specific groups of participants. Some have a global scope while others focus on a more limited set of parties (e.g. regional in nature or limited to arrangements between private sector partners). Obligations can be uniform across participants, or differentiated among them.

Actions: All agreements call for some form of action. Actions vary widely and can include national caps or targets on emissions, standards for certain sectors of the economy, financial payments and transfers, technology development, specific programmes for adaptation and reporting and monitoring. The actions can be implicitly or explicitly designed to support sustainable development. The timing for actions varies considerably, from those taking effect immediately, to ones that may take effect only over the longer term; actions may be taken internally (within contracting Parties) or with others (both with non-Parties as well as non-State actors).

Institutions and compliance provisions: Many agreements contain provisions for establishing and maintaining supporting institutions. These perform tasks as varied as serving as repositories for specific, agreement-related data, facilitating or adjudicating compliance, serving as clearing houses for market transactions or information flows, to managing financial arrangements. In addition, most agreements have provisions in case of non-compliance. These include binding and non-binding consequences and may be facilitative or more coercive in nature.

Other elements: Many (although not all) agreements contain additional elements, including, for example, "principles" and other preambular language. These can serve to provide context and guidance for operational elements, although they may be points of contention during negotiations. In addition, many agreements contain provisions for evaluating progress – with a timetable for reviewing the adequacy of efforts and evaluating whether they need to be augmented or modified.

to describe a full regime. The list of proposals is grouped around the following themes: national emission targets and emission trading, sectoral approaches, policies and measures, technology, development-oriented actions, adaptation, financing and proposals focusing on negotiation process and treaty structure.

13.3.3.1 Goals

Most agreements (including those on climate change such as the UNFCCC and the Kyoto Protocol), include specific goals to guide the selection of actions and timing as well as the selection of institutions. Goals can provide a common vision about both the near-term direction and the longer term certainty that is called for by business. In this discussion, goals are distinguished from targets: the former are long-term and systemic, while the latter relate to actions that are near-term and specific. Targets are described under the 'Targets' section (13.3.3.4.1) below.

The choice of the long-term ambition level significantly influences the necessary short-term action and, therefore, the design of the international regime. For example, if the goal is set at high stabilization levels (e.g. stabilizing concentrations at 750 ppmv CO_2-eq, scenario category D of Chapter 3 of this report), a technology-focused approach that defers emissions reduction to the future would be sufficient for the time being. For low stabilization goals (e.g. 450 ppmv CO_2-eq, category A1, or 550 ppmv CO_2-eq, category B), short-term emission reductions would be necessary in addition to technological development programmes.

International regimes can incorporate goals for the short and medium term and for the stabilization of GHG concentrations. One option is to set a goal for long-term GHG concentrations or a maximal temperature rise (such as the 2°C goal proposed by the EU). Such levels might be set based on an agreement of impacts to be avoided (see Den Elzen and Meinshausen, 2005) or on the basis of a cost-benefit analysis (see Nordhaus, 2001). A number of authors have commented on the advantages and disadvantages of setting long-term goals. Pershing and Tudela (2003) suggest that it may be difficult to gain a global agreement on any 'dangerous' level due to political and technical difficulties. Conversely, Corfee-Morlot and Höhne

31 While not an element, agreements often contain specific information as to the time for initiating actions and, often, a date by which actions are to be completed. In addition, many agreements contain provisions for evaluating progress – with a timetable for reviewing the adequacy of efforts and evaluating whether they need to be augmented or modified.

Table 13.2: *Overview of recent proposals for international climate agreements.*

Name (reference)	Description
National emission targets and emission trading	
Staged systems	
Multistage with differentiated reductions: Gupta, 1998; Berk and den Elzen, 2001; Blanchard et al., 2003; Criqui *et al*., 2003; Gupta, 2003a; Höhne et al., 2003; Höhne *et al*., 2005; Michaelowa *et al*., 2005b; den Elzen and Meinshausen, 2006, den Elzen *et al*., 2006a	Countries participate in the system with different stages and stage-specific types of targets; countries transition between stages as a function of indicators; proposal specify stringency of the different stages
Differentiating groups of countries: Storey, 2002; Ott *et al*., 2004	Countries participate in the system with different stages and stage-specific types of targets
Converging markets: Tangen and Hasselknippe, 2005	Scenario with regional emission trading systems converging to a full global post 2012 market system
Three-part policy architecture: Stavins, 2001	All nations with income above agreed threshold take on different targets (fixed or growth); long-term targets (flexible but stringent); short-term (firm, but moderate); and market-based policy instruments, e.g., emissions trading.
Allocation methods	
Equal per capita allocation: Baer *et al*, 2000; Wicke, 2005	All countries are allocated emission entitlements based on their population.
Contraction and convergence: GCI, 2005	Agreement on a global emission path that leads to an agreed long-term stabilization level for greenhouse gas concentrations ('Contraction'). Emission targets for all individual countries set so per-capita emissions converge ('Convergence').
Basic needs or survival emissions: Aslam, 2002; Pan, 2005	Emission entitlements based on an assessment of emissions to satisfy basic human needs.
Adjusted per capita allocation: Gupta and Bhandari, 1999	Allocation of equal per capita emissions with adjustments using emissions per GDP relative to Annex I average.
Equal per capita emissions over time: Bode, 2004	Allocation based on (1) converging per capita emissions and (2) average per capita emissions for the convergence period that are equal for all countries.
Common but differentiated convergence: Höhne *et al*., 2006	Annex I countries' per capita emissions converge to low levels within a fixed period. Non-Annex I countries converge to the same level in the same timeframe, but starting when their per capita emissions reach an agreed percentage of the global average. Other countries voluntarily take on "no lose" targets.
Grandfathering: Rose *et al*., 1998	Reduction obligations based on current emissions.
Global preference score compromise: Müller, 1999	Countries voice preference for either per capita allocation or allocation based on current national emissions.
Historical responsibility – the Brazilian proposal: UNFCCC, 1997b; Rose *et al*., 1998; Meira Filho and Gonzales Miguez, 2000; Pinguelli Rosa *et al*., 2001; den Elzen and Schaeffer, 2002; La Rovere *et al*., 2002; Andronova and Schlesinger, 2004; Pinguelli *et al*., 2004; Trudinger and Enting, 2005; den Elzen and Lucas, 2005; den Elzen *et al*., 2005c; Höhne and Blok, 2005; Rive *et al*., 2006	Reduction obligations between countries are differentiated in proportion to those countries' relative share of responsibility for climate change – i.e. their contribution to the increase of global-average surface temperature over a certain period of time.
Ability to pay: Jacoby *et al*., 1998; Lecoq and Crassous, 2003	Participation above welfare threshold. Emission reductions as a function of ability to pay (welfare).
Equal mitigation costs: Rose et al., 1998; Babiker and Eckhaus, 2002	Reduction obligations between countries are differentiated so that all participating countries have the same welfare loss.
Triptych: Blok et al., 1997; den Elzen and Berk, 2004; Höhne *et al*., 2005	National emission targets based on sectoral considerations: Electricity production and industrial production grow with equal efficiency improvements across all countries. "Domestic" sectors converge to an equal per-capita level. National sectoral aggregate levels are then adopted.
Multi-sector convergence: Sijm *et al*., 2001	Per-capita emission allowances of seven sectors converge to equal levels based on reduction opportunities in these sectors. Countries participate only when they exceed per capita threshold.
Multi-criteria: Ringius *et al*., 1998; Helm and Simonis, 2001; Ringius *et al*., 2002	Emission reduction obligations based on a formula that includes several variables, such as population, GDP and others.

Table 13.2: *Continued.*

Name (reference)	Description
National emission targets and emission trading	
Alternative types of emission targets for some countries	
Dynamic targets: Hargrave *et al*., 1998; Lutter, 2000; Müller *et al*., 2001; Bouille and Girardin, 2002; Chan-Woo, 2002; Lisowski, 2002; Ellerman and Wing, 2003; Höhne *et al*., 2003; Müller and Müller-Fürstenberger, 2003; Jotzo and Pezzey, 2005; Philibert, 2005b; Pizer, 2005b; Kolstad, 2006	Targets are expressed as dynamic variables – including as a function of the GDP (“intensity targets”) or variables of physical production (e.g. emissions per tonne of steel produced).
Dual targets, target range or target corridor: Philibert and Pershing, 2001; Kim and Baumert, 2002	Two emission targets are defined: (1) a lower “selling target” that allows allowance sales if national emissions fall below a certain level; (2) a higher “buying target” that requires the purchase of allowances if a certain level is exceeded.
Dual intensity targets: Kim and Baumert, 2002	A combination of intensity targets and dual targets.
“No lose”, “non-binding”, one-way targets: Philibert, 2000	Emission rights can be sold if the target is reached, while no additional emission rights would have to be bought if target is not met. Allocations are made at a BAU level or at a level below BAU. Structure offers incentives to participate for countries not prepared to take on full commitments but still interested in joining the global trading regime.
Growth targets, headroom allowances, premium allocation: Frankel, 1999; Stewart and Wiener, 2001; Viguier, 2004	Participation of major developing countries is encouraged by unambitious allocations relative to their likely BAU emissions. To ensure benefit to the atmosphere, a fraction of each permit sold can be banked and definitely removed.
Action targets: Goldberg and Baumert, 2004	A commitment to reduce GHG emission levels below projected emissions by an agreed date through “actions” taken domestically, or through the purchases of allowances.
Flexible binding targets: Murase, 2005	A framework for reaching emission targets modelled after the WTO/GATT (World Trade Organization/General Agreement on Tariffs and Trade) scheme for tariff and non-tariff barriers; targets negotiated through rounds of negotiations.
Modifications to the emission trading system or alternative emission trading system	
Price cap, safety valve or hybrid trading system: Pizer, 1999; Pizer, 2002; Jacoby and Ellerman, 2004.	Hybrid between a tax and emission trading: after the initial allocation, an unlimited amount of additional allowances are sold at a fixed price.
Buyer liability: Victor, 2001b	If the seller of a permit did not reduce its emissions as promised, the buyer could not claim the emission credit. Enforcement is more reliable as buyers deal with developed countries with more robust legal procedures.
Domestic hybrid trading schemes: McKibbin and Wilcoxen, 1997; McKibbin and Wilcoxen, 2002	Two kinds of emissions permits valid only within the country of origin. (1) long-term permits entitle the permit owner to emit 1 tC every year for a long period; permits are distributed once. (2) Annual permits allow 1 tC to be emitted in a single year. An unlimited number of these permits are given out at a fixed price (price cap). Compliance is based on either unit.
Allowance purchase fund: Bradford, 2004	Countries contribute to an international fund that buys/retires emission reduction units. Countries can sell reductions below their BAU levels.
Long-term permits: Peck and Teisberg, 2003	Long-term permits could be used once at any time between 2010 and 2070. Depending on the time of emission they are depreciated 1% annually for atmospheric decay of CO_2. The permit would allow the emission of 1 tC in 2070, 1.01 tC in 2069 and 1.0160 (1.71) tons in 2010.

Table 13.2: *Continued.*

Name (reference)		Description
Sectoral approaches	Sectoral approaches	
	Sector Clean Development Mechanism, sector Crediting Mechanism : Philibert and Pershing, 2001; Samaniego and Figueres, 2002; Bosi and Ellis, 2005; Ellis and Baron, 2005; Sterk and Wittneben, 2005	Sectoral crediting schemes based on emission reductions below a baseline. Excess allowances can be sold.
	Sector pledge approach: Schmidt et al., 2006	Annex I countries have emission targets, with the ten highest-emitting developing countries pledging to meet voluntary, “no-lose” GHG emissions targets in the electricity and major industrial sectors. Targets are differentiated, based upon national circumstances, and sector-specific energy-intensity benchmarks are developed by experts and supported through a Technology Finance and Assistance Package.
	Caps for multinational cooperation: Sussman *et al*., 2004	A cap/and trade system associated with the operations of associated enterprises in developing and developed countries.
	Carbon stock protocol: WBGU, 2003	A protocol for the protection of carbon stocks based on a worldwide system of “non-utilization obligations” to share the costs of the non-degrading use of carbon stocks among all states.
	“Non-binding” targets for tropical deforestationa: Persson and Azar, 2004	Non-binding commitments for emissions from deforestation under which reduced rates of deforestation could generate emissions allowances.
Policies and measures	Policies and measures	
	Carbon emission tax: Cooper, 1998; Nordhaus, 1998; Cooper, 2001; Nordhaus, 2001; Newell and Pizer, 2003	All countries agree to a common, international GHG emission tax; several of the proposals suggest beginning with a carbon tax limited to emissions from fossil fuel combustion.
	Dual track: Kameyama, 2003	Countries choose either non-legally binding emission targets based on a list of policies and measures or legally-binding emission caps allowing international emissions trading.
	Climate “Marshall Plan”: Schelling, 1997, 2002	Financial contributions from developed countries support climate friendly development; similar in scale and oversight to the Marshall Plan.
Technology	Technology	
	Technology research and development: Edmonds and Wise, 1999; Barrett, 2003	Enhanced coordinated technology research and development.
	Energy efficiency standards: Barrett, 2003; Ninomiya, 2003	International agreement on energy efficiency standards for energy-intensive industries.
	Backstop technology protocol: Edmonds and Wise, 1998	New power plants installed after 2020 must be carbon neutral. New synthetic fuels plants must capture CO_2. Non-Annex I countries participate upon reaching Annex I average GDP in 2020.
	Technology prizes for climate change mitigation: Newell and Wilson, 2005	Incentive or inducement prizes targeted at applied research, development and demonstration.
Development-oriented actions	Development-oriented actions	
	Sustainable development policies and measures: Winkler *et al*., 2002b; Baumert *et al*., 2005b	Countries integrate policies and measures to reduce GHG emissions into development plans (e.g. developing rural electrification programmes based on renewable energy, or mass transit systems in placed of individual cars).
	Human development goals with low emissions: Pan, 2005	Elements include: identification of development goals/basic human needs; voluntary commitments to low carbon paths via no-regret emission reductions in developing countries conditional to financing and obligatory discouragement of luxurious emissions; reviews of goals and commitments; an international tax on carbon.

Table 13.2: *Continued.*

Name (reference)		Description
Adaptation	Adaptation	
	UNFCCC impact response instrument: Müller, 2002	A new "impact response instrument" under the auspices of the UNFCCC for disaster relief, rehabilitation and recovery.
	Insurance for adaptation; funded by emission trading surcharge: Jaeger, 2003	A portion of the receipts from sales of emissions permits would be used to finance insurance pools.
Financing	Financing	
	Greening investment flows: Sussman and Helme, 2004	Investments through Export Credit Agencies are conditional on projects that are "climate friendly".
	Quantitative finance commitments: Dasgupta and Kelkar, 2003	Annex I countries take on quantitative financial commitments – e.g. expressed as a percentage of the GDP – in addition to emission reduction targets.
Negotiation process and treaty structure	Negotiation process and treaty structure	
	Bottom-up or multi-facet approach, pledge (with review) and review: Reinstein, 2004; Yamaguchi and Sekine, 2006	Each country creates its own initial proposal relating to what it might be able to commit to. Individual actions accumulate one by one. The collective effect of proposals is periodically reviewed for adequacy and – if necessary – additional rounds of proposals are undertaken.
	Portfolio approach: Benedick, 2001	A portfolio including: emission reduction policies, government research/ development, technology standards and technology transfer.
	A flexible framework: PEW, 2005	A portfolio including: aspirational long-term goals, adaptation, targets, trading, policies, and technology cooperation.
	Orchestra of treaties: Sugiyama et al., 2003	A system of separate treaties among like-minded countries (emission markets, zero emission technology, climate-wise development) and among all parties to UNFCCC (monitoring, information, funding).
	Case study approach: Hahn, 1998	Multiple case studies of coordinated measures, emissions tax, tradable emission permits and a hybrid system in industrialized countries to learn by doing.

Note:

a There is some potential conflict with the terminology here: "non-binding" targets may be interpreted by some as restricting the capacity of countries to trade as they do not necessarily set up caps that impose prices and thus established tradable commodities.

Source: Earlier overviews by Bodansky, 2004; Kameyama, 2004; Philibert, 2005a

(2003) believe such goal-setting is desirable as it helps structure commitments and institutions, provides an incentive to stimulate action and helps establish criteria against which to measure the success of implementing measures.

An alternative to agreeing on specific CO_2 concentration or temperature levels is an agreement on specific long-term actions (such as a technology-oriented target, such as 'eliminating carbon emissions from the energy sector by 2060'). An advantage of such a goal is that it might be linked to specific actions. While links between such actions, GHG concentrations and climate impacts can be made, there are uncertainties in the precise correlation between them. Additionally, several different targets would have to be set to cover all climate-relevant activities (Schelling, 1997; Pershing and Tudela, 2003).

Another option would be to adopt a 'hedging strategy' (IPCC, 2001, chapter 10), which is defined as a shorter term goal on global emissions, from which it is still possible to reach a range of desirable long-term goals. One example of such a strategy is the California goal of reducing emissions to 1990 levels by 2020, and then reducing them to 80% below 1990 levels by 2050. Once the short-term goal is reached, decisions on subsequent steps can be made in light of new knowledge and decreased levels of uncertainty. To implement this option, the international community could agree on a maximum quantity of permissible GHG emissions in, for example, 2020 (Corfee-Morlot and Höhne, 2003; Pershing and Tudela, 2003; Yohe *et al*., 2004).

Another proposal would be to aim at formulating reductions step by step, based on the willingness of countries to act, without explicitly considering a long-term perspective. While such an approach does meet political acceptability criteria, it poses the risk that the individual reductions may not add up to the level required for certain stabilization levels. Some stabilization options may then be out of reach in the near future (see Chapter 3.3, Figure 3.19).

13.3.3.2 Participation

The participation of states in international agreements can vary. At one extreme, participation can be universal; at the other extreme, participation can be limited to just two countries. Many studies propose that participation can be differentiated in different tiers (see Staged systems in Table 13.2). States participating in the same tier would have the same

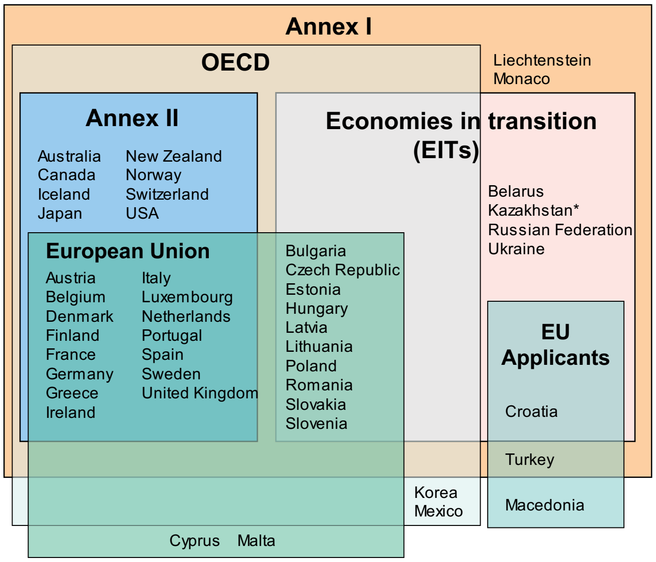


Figure 13.2: *Current country groupings under the UNFCCC, OECD and EU.*
Source: Höhne et al. (2005).

type of commitments (i.e. in the UNFCCC regime). The most important tiers are Annex I and non-Annex I, but there are also special arrangements for economies in transition as well as for least developed countries. Figure 13.2 shows the groupings of countries under the UNFCCC, OECD and EU. The allocation of states into tiers can be made according to quantitative or qualitative criteria or 'ad hoc' (see Table 13.2). According to the principle of sovereignty, states may also choose the tier in which they want to be grouped, provided their choice is accepted by other countries (see Kameyama, 2003; Reinstein, 2004).

Participation in the agreement can be static[32], or it may change dynamically over time. In the latter case, states can "graduate" from one tier of commitments to the next. Graduation can be linked to the meeting of quantitative thresholds for certain parameters (or combinations of parameters) that have been predefined in the agreement, such as emissions, cumulative emissions, GDP per capita, relative contribution to temperature increase or other measures of development, such as the human development index (see Berk and Den Elzen (2001), Gupta (1998, 2003a) and Höhne *et al*. (2003) for a review of per-capita emissions thresholds; Criqui *et al*. (2003) and Michaelowa *et al*. (2005b) for discussion of a composite index using the sum of per-capita emissions and per-capita GDP and Torvanger *et al*. (2005) for further composite indices). Qualitative thresholds such as adherence to certain country groupings (OECD, Economies in Transition) are already in use. Ott *et al*. (2004) combine quantitative and qualitative thresholds. Thresholds can be derived from agreed-upon GHG concentration targets or global emissions paths or be based on other parameters, such as willingness or capacity to pay.

Some have argued that an international agreement needs to include at least the major emitters to be effective, since the largest 15 countries (the EU25 is considered here to be one country) produce as much as 80% of global GHG emissions (Baumert *et al*., 2005a; PEW, 2005; Stewart and Weiner, 2003; Torvanger *et al*., 2005; Schmidt *et al*., 2006). A similar approach has been taken by authors comparing climate change agreements to other multilateral instruments, including disarmament treaties and the Antarctic Treaty (see Murase, 2002a). In these analyses, the authors assert that success can only be achieved if the major stakeholders act. Thus, for example, a nuclear disarmament treaty would be meaningless if it was not ratified by those States with nuclear weapons, even if it was ratified by the 180 non-nuclear States. By analogy, a climate change treaty is meaningful only if commitments are adopted and implemented by the major emitters – noting that the benefits of participation accrue to all countries, including those not taking part in the agreement. Murase (2002a) suggests that a future regime after 2012 thus needs to include key countries or groups such as the USA, EU, Japan, China, India, Korea, Mexico, Brazil, Indonesia, South Africa and Nigeria.

Much of the literature on game theory suggests that the conditions necessary for achieving large-scale stable coalitions mean that relatively modest emissions reductions will be achieved (e.g. Carraro and Siniscalco, 1993; Hoel and Schneider, 1997). Cooperative game theory emphasizes the prospect of building stable coalitions if a transfer scheme (e.g. by emissions trading) can allocate the gains from cooperation in proportion to the benefits from reduced climate impacts (e.g. Chander and Tulkens, 1995; Germain *et al*., 1998; Germain *et al*., 2003). Eykmans and Finus (2003) note that much of the literature focuses on a 'grand (all party) coalition, analyses stability in terms of the aggregate payoff to coalitions and rests on very strong assumptions about implicit punishment of any free-riding countries.' A more extensive discussion of the issues of free-riding is contained in Chapter 10 of the TAR.

Alternative assumptions can provide a richer understanding of possible factors relevant to an agreement by relating relate to the response to payoffs from cooperation, including spillover and trade effects, allowing for the development of multiple coalitions and recognizing trade and the role of technology transfer as well as the potential for other transfer schemes (Tol *et al*., 2000; Finus, 2002; Kemfert *et al*., 2004). They also increase the possibility that partial cooperation (including involving more than one coalition) can close the gap between the global optimum (full cooperation) and "no cooperation" by a substantial amount. While this is essentially a theoretical conclusion (based in some cases on modelling reflecting some empirical evidence), it provides some basis for suggesting that it is too restrictive to assume that a single, all-encompassing global intergovernmental agreement is a *necessary* condition

32 For example, participation in the tiers of commitments of the Kyoto Protocol can only be changed by an amendment which has to be ratified by all parties. As this is extraordinarily difficult, membership in the tiers is essentially fixed.

for effective mitigation action.

Some authors (see, for example, Muller, 2002; Jaeger, 2003) suggest that a climate regime is not exclusively about mitigation but that it also encompasses adaptation and, as such, far wider arrays of countries are vulnerable to climate and must be included in any agreement. Further, several authors (e.g. Meira Filho and Gonzales, 2000; Pan, 2005) argue that even if the majority of emissions are the responsibility of only a few nations, all countries must share the commitments to reduce these for reasons of equity and fairness (recognizing that such actions should be differentiated according to responsibility and capability). Other rationales for global engagement are also used, including that if only some major countries participate, the emissions of non-participating countries could increase by the migration of emission-intensive industries. Therefore, most proposals aim to provide incentives for countries to participate. Some aim at pull incentives, such as temporary over-allocation or no regret structures; others mention push incentives, such as trade sanctions or border tax adjustments (Kuik, 2003; Biermann and Brohm, 2005).

Other authors argue that countries have differentiated historical responsibility and that such a sub-global participation can be effective: Grubb *et al*. (2002) argue that under some scenarios one can expect that technology development driven by the international climate regime in Annex I countries could offset some or all emissions leakage in non-Annex I countries. Sijm (2004) notes that a number of policies could promote this spillover effect in the longer term. These types of policies include international cooperation on Research, Development and Demonstration (RD&D), promoting open trade or using the Clean Development Mechanism. Others argue that with the participation of some large countries, other countries cannot lag behind and that the climate regime should look for that 'tipping point' (Barrett, 2003).

In general, the literature suggests that actions can occur in parallel and that international agreements could have multiple components, since national circumstances are so diverse. However, the suggestion is also made that care should be taken, particularly for countries with limited institutional capacity, to avoid creating too many simultaneous international activities.

13.3.3.3 Implications of regime stringency: linking goals, participation and timing

Several studies have analysed the regional emission allocations or requirements on emission reductions and time of participation in the international climate change regime with the aim of being able to ensure different concentration or temperature stabilization targets (Berk and den Elzen, 2001; Blanchard, 2002; Winkler *et al*., 2002a; Criqui *et al*., 2003; WBGU, 2003; Bollen *et al*., 2004; Groenenberg *et al*., 2004; Böhringer and Löschel, 2005; den Elzen and Meinshausen, 2005; den Elzen and Lucas, 2005, den Elzen *et al*., 2005c; Höhne *et al*., 2005; Michaelowa *et al*., 2005a; Böhringer and Welsch, 2006; Höhne, 2006; Persson *et al*., 2006). A large variety of system designs for allocating emission allowances/permits were analysed, including contraction and convergence, multistage, Triptych and intensity targets. The studies cover a broad spectrum of parameters and assumptions that influence these results, such as population, GDP development of individual countries or regions, global emission pathways that lead to climate stabilization (including overshooting the desired concentration level), parameters for the thresholds for participation and ways to share emission allowances. For example, the studies include very stringent requirements for developed countries with more lenient requirements for developing countries as well as less stringent requirements for developed countries and more ambitious constraints for developing countries within a plausible range. The conclusions of these studies and their implications for international regimes can be summarized as follows:

- Under regime designs for low and medium concentration stabilization levels (i.e. 450 and 550 ppm CO_2-eq, category A and B; see Chapter 3, Table 3.10) GHG emissions from developed countries would need to be reduced substantially during this century. For low and medium stabilization levels, developed countries as a group would need to reduce their emissions to below 1990 levels in 2020 (on the order of –10% to 40% below 1990 levels for most of the considered regimes) and to still lower levels by 2050 (40% to 95% below 1990 levels), even if developing countries make substantial reductions. The reduction percentages for individual countries vary between different regime designs and parameter settings and may be outside of this range. For high stabilization levels, reductions would have to occur, but at a later date (see Box 13.7).
- Under most of the considered regime designs for low and medium stabilization levels, the emissions from developing countries need to deviate – as soon as possible – from what we believe today would be their baseline emissions, even if developed countries make substantial reductions. For the advanced developing countries, this occurs by 2020 (mostly Latin America, Middle East and East Asia). For high stabilization levels, deviations from the reference level are necessary only at a later date.
- Reaching lower levels of GHG concentrations requires earlier reductions and faster participation compared to higher concentrations.
- For many countries, the overall target set is critical; it dictates the emissions reduction requirements more specifically than does the approach chosen to meet that target.
- The wide diversity of approaches means that not all countries participate under all regimes – even if an identical concentration target is achieved. Obviously, required national actions differ enormously, depending on whether a country participates in a system. However, the difference in reductions required between the various approaches is small for participating countries.

Box 13.7 The range of the difference between emissions in 1990 and emission allowances in 2020/2050 for various GHG concentration levels for Annex I and non-Annex I countries as a group[a]

Scenario category	Region	2020	2050
A-450 ppm CO_2-eq[b]	Annex I	–25% to –40%	–80% to –95%
	Non-Annex I	Substantial deviation from baseline in Latin America, Middle East, East Asia and Centrally-Planned Asia	Substantial deviation from baseline in all regions
B-550 ppm CO_2-eq	Annex I	-10% to -30%	-40% to -90%
	Non-Annex I	Deviation from baseline in Latin America and Middle East, East Asia	Deviation from baseline in most regions, especially in Latin America and Middle East
C-650 ppm CO_2-eq	Annex I	0% to -25%	-30% to -80%
	Non-Annex I	Baseline	Deviation from baseline in Latin America and MIddle East, East Asia

Notes:

[a] The aggregate range is based on multiple approaches to apportion emissions between regions (contraction and convergence, multistage, Triptych and intensity targets, among others). Each approach makes different assumptions about the pathway, specific national efforts and other variables. Additional extreme cases – in which Annex I undertakes all reductions, or non-Annex I undertakes all reductions – are not included. The ranges presented here do not imply political feasibility, nor do the results reflect cost variances.

[b] Only the studies aiming at stabilization at 450 ppm CO_2-eq assume a (temporary) overshoot of about 50 ppm (See Den Elzen and Meinshausen, 2006).

Source: See references listed in first paragraph of Section 13.3.3.3

Several studies have gone one step further and have, based on emission allocations, calculated emission reduction costs and possible trades of emission allowances at a regional level for different concentration or temperature stabilization targets (Criqui *et al*., 2003; WBGU, 2003; Bollen *et al*., 2004; Böhringer and Welsch, 2004, 2006; Böhringer and Löschel, 2005; den Elzen and Lucas, 2005; den Elzen *et al*., 2005c; Persson *et al*., 2006). Researchers have also analysed a large variety of system designs. With cost analysis even more assumptions are relevant, such as detailed assumptions on emission reduction costs per sector and region. Costs have been calculated using a variety of models, ranging from those with detailed sectoral representation focussing on the technological aspects to macroeconomic models focussing on the economy as a whole. How (and what) costs are calculated plays a role. Some studies present annual direct mitigation costs (only direct abatement costs) or energy costs, such as mitigation costs and costs of losses of fossil fuel exports or gains from increased exports of biofuels. Other studies present full macro-economic costs, calculated as (cumulative) GDP losses in a specific target year. The cumulative impact of climate policies on GDP may be lower than expected from the annual abatement costs levels due to the fact that climate policy leads mostly to the substitution of investments and activities and much less to an overall reduction of the GDP. The conclusions of these studies on costs can be summarized as follows:

Global costs

- The total global costs are highly dependent on the baseline scenario, marginal abatement costs estimates, the participation level in emission trading and the assumed concentration stabilization level (see also Chapter 11).
- The total global costs does not vary significantly for the same global emission level; however, costs will vary with the degree of participation in emission trading (how and when allowances are allocated). If, for example, some major emitting regions do not participate in the reductions and in emission trading immediately, the global costs of the participating regions may be higher (see also Chapter 3, e.g. Bollen *et al*., 2004; den Elzen *et al*., 2005c).

Regional costs

- Regional abatement costs are largely dependent on the assumed stabilization level and baseline scenario. The allocation regime is also an important factor, although in most countries the extent of its effect is less than that of the stabilization level (see Criqui *et al*., 2003; den Elzen and Lucas, 2005; den Elzen *et al*., 2006b). The allocation parameter having the largest effect is the timing of participation. Under a staged approach, whether a region participates early or late is of great importance. If, for example, convergence of the per capita emissions were to occur by the end of this century, developing regions would incur high costs relative to what might occur in the reference or baseline cases. Conversely, if convergence were to occur by the middle of the century, developed countries would incur higher costs relative to what they might incur in a reference or baseline case (see Nakicenovic and Riahi, 2003; den Elzen *et al*., 2005a; Persson *et al*., 2006).

- Abatement costs (only costs from reducing emissions) as a percentage of GDP vary significantly by region for allocation schemes that ultimately lead to convergence in per capita emissions by the middle of this century. The costs are above the global average for the Middle East and the Russian Federation, including surrounding countries, and – to a lesser extent – for Latin America. The costs are near the world average for the OECD regions and below the world average for China. The other developing regions, such as Africa and South-Asia (India), experience low costs or even gains as a result of financial transfers from emission trading. (Criqui *et al*., 2003; den Elzen and Lucas, 2005).
- In addition to the abatement costs of reducing emissions, other costs arise from changes in international trade. Fossil fuel-exporting regions are also likely to be affected by losses in coal and oil exports compared to the baseline, while some regions could experience increased bio-energy exports (i.e. the Russian Federation and South America) (see Nakicenovic and Riahi, 2003; van Vuuren *et al*., 2003; Persson *et al*., 2006; and also Chapter 11).
- The economic impacts in terms of welfare changes show a similar pattern for different allocation schemes. For example, allocation schemes based on current emissions (sovereignty) lead to welfare losses for the developing countries. Allocation schemes based on a per capita convergence lead to welfare gains for developing countries, without leading to excessive burdens for industrialized countries. (Böhringer and Welsch, 2004)

13.3.3.4 Actions

13.3.3.4.1 Targets

While many types of commitments are identified in the literature on climate change, the most frequently evaluated commitment is that of the binding absolute emission reduction target as included in the Kyoto Protocol for Annex I countries. The broad conclusion that can be drawn from the literature is that such targets provide certainty about future emission levels of the participating countries (assuming targets will be met). These targets can also be reached in a flexible manner across GHGs and sectors as well as across borders through emission trading and/or project-based mechanisms (in the Kyoto Protocol case, this is referred to as Joint Implementation (JI) and as the Clean Development Mechanism (CDM).

One crucial element is defining and agreeing on the level of the emission targets. Examples of processes to agree on a target include:

- Participating countries make proposals (pledges) for individual reductions on a bottom-up basis. This approach has the risk that proposed reductions may not be adequate to lead to the desired stabilization levels.
- A common formula can be agreed upon for determining the emission targets. This rule could lead to reduction percentages for each individual country (which could subsequently be modified by negotiations).
- An overall target can be given to a group of countries, with the group deciding internally on how to share the target amongst the participants. This approach has been applied to the EU for the purpose of the Kyoto Protocol. It could, in principle, also be applied to any other group of countries.

Many authors have raised concerns that the absolute or fixed targets may be too rigid and cap economic growth (Philibert and Pershing, 2001; Höhne *et al*., 2003; Bodansky, 2004). To address these concerns, a number of more flexible national emission targets have been proposed (see alternative types of emission targets in Table 13.2). These options aim at maintaining the advantages of international emissions trading while providing more flexibility to countries to avoid extremely high costs and, thereby, potentially allowing for the adoption of more stringent targets. However, this flexibility reduces the certainty that a given emission level will be reached. Thus, there is a trade-off between costs and certainty in achieving an emissions level (see Jotzo and Pezzey, 2005). Other disadvantages that have been mentioned are adding to the complexity of the system or, in the case of intensity targets, the difficulty in coping with economic recession as well as the potential for creating ambiguity for market investors.

Additional understanding comes from the political science literature which emphasizes the importance of analysing the full range of factors bearing on decisions by nation states, including domestic pressures from the public and affected interest groups, the role of norms and the contribution of NGOs (environment, business and labour) to the negotiation processes. Studies of the European Acid Rain Regime have revealed, for example, that although agreements on an ambitious target can serve as a driver for policy implementation, they may not necessarily result in a good environmental consequence if the countries involved do not have the capacity to comply with what they have committed themselves to in good faith (Victor, 1998). While such case study-based analyses yield conclusions that are dependent on the choice of cases and the manner in which the analysis is carried out, they can provide insights which are more accessible to policymakers than more quantitative economic analyses.

13.3.3.4.2 Flexibility provisions

Many environment agreements seek to address complex issues by allowing for additional flexibility as a means to achieve their goals. Flexibility has been suggested as to 'how', 'when', 'where' and 'what' emissions are to be reduced. In the climate change context, emission reductions under an international agreement can conceptually be achieved any 'where' on the globe. It is also possible to shift the timing ('when') of emission reductions (depending on the emission pathway), the 'how' (i.e. choice of policy instrument) and the 'what' in terms of the specific emission source or sink that is the target of the policy.

The Kyoto Protocol incorporates three articles that provide flexibility as to 'where' emission reductions occur, namely, through provisions on international emission trading, JI and the CDM. Under Kyoto's international ETS, emission allowances may be traded between governments of Annex B parties if a surplus occurs in one country. Emission reductions achieved through projects between Annex I countries are called JI, while emission reduction projects located in non-Annex I countries are called CDM projects. Extensive rules have been agreed upon to ensure that credits created under these project mechanisms actually represent the emissions reduced.

International Emissions Trading

Emissions' trading has become an important implementation mechanism for addressing climate change in many countries. The overall value of the global carbon market was over 10 billion US$ in 2005, and in the first quarter of 2006 the transaction level reached 7.5 billion US$ (World Bank and IETA, 2006). The most advanced ETS is that developed by the EU. While this system is an international one, it bears many of the characteristics of a national programme, with oversight by the European Commission and a centralized regulatory and review mechanism (see Box 13.4 for details, including those on trading prices and volumes). A larger global system of international trading is slowly developing through emission credits generated by the project-based mechanisms[33]. Theoretically, a fully global ETS would provide market players and policymakers with information thus far absent from decision-making: the actual, unfettered, global cost of GHG mitigation in a range of economic activities. In this context, at the international level, such a regime would mirror the information provided by national trading programmes at a global scale.

Lecocq and Capoor (2005) note that while the international GHG emissions market remains fragmented, trading activity has increased substantially during the last 5 years. According to their analysis, regional, national and sub-national trading programmes are all operating under different rules, which could inhibit 'market convergence' and increase the costs of trading. Others indicate that a global market can incorporate diverse domestic and regional systems despite differences in design; they reiterate the point made by others that such a system may be significantly less efficient that a single globally optimized regime (Baron and Philibert, 2005).

A full assessment of the elements required to link multiple regimes is provided by Haites (2003a), who identifies only a few situations that might prevent linkages (a formal prohibition in one system to allow links, and circumstances where a single firm's membership in multiple programmes creates the potential for double counting). However, issues that could complicate links between two or more emissions trading programmes include concerns on the effectiveness of compliance enforcement and on whether the linked regimes provide adequate protection of either system's environmental objectives. As Bygrave and Bosi (2004a,b) note, links do not need to be formal; market arbitrage can provide opportunities for purchasing allowances in multiple markets even if there is no specific recognition of one system's permits under another's structure.

Various authors have analysed the size of the allowance surplus of the countries in transition, barriers to accessing allowances, the potential market power of cartels and links to energy security. Such surpluses can alter the overall costs of compliance with the Kyoto commitments – but only if trade in such surplus allowances is undertaken. Victor *et al*. (2001a) estimated the joint Russian and Ukrainian surplus at 3.7 billion tCO_2 for the entire commitment period 2008–2012. Berkhout and Smith (2003) estimate the surplus level of the former Soviet Union through to 2030 and state that it could only cover half of an assumed 30% reduction target for a 28-member state EU. Golub and Strukova (2004) see the Russian surplus as being up to 3 billion tCO_2, arguing that due to barriers in the Russian capital market, forward trading with OECD countries represents the only opportunity to raise initial capital to mobilize no-regret and low-cost GHG reductions. Maeda (2003) shows that permits for surplus emissions in the international emissions trading regime may affect the economic efficiency of the Kyoto mechanism and suggests that considerable market power exerted by sellers could affect the price (e.g. if all of the economies in transition form a cartel, if Ukraine forms a cartel with Russia or even if Russia acts alone). Kuik (2003) sees a trade-off between economic efficiency, energy security and carbon dependency with respect to the EU acquisition of Russian and Ukrainian assigned amount units. One proposal for reducing concerns over trading in surplus allowances is that of the 'Green Investment Scheme', in which revenues from sales of surplus allowances are spent on national policies, programmes and projects to further reduce emissions; this option is explained further below.

Project-based mechanisms (Joint Implementation and the Clean Development Mechanism)

The earliest project-based mechanism of the UN Climate Convention process was the pilot phase of 'Activities Implemented Jointly' (AIJ). Most of the 150 AIJ projects were small, and many were only partially implemented due to the lack of financing that resulted from the lack of emissions credits. Only half a dozen investor countries and even fewer host countries developed real, national AIJ programmes. Selection criteria for AIJ programmes often delayed the acceptance of

33 The EU ETS has also an international component as it involves cross-border trades and transactions between national allowance registries.

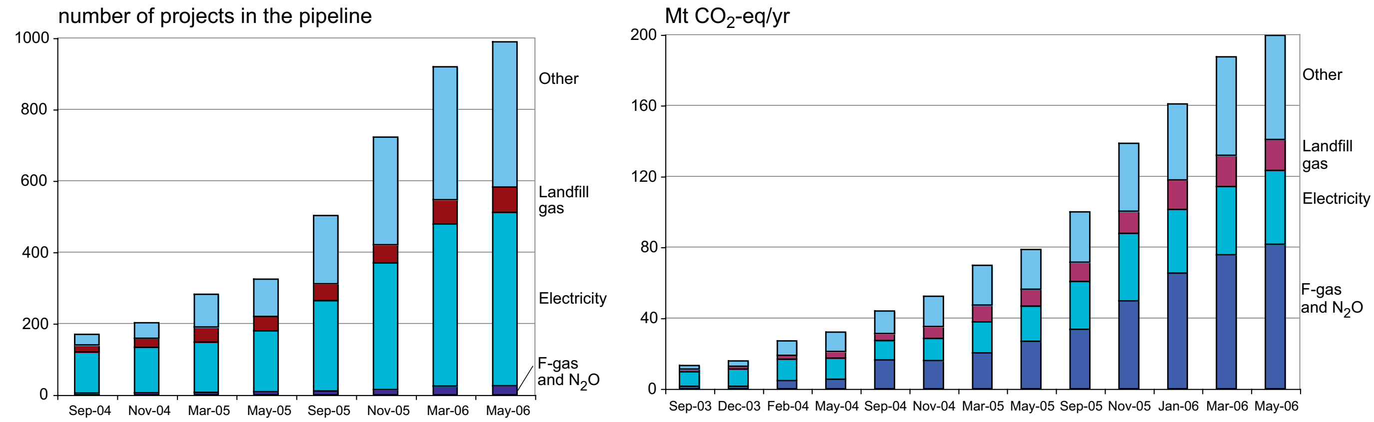


Figure 13.3: *Evolution of the Clean Development Mechanism portfolio in terms of CO_2 -equivalents per year and number of projects.*
Source: Ellis and Karousakis (2006).

projects, and most that were undertaken were commercially viable only if additional financing was provided by a separate investment subsidy (Michaelowa, 2002).

Since 2000, the CDM has allowed crediting of project-based emission reductions in developing countries; this is the first of the Kyoto Protocol's market mechanisms to be implemented. A number of analysts have estimated CDM volume and price. Chen (2003) derived prices of 2.6–4.9 US\$/tCO_2 and annual volumes of approximately 600–1000 million certified emissions reductions (CERs). Jotzo and Michaelowa (2002) and Michaelowa and Jotzo (2005) model an annual CER demand of 360 million tCO_2 and a price of 3.6 €/tCO_2. Springer and Varilek (2004) predict a likely CER price of less than 10 US\$/tCO_2 in 2010. CER prices increased from approximately 3 €/tCO_2 in 2003 to more than 20 €/ton in early 2006 (at the time of peak prices in the EU ETS); as of October 2006, they had declined to about 13 €/tCO_2. CER prices have been relatively closely tied to EU ETS prices over time.

As of May 2006, the volume of CERs estimated from nearly 1000 proposed projects in 69 countries was 200 MtCO_2-eq/year in 2008–2012 and 330 Mt MtCO_2-eq/year in the pre-2008 period (Ellis and Karousakis, 2006; specific project information can be found at http://cdm.unfccc.int; recent updates on the CDM/JI pipeline can also be found at the UNEP/RISO site, www.cd4cdm.org/publications/CDMpipeline.xls) (See Figure 13.3). While not all projects will be implemented, the UNFCCC cites 491 registered projects and estimates CERs equal to 740 MtCO_2-eq from those projects through to the end of 2012.[34] Ellis and Karousakis (2006) also indicate that almost half of the proposed CDM projects are in the electricity sector and that many are small renewable projects occurring in 40 countries. However, the majority of credits have come from CDM projects reducing nitrous oxide (N_2O), trifluoromethane (HFC-23) and, to a lesser extent, methane (CH_4). Projects that have not yet had methodologies approved will be under-represented in the project mix – even if they represent opportunities for significant emissions reductions at the national or global level. Publicly committed budgets for CER acquisition stood at approximately 7.5 billion US\$ (World Bank, 2006) (See Figure 13.4). At such a scale, the CDM begins to reach the same order of magnitude as Global Environment Facility (GEF) and Official Development Assistance (ODA) resources.

It was initially assumed that CDM projects would be undertaken as bilateral arrangements between Annex I and non-Annex I convention Parties (and private sector companies in those countries). As of October 2006, 56% of registered projects were being undertaken unilaterally, indicating that companies in developing countries are procuring the financing to implement projects and sell the CERs to industrialized countries.[35]

A CDM project has to go through an elaborate project cycle that includes external validation and which has been defined by a decision of the 7th Conference of the Parties to the UNFCCC (2001) and is in keeping with the decisions of the CDM Executive Board that is overseeing the project cycle (see, for example, UNFCCC, 2003a–c). As CDM projects are implemented in countries without emissions targets, project 'additionality' becomes important to avoid generating fictitious emission reduction credits through 'business as usual' activities. Several tests of additionality have been discussed in the literature; these include investment additionality (see Greiner and Michaelowa, 2003) and environmental additionality (see Shrestha and Timilsina, 2002). The CDM Executive Board has developed an additionality tool that project proponents can use to test and demonstrate the additionality of a CDM project (http://cdm.unfccc.int/methodologies/PAmethodologies/Additionality_tool.pdf).

34 As of January 22, 2007. See: http://cdm.unfccc.int
35 The CDM Executive Board at its 18th meeting decided that registration can take place without an Annex I Party being involved at the time of registration. An Annex I partner would need to issue a letter of approval after registration in order to receive the CERs.

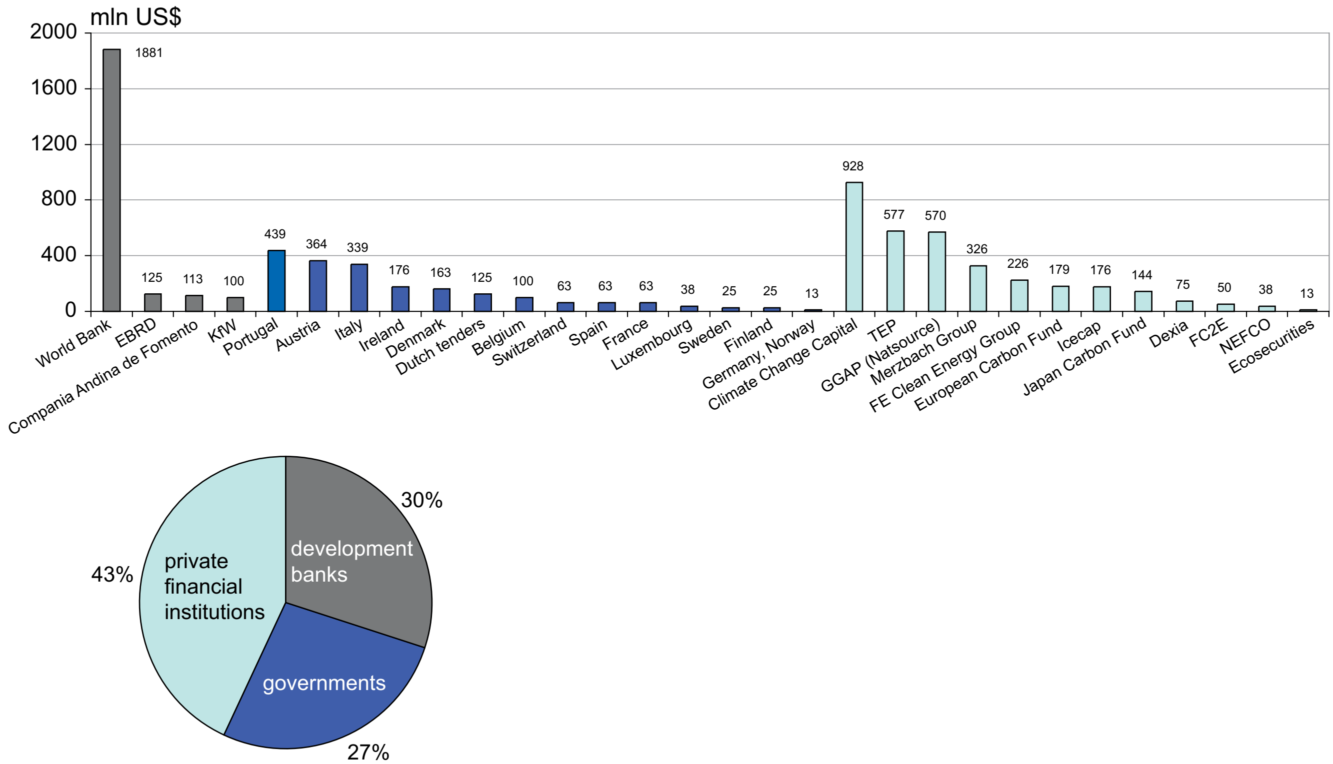


Figure 13.4: *Budgets for the acquisition of certified emissions reductions (CERs) and emission reductions units (ERUs).*
Note: Status as of October 10, 2006 at which time the total budget was almost € 6 billion.

If a project is additional, the next step is to determine a 'baseline' – the emissions that would have occurred if the project had not taken place. One potential risk is the overestimation of baseline emissions, which is a major problem as all participants profit from an overestimate as there is then no incentive to correct it. Stringent rules and modalities are required for determining baselines affecting the efficient processing of the CDM (Bailey *et al*., 2001). Fischer (2006) argues that due to pressure from industry, rules for standard emission rates are likely to be systematically biased to over-allocation and also risk creating inefficient investment incentives. Alternatively, Broekhoff (2004) focuses on costs and efficiency, arguing that the availability of data and the level of data aggregation determine to a large extent the cost of deriving multi-project baselines. Other authors examine specific baseline issues in the energy sector, particularly the use of models, the need to consider size, vintage, generation type and operational characteristics and issues relating to technology and sectoral approaches (see Fichtner *et al*., 2001; Zhang *et al*., 2001; Spalding-Fecher *et al*., 2002; Begg and Van der Horst, 2004; Illum and Meyer, 2004; Kartha *et al*., 2004; Rosen *et al*., 2004; Sathaye *et al*., 2004).

In order to account for any emissions that occur outside of the CDM project boundary but which are a consequence of the CDM project – emissions referred to a 'carbon leakage' – a CDM project should also include a leakage estimate. According to the UNFCCC CDM glossary of terms, leakage is defined as the net change of anthropogenic emissions by sources of GHGs that occur outside the project boundary and which is measurable and attributable to the activity of the CDM project. Leakage issues have been discussed by a number of authors (see, for example, Geres and Michaelowa (2002) and Kartha *et al*. (2002) for the electricity sector and the Working Group on Baseline for CDM/JI Project (2001)). There is a general consensus that the determination of project boundaries is critical to any evaluation of leakage.

The coverage of forestry and forest-related projects is a contentious issue under the CDM. The problems primarily relate to the impermanence of the forest and to leakage to other regions. Dutschke (2002) suggests leasing CDM credits to address the non-permanence of forestry sinks. The CDM has addressed the issue of non-permanence through the creation of separate CDM credits, which are called temporary CERs. According to Nelson and de Jong (2003), development priorities can be lost. This is illustrated by the case of a forestry project in Chiapas in which Mexico shifted from a development emphasis with multiple species to two species when the focus changed to carbon sales by individual farmers. Data (or its scarcity) as well as price uncertainty also pose problems. Vöhringer (2004) notes that establishing historical deforestation rates is a major problem in Costa Rica. Van Vliet *et al*. (2003) analysed six proposed plantation forestry projects in Brazil for uncertainty and, based on their results, they suggest that fluctuations in product prices cause variations of up to 200% in CERs and net present value, leading to difficulties in determining the additionality of such projects, thereby making five of the six projects ineligible for CDM.

Perhaps the most critical issue in the context of the viability of the CDM over the longer term is whether there will be an ongoing price signal that encourages both emission reduction commitments and a market demand – over the longer term. This will clearly depend on the shape of both international agreements and evolving national programmes that might support project offsets. Independent of the market demand issues, an important suggestion to enhance the CDM relates to improving the sustainable development benefits of a CDM. One proposal[36] for doing this is the 'Gold Standard', which calls for enhanced environmental assessment, stakeholder consultations and the use of a qualitative sustainability matrix, expanding the CDM regime to allow programmes and policies to be credited – a concept elaborated on in a decision by the first meeting of the Kyoto Parties in 2005, and analysed by Ellis (2006) – and extending CDM project incentives beyond 2012.

Joint Implementation has been much less extensively researched than the CDM. Its later start date and unclear international rules (for example, the 'second track' rules were only agreed upon in October 2006) have generated considerable uncertainty with regard to implementation. Transactions under JI are seen as both cumbersome and beset with institutional obstacles (Korppoo, 2005). In addition, several authors have argued that JI projects will potentially be 'double counted' – given credit under both the project mechanism as well as under the rules for EU ETS. A number of proposals have been made to address this issue. Koch and Michaelowa (1999) and Moe *et al*. (2003) have suggested a 'Green Investment Scheme' (GIS) in which revenues from sales of Assigned Amount Units (AAU) are allocated to projects that reduce GHG emissions. Blyth and Baron (2003) suggest that the scale of a GIS in Russia could reach as much as € 1.25–3.5 billion per annum. This is a very approximate figure and depends on the balance of supply and demand and the prevailing allowance price. Fernandez and Michaelowa (2003) discuss the impact of defining the 'acquis communautaire' as the baseline for JI projects in the new EU Member States and stress the need to establish a predictable legal framework in the host countries, while Van der Gaast (2002) sees a reduced scope for JI in Eastern Europe due to the 'acquis' which could also be increased by using a GIS.

National institutions for project-based mechanisms have been slow to develop. The institutional problem is often exacerbated in countries with unstable economies and institutions and by project developers who often have very short time horizons, are unwilling to wait for the revenues and who cannot provide regular and ongoing monitoring and verification reports of emission reductions (see Michaelowa (2003a) for an overview of such issues in CDM host countries, Korppoo (2005) for specific issues related to the Russian Federation and Figueres (2004) for issues specific to Latin America).

Sectoral approaches

A number of researchers have suggested that sectoral approaches may provide an appropriate framework for post-Kyoto agreements (see sectoral approaches in Table 13.2). Under such a system, specified targets could be set, starting with specific sectors or industries that are particularly important, politically easier to address, globally homogeneous and/or relatively insulated from competition with other sectors. Such an approach may be binding (e.g. such as an agreement in the International Civil Aviation Organization) or voluntary (such as an agreement through the International Standardization Organization). Targets may be fixed or dynamic, and 'no-lose', binding or non-binding (Philibert and Pershing, 2001; Samaniego and Figures, 2002; Bodansky, 2004). Bosi and Ellis (2005) and Baron and Ellis (2006) have explored different design options for sectoral crediting, including policy, rate-based and fixed limit approaches, and Ellis and Baron (2005) have assessed how these options could be applied to the aluminium and electricity sectors.

Sectoral commitments have the advantage of being able to be specified on a narrower basis than total national emissions. Baumert *et al*. (2005b) consider specific options in aluminium, cement, iron and steel, transportation and electricity generation and conclude that while not all sectors are amenable to such approaches, considerable precedent already exists for agreement both between companies and by governments. Sectoral approaches provide an additional degree of policy flexibility and make the comparison of efforts between countries within a sector a relatively easy process – although comparing efforts across sectors may be difficult (see Philibert, 2005a). An additional disadvantage to sectoral approaches is that they may create economic inefficiency. Trading across all sectors will inherently be at a lower cost than trading only within a single sector.

13.3.3.4.3 Coordination/harmonization of policies

As an alternative to or complementary to internationally agreed caps on emissions, it has been proposed that countries agree to coordinated policies and measures that reduce the emission of GHGs. A number of policies that would achieve this goal have been discussed in the literature, including taxes (such as carbon or energy taxes), trade coordination/liberalization, R&D, sectoral policies and policies that modify foreign direct investment (FDI). Sectoral policies have been discussed above, R&D is discussed in Section 13.2.1.6 and FDI is discussed below on financing. This discussion focuses on harmonized taxes as well on as trade and other policies.

36 This is already being applied for some projects on a voluntary basis. See: http://www.cdmgoldstandard.org.

Box 13.7 Climate change and the World Trade Organization (WTO)

There is a history of international cooperation between environmental agreements and the WTO (see, for example, Frankel and Rose, 2003). However, there is also literature pointing to potential conflicts. To date, disputes between climate and trade agreements have not been legally tested. Should a complaint arise, the attitude of a WTO panel may depend on whether the disputed trade measure stems from a treaty obligation or a national policy. Neither the UNFCCC nor the Kyoto Protocol has been formulated in language that can reasonably be interpreted to require or authorize a trade measure as a strategy to promote membership, make the climate regime more effective or enforce the treaty. Thus, any use of a climate trade measure would be considered to be a national-level action (see Fischer *et al*., 2002).

Two examples help demonstrate the range of possible pitfalls:

- In 1998, Japan introduced the 'top-runner' programme as part of its domestic efforts to implement the Kyoto Protocol. This legislation was intended to ensure that automobiles and other manufactured products would be more energy efficient; it required new appliance and manufactured goods be as efficient as the 'top-runner' in the same category. The legislation raised concern among other automobile-exporting countries, most notably the USA and the EU, which feared that the measures might have adverse effects on their exports; consequently, the latter suggested that the legislation was not compatible with WTO rules on free trade. Conversely, according to Yamaguchi (2004), the Japanese legislation provides for objective standards that would be applied equally to domestic and imported cars and, accordingly, there would be no discriminatory treatment as a matter in law. After discussions between all parties over several years, no formal appeal was ever submitted under the General Agreement on Tariffs and Trade (GATT) or the Technical Barriers to Trade (TBT) Agreement (see Murase, 2004).
- Murase (2002b) considers potential conflicts between the use of the Kyoto Protocol's project-based flexibility mechanisms (CDM and JI) and various trade agreements. Inasmuch as project-based offsets represent foreign direct investment (FDI), they may run counter to both the GATT and Subsidies and Countervailing Measures Agreement as well as the common practice application of the Trade Related Investment Measures (TRIMs) and Agriculture Agreements. Adding an additional point of complexity, Werksman *et al*. (2001) suggest that the effective functioning of the CDM may require investor discrimination in a manner prohibited by the Most Favored Nation (MFN) clause of international investment agreements.

Assunção and Zhang (2002) explore other areas of interaction between domestic climate policies and the WTO, such as the setting of energy efficiency standards, the requirement for eco-labels and the implemention of targeted government procurement programmes. They suggest that an early process of consultation between WTO members and the Parties to the UNFCCC may be necessary to enhance synergies between the trade and climate regimes. To this end, they recommend the establishment of a joint WTO/Framework Convention on Climate Change (FCCC) working group that would specifically focus on greater coherence between trade, climate change and development policy.

One of the leading proponents of a harmonized tax has been Cooper (1998, 2001). Under his proposals, all participating nations – industrialized and developing alike – would tax their domestic carbon usage at a common rate, thereby achieving cost-effectiveness. Aldy *et al*. (2003) have suggested a number of problems with Cooper's proposals, including issues of fairness (whether developed and developing countries should have identical tax rates given the relative welfare and relative responsibilities), whether any incentive exists for developed countries to adopt a tax and how to manage gaming behaviour (in which a government may change tax codes to neutralize its effects or to benefit certain economic sectors). Additional criticism of a common tax structure comes from the modelling community: Babiker *et al*. (2003) note that while an equal marginal abatement cost across countries is economically efficient, it may not be politically feasible in the context of existing tax distortions. They also note that many countries which currently apply such taxes have exempted certain industries, thereby significantly increasing the overall costs of the tax regime. In addition, competitive concerns can arise if one country adopts a tax and a trading partner does not. Several solutions have been proposed, including the use of trade bans or tariffs to induce action. Governments may also seek to use border tax adjustments under such circumstances (Charnovitz, 2003). However, it has been argued that such a measure could be as disadvantageous to a target foreign country as a trade measure. To date, World Trade Organization (WTO) case law has not provided specific rulings on climate-related taxes. Any proposed border adjustments would need careful design and also take WTO law into account (Biermann and Brohm, 2005) (see Box 13.7).

The importance of harmonizing environmental standards – including those related to climate change – has been evaluated by Esty and Ivanova (2002), who conclude that both economic and ecological interdependence demand coordinated national policies and international collective action. To this end, they propose the creation of a Global Environmental Mechanism to help manage the environmental components of a globalizing world, primarily through information and analysis and the creation of a policy space for environmental negotiation and bargaining.

Other fora, in addition to the WTO, also offer opportunities to exchange information and coordinate climate-related policies and activities. For example, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) offers an opportunity to unite efforts in a common cause to both protect endangered species and the climate. Similarly, meetings of Asia Pacific Economic Cooperation (APEC) provide a platform for regional economies to take steps that meaningfully address the adverse impact of climate change (Ivanova and Angeles, 2005). The APEC Virtual Center (APEC-VC) for region-wide Environmental Technology Exchange launched by the Asia-Pacific economies provides information on environmental technology gathered by regional and local governmental authorities as well as by companies and environment-related organizations. The North American Commission on Environmental Cooperation (the NACEC or CEC), which was created within the North America Free Trade agreement (NAFTA), offers another model: Canada, Mexico and the USA signed an agreement to cooperate on reducing the threat of global change. The trilateral agreement is the basis for public-private partnerships to reduce GHG emissions in North America and to boost investment in green technology. It should be acknowledged that the NACEC could not prevent the detrimental decline in the Mexican environment during their participation in NAFTA (Gallagher, 2004); therefore, some caution must be exercised with regard to the environment when engaging in trade agreements.

13.3.3.4.4 Technology

A number of issues related to technology research, development and deployment (including transfers and investment) have been explored in the literature on climate change. Many authors have asserted that a key element of a successful climate change agreement will be its ability to stimulate the development and transfer of technology – without which it may be difficult or impossible to achieve emissions reductions at a significant scale (Edmonds and Wise, 1999; Barrett, 2003; Pacala and Socolow, 2004).

Technology agreements

The studies reported in the literature make it very clear that R&D support, price signals and other arrangements can all contribute to technology development and diffusion. Financial and human resources, often scarce in developing countries, will be needed to promote R&D, while monetary and political incentives as well as institutional arrangements will be required to promote diffusion (see IPCC (2000) which contains a comprehensive review of technology transfer issues, including proposals for improving international agreements.) Technology agreements may also seek to address barriers in technology research, development and diffusion. (For additional details on specific sectors and technologies, see Chapters 4–10).

One variant of a technology agreement is formulated by Barrett (2001, 2003) in a proposal which emphasizes both common incentives for climate-friendly technology research and development (R&D) and technology protocols (common standards) rather than targets and timetables. While this proposal could potentially be environmentally effective, depending on the payoffs to the cooperative R&D efforts and the rate of technology deployment, Barrett notes that the system would neither be efficient nor cost-effective, not least because the technology standards would not apply to every sector of the global economy and may entail some technological lock-in. However, Barrett assumes that if standards are set in enough key countries, a ‘tipping effect’ is created which ultimately would lead to widespread global adoption. In reviewing Barrett’s assessment, Philibert (2004) expresses doubts as to whether such a tipping effect would be applicable and suggests, alternatively, that for some technologies (e.g. CO_2 capture and storage), cost constraints may be more critical than acceptability in determining market penetration.

The concept of regional technology-specific agreements has also been explored by Sugiyama and Sinton (2005), who suggest that they may offer an interim path to promote cooperation and develop new, lower cost options to mitigation climate change – allowing any future negotiations on emission caps to proceed more smoothly. Box 13.8 lists some examples of existing international technology coordination programmes.

Technology transfer

One mechanism for technology transfer is through the establishment of – and subsequent contributions to – special funding agencies that disburse money to finance emissions reduction projects or adaptation activities. The UNFCCC and the Kyoto Protocol already include provisions for establishing and funding project activities, although contributions to and participation in these are mostly voluntary. UNFCCC also includes provisions for technology transfer under Article 4.5. The CDM could also be a vehicle for technology transfer, but the effects are unclear at this point.

As part of the Marrakesh Accords, at the seventh Conference of the Parties (COP 7), Parties were able to reach an agreement to work together on a set of technology transfer activities, which were grouped under a framework for meaningful and effective actions to enhance the implementation of Article 4.5 of the Convention. This framework[37] has five main themes:

1. Technology needs and needs assessments;
2. Technology information;
3. Enabling environments;
4. Capacity building;
5. Mechanisms for technology transfer.

37 See UNFCCC decision 4/COP 7 on the Development and Transfer of Technologies

Box 13.8 Examples of coordinated international R&D and technology promotion activities

- **International Partnership for a Hydrogen Economy:** Announced in April 2003, the partnership consists of 15 countries and the EU, working together to advance the global transition to the hydrogen economy, with the goal of making fuel cell vehicles commercially available by 2020. The Partnership will work to advance the research, development and deployment of hydrogen and fuel cell technologies and to develop common codes and standards for hydrogen use. See: www.iphe.net.
- **Carbon Sequestration Leadership Forum:** This international partnership was initiated in 2003 and has the aim of advancing technologies for pollution-free and GHG -free coal-fired power plants that can also produce hydrogen for transportation and electricity generation. See: www.cslforum.org.
- **Generation IV International Forum:** This is a multilateral partnership fostering international cooperation in research and development for the next generation of safer, more affordable and more proliferation-resistant nuclear energy systems. This new generation of nuclear power plants could produce electricity and hydrogen with substantially less waste and without emitting any air pollutants or GHG emissions. See: http://nuclear.energy.gov/genIV/neGenIV1.html.
- **Renewable Energy and Energy Efficiency Partnership:** Formed at the World Summit on Sustainable Development in Johannesburg, South Africa, in August 2002, the partnership seeks to accelerate and expand the global market for renewable energy and energy-efficiency technologies. See : http://www.reeep.org
- **Asia-Pacific Partnership on Clean Development and Climate:** Inaugurated in January 2006, the aim of this partnership between Australia, China, India, Japan, Republic of Korea and USA is to focus on technology development related to climate change, energy security and air pollution. Eight public/private task forces are to consider (1) fossil energy, (2) renewable energy and distributed generation, (3) power generation and transmission, (4) steel, (5) aluminium, (6) cement, (7) coal mining and (8) buildings and appliances. See: http://www.asiapacificpartnership.org.

Actions to implement the framework include the organization of meetings and workshops, the development of methodologies to undertake technology needs assessment plans, the development of a technology transfer information clearinghouse, including a network of technology information centres, actions by governments to create enabling environments that will improve the effectiveness of the transfer of environmentally sound technologies and capacity building activities for the enhancement of technology transfer under the Convention. Funding for technology needs assessments has been provided, and further funds for technology may become available from the UNFCCC's Special Climate Change Fund.

Other international efforts have also been undertaken to promote technology transfer in support of climate change mitigation efforts, including those by the UN Industrial Development Organization (UNIDO) and by the Climate Technology Initiative (CTI) of the IEA. As noted by the US National Research Council, additional work is particularly needed to assist poor countries as these lack scientific resources and economic infrastructure as well as the appropriate technologies to reduce their vulnerabilities to potential climate changes (NRC, 2003).

The distinction between public financing for climate change mitigation and private financing for technology investment is often blurred: Clean energy projects are frequently a blend of the two, with public financing used to leverage private investment. For example, the International Finance Corporation (IFC) clean energy financing projects in Eastern Europe, Russia, China and the Philippines use technical assistance funds to train commercial banks in energy efficiency while concurrently lending partial risk guarantees and offering credit lines to encourage banks to provide loans. In this manner public funds are heavily leveraged and provide a source financing for clean energy investments.[38]

Development oriented actions

A 'Sustainable Development Policies and Measures' (SDPAMS) approach proposed by Winkler *et al*. (2002b) and further elaborated by Bradley *et al*. (2005) focuses on linking climate mitigation and adaptation to priority development needs. In its standard form, such an approach would be domestic and unilateral and – with its focus on developmental needs – would also bring GHG benefits. However, the authors also suggest that simultaneous SDPAMS pledges (and possibly harmonized pledges) could be made by both developing and developed countries. However, Bradley *et al*. (2005) do note several limits to this approach and suggest that it may not be suitable for developed countries, nor for every technology or policy. Finally, they note that SDPAMS may not attract the necessary funding for it to be implemented on the scale required for global climate change mitigation.

13.3.3.5 Financing

Funding sources for GHG mitigation in developed and developing countries is a crucial issue in the international debate on tackling climate change. Financing is categorized in the literature in terms of public flows (including Development

38 See www.ifc.org/CEEF.

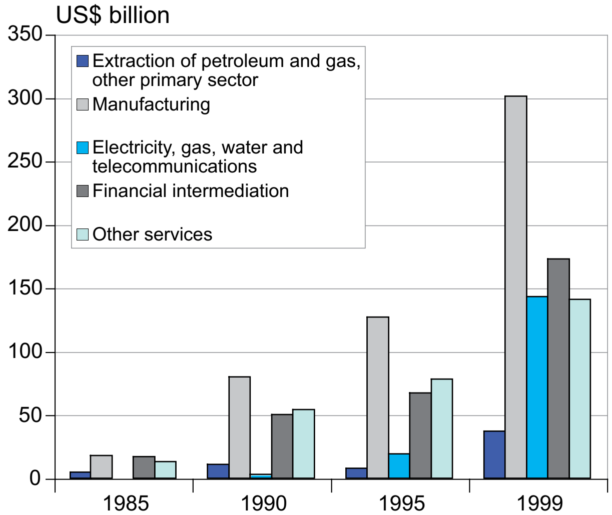


Figure 13.5: *Total OECD foreign direct investment (FDI) outflows to selected sectors.*

Source: OECD (1999)

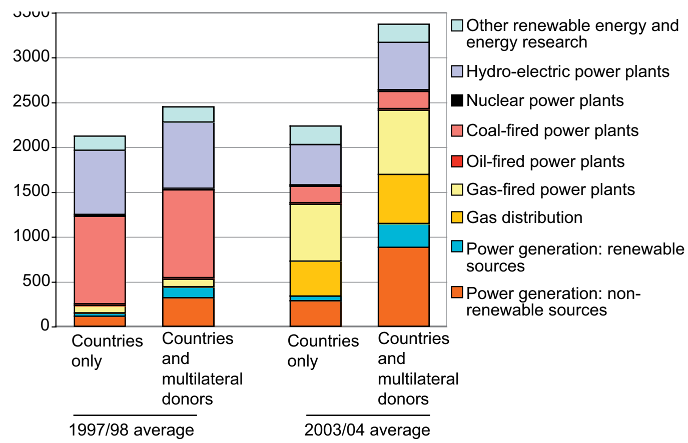


Figure 13.6: *Development assistance for energy*

Source: OECD.

Assistance and government loan guarantees through export credit agencies), private flows or foreign direct investment (FDI) and financing from multilateral institutions, including the Global Environment Facility (GEF) and international financial institutions. Public financing is the main form of assistance for developing country climate change mitigation, while the private sector provides the technology investments. CDM resources are significant when compared with GEF funding, but small in comparison to FDI resources (Ellis *et al*., 2007). In addition to these instruments, a World Bank survey of contingent financing and risk mitigation instruments for clean infrastructure projects describes the characteristics and potential use of other instruments, such as insurance, reinsurance, loan guarantees, leases and credit derivatives[39] (IPCC, 2000; World Bank, 2003). A small percentage of public funds are used to leverage private investment in clean energy projects.

13.3.3.5.1 Foreign direct investments

OECD trade and FDI have grown strongly in relation to GDP during the past decade: cumulative net FDI outflows between 1995 and 2005 amounted to 1.02 trillion US$. As a share of GDP, outward FDI grew from 1.15% of the GDP in 1994 to 2.02% in 2004. However, while the total sums grew, only 35% went to non-Annex I countries – and of that, nearly 70% went to five countries, namely China (including Hong Kong), Brazil, Mexico, Singapore and South Korea.[40] See also OECD (2005 d) for trends in FDI relative to ODA.

One common assertion in international environmental negotiations is that FDI promotes sustainable development as multinational corporations (MNCs) transfer both cleaner technology and better environmental management practices. However, empirical studies find little evidence that MNCs transfer either significant cleaner technology or better practices. In statistical studies of Mexico (manufacturing) and Asia (pulp and paper), foreign firms and plants performed no better than domestic companies (Zarsky and Gallagher, 2003). According to Jordaan (2004) the externalities from the presence of foreign-owned firms do not occur automatically, but are dependant on underlying characteristics of the industries and manufacturing firms.

Most FDI in developing countries is targeted to activities such as the extraction of oil and gas, manufacturing and electricity, gas and water, which have the aim to improve economic development but also to increase GHG emissions (Figure 13.5). Maurer and Bhandari (2000) report that during the mid- to late-1990s the major developed countries co-financed energy-intensive projects and exports valued at over 103 billion US$ through their export credit agencies (ECAs). These projects and exports included oil and gas development, fossil fuel power generation, energy-intensive manufacturing, transportation infrastructure and civilian aircraft sales. These countries accounted for 90% of the co-financing provided by ECAs to these energy-intensive exports and projects. By comparison, industrialized countries have directed just a fraction of their ECA financing to renewable energy projects. Between 1994 and 1999 ECAs supported a total of 2 billion US$ in renewable energy projects.

13.3.3.5.2 Direct international transfers

Official development assistance (ODA) remains an important source of financing for those parts of the world and sectors

39 See the website of the World Bank carbon finance unit for additional information on financial instruments: http://carbonfinance.org.
40 See UNCTAD, Foreign Direct Investment Database: http://www.unctad.org/Templates/Page.asp?intItemID=1923&lang=1.

where private flows are comparatively low, although this is a modest financial resource relative to global private direct investment, which was 106 billion US$ in 2005. Data from the OECD suggest that development assistance for energy projects (approximately 3.2 billion US$ in 2004) from bilateral sources has remained relatively flat over the last 6 years.. There has been a shift in support away from coal technologies to those of gas and some extent renewables[41] (see Figure 13.6).

The effectiveness of ODA depends on various factors, the most important of which are good governance, policy and institutional frameworks that encourage private investment (macroeconomic and political stability, respect for human rights and the rule of law), minimum levels of investment in human capital (education, good health, nutrition, social safety nets) and policies and institutions for sound environmental management.

13.3.3.5.3 GEF and the multilateral development banks (MDBs)

The GEF, established in 1991, provides support to developing countries for projects and programmes that protect the global environment. Jointly implemented by the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP) and the World Bank, GEF provides grants to fund projects related to biodiversity, climate change, international waters, land degradation, the ozone layer and persistent organic pollutants.[42]

Compared to the magnitude of the environmental challenges facing recipient countries, GEF efforts are relatively modest in scope. From 1991 to 2004, GEF allocated 1.74 billion US$ to climate change projects and activities; even when this amount is matched by the more than 9.29 billion US$ in co-financing, the overall scale of the GEF is small.[43] Funding is given to five project types, namely renewable energy, energy efficiency, sustainable transportation, adaptation, low GHG energy technologies and enabling activities. Hall (2002) analysed the GEF portfolio and noted the focus on incremental, one-time investments in mitigation projects that test and demonstrate a variety of financing and institutional models for promoting technology diffusion. He suggests that this approach should help contribute to a host country's ability to understand, absorb and diffuse technologies.

According to a review of the GEF by the World Bank (2006), 'the GEF's track record in reducing the long-term cost of new low GHG-emitting technologies has not been encouraging'. The continued effectiveness of GEF project funding for technology project types will depend on factors such as the duplication of successful technology transfer models, enhanced links with multilateral banks and co-ordination with other activities that support national systems of innovation and international technology partnerships. It has been suggested that GEF reform will be needed to enhance its effectiveness and transparency, particularly with respect to determining contributions and for evaluating priorities for disbursements (Grafton *et al*., 2004).

The World Bank (2004a) review of its investments in extractive industries determined that in the future it would be more selective, with a greater focus on the needs of poor people and a stronger emphasis on good governance and on the promotion of environmentally and socially sustainable development. The IFC has revised its performance standards in 2006 to require the reporting of GHG emissions for projects with both direct and indirect emissions of greater than 100,000 tonnes annually. The standards also require the consideration of alternatives or improvements to the energy efficiency of energy intensive projects (see http://www.ifc.org/ifcext/enviro.nsf/Content/ENvSocStandards). However, Sohn *et al*. (2005) note that the World Bank has continued to both support traditional CO_2-intensive fossil fuels projects and provide relatively limited resources to renewable and low CO_2-emitting energy alternatives. They suggest that Governments may use their leverage to direct the activities of multilateral development banks through their respective Boards and Councils in order to strengthen MDB programmes to account for the environmental consequences of their lending; develop programmatic approaches to lending that remove institutional barriers and create enabling environments for private technology transfers.

The higher perceived risk in developing countries, as reflected in sovereign credit ratings, can be compounded further by including new and emerging technologies. International or regional financing institutions can play a critical role in lowering the risk and leveraging private finance into the sector. MDBs have responded to this challenge by establishing several new initiatives. For example, the European Bank for Reconstruction and Development's (EBRD) new Sustainable Energy Initiative was launched in May 2006 to address the wasteful and polluting use of energy. The EBRD plans to invest up to € 1.5 billion in energy efficiency, renewables and clean energy projects over the next 3 years, which could lead to up to € 5 billion of total investment. The Asian Development Bank (ADB) launched the Energy Efficiency Initiative (EEI) in July 2005, the core objective of which is to expand ADB's investments in energy efficiency projects (including renewable energy), with an indicative annual lending target of 1 billion US$ between 2008 and 2010. The World Bank has announced the establishment of the Clean Energy Fund Vehicle with a capitalization of 10 billion US$ and an annual disbursement of 2 billion US$ to accelerate the transition to a low carbon economy.

41 See OECD website for information on development activities, including statistics, data, indicators and methods for accessing data: http://www.oecd.org/topicstatsportal/0,2647,en_2825_495602_1_1_1_1_1,00.html
42 See the website of the Global Environment Facility for additional information: http://www.gefweb.org/
43 http://www.gefweb.org/Projects/focal_areas/focal_areas.html#cc

13.3.3.6 *Capacity building*

The literature on climate change has not addressed capacity building to any extent, despite its critical relevance to the climate change issue. Part of the solution to the climate change problem has been cast in terms of helping developing countries with technology transfer and assistance. The importance of this is recognized in the text of the UNFCCC and Kyoto Protocol as well as in the more detailed implementing framework of the Marrakech Accords.

The capacity building framework within the climate change regime focuses on developing the capacity in developing countries to implement decisions. Capacity building has been defined historically as the formal training of employees, technological gate-keeping and learning-by-doing, with the recognition that this is a slow and complex process. According to Yamin and Depledge (2004), the Marrakesh Accords have been partially successful in bringing some additional coherence, coordination and prioritization into the process of capacity building. These authors argue that the effort to promote country-driven and contextually tailored efforts that are both iterative and involve learning-by-doing are appropriate.

Other ideas on capacity building also abound. Sagar (2000) argues that it may be more relevant to strengthen the domestic capacity for undertaking policy research and innovation as well as for managing technological and institutional change rather than merely creating the capacity for implementing policies developed elsewhere. This proposal is based on the idea that only context-relevant policy instruments are likely to work within the specific domestic circumstances of the relevant countries.

A number of recent analyses carried out on this subject have questioned whether capacity building can be initiated from outside a country. Since capacity issues are embedded in local contexts, the OECD has argued that it may be a mistake to assume that capacity building can be easily accomplished from outside this context.

Najam *et al*. (2003) note the importance of capacity building for developing countries and require that it be an integral part of any future agreement if it is to have wide support from this group. In particular, they argue that inasmuch as efforts to combat climate change and promote sustainable development are 'two sides of the same coin' enhancing the capacities of communities and countries to fight climate change will have multiple benefits. They also make the case that the most pressing need in this context is to strengthen the social, economic and technical resilience of the poorest and most vulnerable countries against extreme climatic events.

13.3.3.7 *Compliance*

Using game theory, Hovi and Areklett (2004) argue that a compliance system has to meet several criteria: (1) consequences of non-compliance have to be more than proportionate; (2) punishment needs to take place when behaviour is suboptimal; (3) an effective enforcement system must be able to curb collective as well as individual incentives to cheat. The compliance system agreed under Kyoto is viewed as only partially fulfilling these criteria. For example, Nentjes and Klaassen (2004) note that the obligation to fully restore any excess emissions in subsequent periods does not exclude the option of postponing restoration forever. If such an outcome occurs, the trading mechanisms under the Protocol may be substantially weakened. However, it is pointed out that introducing adversarial elements (such as sanctions) into the system are highly undesirable in view of the fact that the Kyoto Protocol currently covers only one third of the total GHG emissions of the world (Murase, 2005).

There are two schools of thought regarding the appropriate response to non-compliance contemplated under the Kyoto Protocol (see Murase, 2002b). One view advocates 'soft' compliance-management, which favours primarily facilitative and promotional approaches by rendering assistance to non-compliant States; those holding this view often refer to 'the non-compliance procedure' used under the Montreal Protocol. The other view takes a 'hard' enforcement approach in order to coerce compliance by imposing penalties or sanctions on non-complying parties. Financial penalties and economic or trade sanctions have been proposed along these lines. However, it has been suggested that such measures could be in conflict with WTO/GATT rules on trade liberalization (Mitchell, 2005).

A more nuanced view is provided by Wettestad (2005), who concludes that there are eight lessons to be learnt from other regimes. These include the need for an institutional warm-up period, wise institutional engineering, moderate expectations from the verification process, increased transparency, efforts to maintain close cooperation between the Facilitative and Enforcement Branch of the Compliance Committee, the search for opportunities to engage civil society in the process and a focus on assistance and compliance facilitation using the enforcement mechanism as an important but 'hidden' stick.

In his review of the Kyoto Protocol's compliance mechanism, Barrett (2003) argues that failure to comply over two compliance periods can essentially be equivalent to indefinitely postponing action: A country that is found in non-compliance in the first period has to make up the difference plus 30% in the next period. If it fails to achieve the latter target as well, it will have to make up the difference in the period thereafter – a process that can continue indefinitely. Perhaps the most important point in his proposal is that if countries feel that they cannot easily meet their commitments, they will negotiate for higher allowances in the period thereafter – or even withdraw from the agreement entirely. He also notes that the Protocol does not have any procedures to deal with countries that decide not to cooperate with the rules.

There is a significant body of research that compares various dispute settlement procedures. A number of these assessments examine environmental agreements (see, for example, Werksman, 2005), while others more specifically focus on possible conflicts between climate agreements and trade agreements (see, for example, Murase, 2002b). With respect to the latter, Murase notes the need for a coordinating authority to be established between a multilateral environmental agreement (MEA) and the WTO. Given that MEAs and the WTO are independent treaties on equal footing, neither can automatically be given the right to make a decision in the case of a conflict. As a result, a number of authors (e.g. Esty, 2001; Murase, 2002b) have called for the establishment of a new institution, such as a World Environment Organization (WEO), that would embody its own dispute settlement mechanism. This institution would function as a counterpart of WTO by attaining an equal footing between the two regimes.

13.3.3.8 Adaptation

The element of adaptation in international climate agreements has been far less explored to date than mitigation.[44] While most authors agree that adaptation is a vital part of a future agreement (although Schipper (2006) suggests that it was not a key focus of the initial UNFCCC negotiators), there is little mention in climate change literature of concrete proposals detailing the actions or obligations that should be undertaken by countries. Most proposals focus on leveraging funding for adaptation activities with an additional set of proposals addressing more specifically the links between adaptation, vulnerability and development agendas (see, for example, Najam *et al*., 2003).

Parry *et al*. (2005) develop an assessment of how adaptation may be incorporated into a future climate change architecture. They begin by noting that much of the adaptive response is likely to be local and, consequently, it is less conducive to a common international approach. Instead, they argue that a key need will be for efforts to incorporate adaptation into development policies and practices, including local, sectoral and national decision-making – a process they refer to as 'climate-proofing'. At the local level, this would incorporate strategies for municipal planning, including developing and maintaining seed banks, emergency preparedness services and community social services. At the sectoral level, it would include efforts to build climate into infrastructure design and maintenance codes and standards. At the national level, it would include integration into national planning and budget processes – for example, by examining whether planned expenditures will increase exposure to the impacts of climate change – and by doing so, minimize the financial risk, promote macro-economic stability and set aside sufficient funds to manage the consequences of climate shocks. Finally, at the international level, they suggest that key opportunities exist for integrating adaptation into the Millennium Development Goals and into lending practices of international institutions and bilateral aid agencies.

Three funds have been created under the UNFCCC and the Kyoto Protocol to manage adaptation issues: the Least Developed Countries Fund, the Special Climate Change Fund (both under the UNFCCC) and the Adaptation Fund (under the Protocol). In addition, the GEF has been requested to consider adopting more flexible approaches to funding adaptation (though this may not happen with core GEF funds, but with new money from these other funds that would be disbursed by the GEF).

Corfee-Morlot *et al*. (2002) suggest that it would be unrealistic to expect the GEF to cover the full cost of adaptation as such expenses would quickly exhaust their resources. Huq and Burton (2003) propose integrating adaptation into the mainstream work of development agencies, thereby allowing for more cost-effective and wider ranging support. However, as noted by Huq and Reid (2004), doing so runs the risk of diluting other existing aid efforts – which often have considerably higher priorities in-country than climate change adaptation.

The potential role for private (and public) insurance has also been suggested as a possible mechanism to pay for adaptation (e.g. Bals *et al*., 2005). Parry *et al*. (2005) list possible insurance schemes and risk transfer instruments, including:

- An international insurance pool (a collective loss-sharing fund to compensate victims of climate change damages);
- Public-private insurance partnerships (where the insurer is the government, but policies are developed and managed by the private sector);
- Regional catastrophic insurance schemes (regional cash reserves are pooled through mandatory contributions from member governments, and reserves are used for weather-related catastrophes);
- Micro-insurance (risk pooling for low-income individuals affected by specific risks);
- Catastrophe bonds (giving private insurers protection against extreme events; capital is provided by large institutional investors);
- Weather derivatives (financial mechanisms to hedge financial risk from catastrophic weather events)
- Weather hedges (providing protection for farmers; currently sold by banks, farm cooperatives and micro-finance institutions).

13.3.3.9 Negotiating process

It is important that several technical issues be taken into consideration when an agreement is negotiated and implemented. Since the international negotiation process under the UNFCCC is based on decisions by consensus, an approach

44 See IPCC(2007b), Chapter 17 and 18 for a broad review of adaptation issues.

Table 13.3: *Assessment of international agreements on climate change.*[45]

Approach	Environmental effectiveness	Cost-effectiveness	Meets distributional considerations	Institutional feasibility
National emission targets and international emission trading (including offsets)	Depends on participation and compliance.	Decreases with limited participation and reduced gas and sector coverage.	Depends on initial allocation.	Depends on capacity to prepare inventories and compliance. Defections weaken regime stability.
Sectoral agreements	Not all sectors amenable to such agreements, thereby limiting overall effectiveness. Effectivenss depends on whether agreement is binding or non-binding.	Lack of trading across sectors increases overall costs, although they may be cost-effective within individual sectors. Competitive concerns reduced within each sector.	Depends on participation. Within-sector competitiveness concerns are alleviated if treated equally at global level.	Requires many separate decisions and technical capacity. Each sector may require cross-country institutions to manage agreements.
Coordinated policies and measures	Individual measures can be effective; emission levels may be uncertain; success will be a function of compliance.	Depends on policy design.	Extent of coordination could limit national flexibility, but may increase equity.	Depends on the number of countries (easier among smaller groups of countries than at the global level).
Cooperation on Technology RD&D[a]	Depends on funding, when technologies are developed and policies for diffusion.	Varies with degree of R&D risk. Cooperation reduces individual national risk.	Intellectual property concerns may negate the benefits of cooperation.	Requires many separate decisions. Depends on research capacity and long-term funding.
Development-oriented actions	Depends on national policies and design to create synergies.	Depends on the extent of synergies with other development objectives.	Depends on distributional effects of development policies.	Depends on priority given to sustainable development in national policies and goals of national institutions.
Financial mechanisms	Depends on funding selection criteria.	Depends on country and project type.	Depends on project and country.	Depends on national institutions.
Capacity building	Varies over time and depends on critical mass.	Depends on programme design.	Depends on selection of recipient group.	Depends on country and institutional frameworks.

[a] Research, Development and Demonstration.

that is simple and requires a small number of separate decisions by international bodies most likely has a higher chance of being agreed upon. This may be true of any agreement that engages multiple countries.

It has been reported in the literature that ownership of an instrument – and hence its commitment and effectiveness – is linked to the manner in which the agreement was negotiated, and that the leadership (directional, instrumental and structural) demonstrated in a regime may stimulate its effectiveness. Kanie (2003) concludes that in the EU, the introduction of policies and measures and institution building changed the dynamics of the climate change negotiation process by enhancing leadership capacity.

The role and influence of non-State actors in the process of negotiation also increase the legitimacy and compliance-pull of a regime, both because such participation promotes the broader acceptability of the agreement and because it may increase knowledge about the regime. Agreements are also more likely to be effective when they are negotiated in accordance with established rules of procedure, when the negotiators of key countries have been able to adequately prepare themselves for the negotiation and when the subject matter of the negotiations is designed to address the problem and has not been artificially limited to make the solutions more attractive to the more powerful countries (Andresen and Wettestad, 1992; Benedick, 1993; Sebenius, 1993; Greene, 1996; Gupta and Grubb, 2000; Gupta and Ringius, 2001). The attention of the regular media to climate negotiations can also mobilize awareness of the issue which then increases pressure on the negotiators to achieve a result (Newell, 2000).

13.3.4 Evaluating international climate change agreements

This section reviews the literature using the same criteria as in Section 13.2: environmental effectiveness, cost-effectiveness, distributional considerations and institutional feasibility. The discussion is summarized in Table 13.3, and then discussed in

45 The table examines each approach based on its capacity to meet its internal goals – not in relation to achieving a global environmental goal. If such targets are to be achieved, a combination of instruments needs to be adopted. Not all approaches have received an equivalent evaluation in the literature; evidence for individual elements of the matrix varies.

greater depth in the text. As is the case with national policies, international agreements are instruments that can be designed well or poorly and be stringent or lax, binding or non-binding, or politically attractive or unattractive.

13.3.4.1 *Environmental effectiveness*

Environmentally effective international agreements lead to reductions in global GHG emissions and/or concentrations or to decreased climate impacts. The literature suggests that to achieve such success, agreements must provide incentives or deterrents to both State and individual behaviour in order to achieve a specific outcome. However, at the international level, there is some dispute as to whether agreements change trends, or merely codify actions already underway.

An additional critical element in the effectiveness of an international agreement is that of the implementation context: The relevant literature shows that agreements tend to be more successful in countries with both a high level of domestic awareness and resources and a strong institutional and legal framework and where there is clear political will. Where global agreements are designed using only blue-print approaches to instruments, these instruments may ultimately ignore the specific cultural and institutional contexts within which they are designed to function and may actually not work as well (see conclusions of the Millennium Ecosystem Assessment, 2005). Agreements that promote ancillary objectives, such as reductions in ordinary air pollution levels, also have a higher chance of success.

An agreement that includes a limited group of countries (particularly if they are not major emitters) may be less effective – and this weakness may be exaggerated when emissions of non-participating countries increase by the migration of emission-intensive industries. Conversely, additional benefits may accrue due to technology spillover that may enhance environmental effectiveness (see Section 13.3.3.2).

The timing of an agreement's provisions may also affect its effectiveness: Focusing only on longer term emission reductions (as suggested under some forms of technology agreements) may preclude the possibility of reaching low climate stabilization levels, as many lower levels require immediate emission reductions.

13.3.4.2 *Cost-effectiveness*

A cost-effective international agreement would minimize global and national costs and provide participating sovereign nations with sufficient flexibility to reach their commitments in a fashion tailored to their national needs and priorities. To achieve this, agreements would need to avoid being prescriptive in its actions but, instead, leave room for the implementation of the target, (e.g. while reducing emissions in different sectors or reducing the emissions of different gases, they should not create significant distortions in competitiveness between countries).

Many analysts argue that the most cost-effect system would be one which enables emission trading with the broadest possible participation of countries. Such a system would allow the emission reductions to occur in those countries, sectors and gases where they can be achieved at the lowest cost. An approach based on specific policies and measures would have to be designed carefully to be as efficient as an emission trading system. The flexibility provided to private actors in a trading regime also increases the system's cost-effectiveness.

13.3.4.3 *Distributional considerations, including equity*

Perhaps the most politically charged issue in international negotiations is that of equity. Whether a system of national emission targets within an international agreement can be conducive to social development and equity depends on participation and the initial allocation of emission rights. For example, Pan (2005) suggests that all countries should participate – but that emissions associated with basic needs should be exempt from limits, while emissions associated with luxury activities should be constrained. Conversely, Gupta and Bhandari (2003) suggest that in the initial stages of an agreement, obligations should only be assigned to a limited set of (wealthier) parties. Exemptions to sectors or countries and modifications to the allocation of obligations can help address equity issues.

13.3.4.4 *Institutional feasibility*

Two aspects of institutional feasibility are critical in reaching successful international agreements: (1) negotiating and adopting an agreement and (2) the subsequent (usually national) implementation of that agreement.

Since international agreements are usually adopted by consensus, successful agreements are often relatively simple and require only a limited number of separate decisions by international bodies. In addition, global agreements usually require that all data and tools necessary for enforcement be widely available and verifiable (or if not, that they become available in the future). While there has been no comprehensive critique of the proposals in Table 13.3 in terms of their institutional feasibility, the latter clearly varies widely – for example, in terms of the extent to which they try to accommodate national circumstances and different levels of technical sophistication. Hence, the feasibility of reaching agreements will also vary accordingly.

A sectoral or technology approach would require multiple decisions: which sectors, which types of technologies, and how to regulate or support them. Choosing the sectors (and determining sectoral boundaries) or technologies for agreement may be difficult – unless participation were voluntary (e.g. the current suite of IEA implementing agreements, or the bilateral and multilateral efforts on specific technologies). This may require compromises on environmental effectiveness and equity. In addition, the assessment of whether a country had fulfilled its obligations would be complex. Philibert (2005a) notes that determining the effectiveness of technology or sectoral agreements could be difficult. In the case of a technology approach, definitive conclusions would likely be delayed until the technologies began to diffuse – and that could mean concomitant requirements for establishing long-lived institutions. The establishment of international institutions to manage coordinated policies and measures or development-oriented approaches may also be complex. While some private sector international institutions exist (e.g., the Aluminium Institute, which has set targets for GHG reductions in aluminium processing among its member companies), most sectors do not have such institutional arrangements. Similarly, while there are institutions designed to promote development (e.g., the Bretton Woods institutions), few have integrated climate change into their portfolios (see Maurer and Bhandari, 2000). Kanie (2006) argues that while the Kyoto Protocol will remain the core of the institutional system, a network will ultimately be both necessary – and increase effectiveness. The creation of a web of institutions tackling climate change and related issues not only ensures that any shortcoming in one institution does not lead to the collapse of the whole system, but it also enhances collective strength.

13.4 Insights from and interactions with private, local and non-governmental initiatives

This section addresses voluntary actions taken by sub-national governments, corporations, NGO’s and others that are independent of national government programs or policies. See Box 13.9. Note that in contrast, section 13.2 addresses voluntary agreements between national governments and private parties.[46]

13.4.1 Sub-national initiatives

Local, state, provincial or regional governments have developed GHG policies and programmes that are either synergistic with national policies or are independent of these policies. Several reasons are given in the literature as to why sub-national entities undertake independent policies on GHGs or other environmental issues. Oates (2001) and Vogel *et al*. (2005) highlight the influence that State governments in the USA have had on national policy by experimenting with innovative initiatives. Rabe (2004) argues that some US states have enacted GHG policies to create incentives for new emission reduction technologies or to facilitate the recognition of emission reductions by companies in the event of future national regulations. Regional or local GHG reductions may also be motivated by the desire to achieve additional environmental co-benefits, such as reductions in air pollution.

On the other hand, sub-national actions to address climate change may be viewed as a ‘free rider’ problem because non-participating regions may benefit from the actions of the participating areas without paying the costs (Kousky and Schneider, 2003). Regional or local initiatives may also cause ‘leakage’ if mandatory requirements in one jurisdiction cause a shift in economic activity and emissions to other jurisdictions without mandatory requirements (Kruger, 2006).

Sub-national governments in the USA and Australia, two countries that are not Parties to the Kyoto Protocol, have been among the most active on GHG policy, with a number of US states having adopted or proposed a variety of programmes to address GHGs, including renewable energy portfolio standards, energy efficiency programmes, automobile emissions standards and emissions registries. Perhaps the most notable examples of such an initiative are those of eight states in north-eastern and mid-Atlantic USA announcing their intent to adopt a regional cap-and-trade programme, known as the Regional Greenhouse Gas Initiative (RGGI); three western states – California, Washington and Oregon – may explore a similar initiative (McKinstry, 2004; Peterson, 2004; Pew Center, 2004; Rabe, 2004). Australian states have developed a broad array of programmes to reduce, sequester or measure GHG emissions (see http://www.epa.qld.gov.au/environmental_management/sustainability/greenhouse/greenhouse_policy/other_states_and_territories/). For example, the Australian state of Victoria has adopted a series of programmes to support renewable energy projects and the development of a ‘green power’ market (Northrop, 2004), while that of New South Wales has developed a credit-based emissions trading scheme for electricity retailers, generators and some electricity users. (Fowler, 2004; Baron and Philibert, 2005; MacGill, *et al*., 2006). Finally, the Australian states have announced their intention to explore the development of a multi-jurisdictional emissions trading system (see http://www.cabinet. nsw.gov. au/ greenhouse/report.pdf).

Northrop (2004) reports that more than 600 cities worldwide have participated in programmes to implement measures aimed at reducing local GHG emissions.[47] These include cities in developing countries. In total, 18 cities in South America,[48] 12 cities in South Africa[49] and 17 cities in India[50] are becoming more active in developing environmental measures at the local level. Kousky and Schneider (2003) find that cities have primarily adopted GHG policies with co-benefits, including more efficient energy use. Fleming and Webber (2004) describe a variety of GHG measurement and energy efficiency measures undertaken at the regional and local level in the UK, and Pizer and

46 See Higley *et al*. (2001), OECD (2003e) and Lyon and Maxwell (2004) for typologies of different types of approaches and initiatives.
47 These cities participate in the International Council for Local Environmental Initiatives (ICLEI), Cities for Climate Protection (CCP) programme. See http://www.iclei.org.
48 http://www.iclei.org/index.php?id=528.
49 http://www.iclei.org/index.php?id=700.
50 http://www.iclei.org/index.php?id=1089.

Tamura (2004) summarize measures undertaken by the Tokyo city government to reduce GHGs and control the 'heat island' effect. These types of initiatives may influence sub-national and national government policies and serve as incubators for new approaches to achieve GHG emission reductions.

13.4.2 Corporate and NGO actions

Corporations and NGOs, including industry associations and environmental advocacy groups, have started a variety of programmes and initiatives to address GHG emissions. The various factors leading corporations to adopt voluntary environmental action have been explored in the literature (Lyon and Maxwell, 2004; Thalmann and Baranzini, 2005). While some companies have attributed these actions to sustainable development goals or environmental stewardship policies (Margolick and Russell, 2001), it is often difficult to separate these goals from economic motives (Kolk and Pinske, 2004). Less controversial is the notion that companies adopt voluntary initiatives to create financial value in one form or another (Lyon and Maxwell, 2004).

There are both political and non-political drivers of corporate voluntary environmental action. Political drivers include a desire to pre-empt or influence future regulation. For example, trade associations in 30 countries have sponsored codes of management practices, the objectives of which are partly intended to forestall the imposition of government mandates (Nash and Ehrenfeld, 1996). Alternatively, corporations may adopt voluntary initiatives to influence future regulation in ways that improve their strategic positions. By adopting environmental technologies or other strategies ahead of regulatory mandates, corporations can signal to regulators that these alternatives are practical or relatively cost-effective (Reinhardt, 1999). Hoffman (2005) finds that some companies have adopted internal emissions trading schemes or GHG measurement programmes to gain expertise that will help them influence future national or international policies. A related motivation for voluntary action is the desire to manage the risks of future regulations by taking action that would increase profitability or protect a company's competitive position in the event of future regulatory mandates (Margolick and Russell, 2001).

Non-political drivers of voluntary corporate environmentalism include the desire to reduce costs through practices that also have environmental benefits (sometimes known as 'eco-efficiency'). Esty and Porter (1998) discuss how the desire to reduce energy or material costs drives corporate voluntary action, although this point of view is subject to some debate (Palmer *et al*., 1995; Porter and van der Linde, 1995). Hoffman (2005) and Margolick and Russell (2001) describe a variety of actions taken by US and Canadian companies to reduce GHG emissions while also reducing energy and operational costs.

Companies may also adopt environmental initiatives to appeal to green consumers, environmentally conscious stakeholders or even their own employees. Reinhardt (1998) discusses how this approach can take the form of companies differentiating their products by their environmental performance. Other companies have identified market opportunities for new products from potential GHG gas regimes (Reinhardt and Packard, 2001; Kolk and Pinske, 2005). In terms of the composition of the stakeholders, Maxwell *et al*. (2000) find that firms located in US states with a higher per capita membership in environmental organizations had more rapid reductions of toxic emissions. Margolick and Russell (2001) and Reinhardt (2000) report that corporate managers cited employee retention and recruitment as reasons for taking voluntary action.

Voluntary corporate-wide emissions targets for GHGs have become particularly popular. For example, Hoffman (2005) finds that as many as 60 US corporations have adopted corporate GHG emissions reduction targets and that some of these companies have participated in one of several partnership programmes run by NGOs (see Box 13.9). Under many of these programmes, companies develop a corporate GHG inventory and adopt an emission target. These targets take different forms, including absolute targets and intensity targets based on emissions or energy use per unit of production or sales (Margolick and Russell, 2001; King *et al*., 2004). Corporate targets have also been implemented with internal trading systems, such as those operated by British Petroleum (Margolick and Russell, 2001; Akhurst *et al*., 2003) and Petroleos Mexicana (PEMEX) (Bygrave, 2004).

Levy and Newell (2005) describe how the business sector, sometimes in partnership with NGOs, has initiated environmental certification or standardization regimes to fulfill a quasi-governmental role or to augment the role of governments. One of the most widely-used examples of this type of standard setting is the Greenhouse Gas Protocol, an initiative organized by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI) to develop an internationally accepted accounting and reporting standard for GHGs (WRI/WBCSD, 2004). The WRI/WBCSD reporting standard has been used by corporations, NGOs and government voluntary programmes. The International Standards Organization (ISO), based on the WRI/WBCSD, has adopted standards for the reporting of GHGs at the company and project level.[51]

Other standardization or certification efforts have been formed to support markets for project-based mechanisms or emissions trading. For example, the International Financial Reporting Interpretations Committee (IFRIC), which is the interpretive arm of the International Accounting Standards Board (IASB), has issued guidelines on financial accounting for emission allowances.[52] The International Emissions Trading

51 The relevant ISO standards are ISO 14064 Part 1. This may be found at: http://www.iso.org/iso/en/CatalogueDetailPage.CatalogueDetail?CSNUMBER=38381&scopelist=PROGRAMME

52 See http://www.iasb.org/news/index.asp?showPageContent=no&xml=10_262_25_02122004_31122009.htm

Box 13.9 Examples of private partnerships and programmes

Business Leader Initiative on Climate Change (BLICC): Under this initiative, five European companies monitor and report their GHG emissions and set a reduction target. See http://www.respecteurope.com/rt2/BLICC/

Carbon Disclosure Project: Under this project, 940 companies report their GHG emissions. The project is supported by institutional investors controlling about 25% of the global stock markets. See http://www.cdproject.net

Carbon Trust: The Carbon Trust is a not-for-profit company set up by the UK government to reduce carbon emissions. The Trust provides technical assistance, investment funds and other services to companies on emission reduction strategies and for the development of new technologies. See http://www.thecarbontrust.co.uk/default.ct

Cement Sustainability Initiative: Ten companies have developed 'The Cement Sustainability Initiative' for 2002–2007 under the umbrella of the World Business Council for Sustainable Development. This initiative out-lines individual or joint actions to set emissions targets and monitor and report emissions.

Chicago Climate Exchange: The Chicago Climate Exchange is a GHG emission reduction and trading pilot programme for emission sources and offset projects in the USA, Canada and Mexico. It is a self-regulatory, rules-based exchange designed and governed by the members who have made a voluntary commitment to reduce their GHG emissions by 4% below the average of their 1998–2001 baseline by 2006. See http://www.chicagoclimatex.com

Offset Programmes: Braun and Stute (2004) identified 35 organizations that offer services to offset the emissions of companies, communities and private individuals. These organizations first calculate the emissions of their participants and then undertake emission reduction or carbon sequestration projects or acquire and retire emission reduction units or emission allowances.

Pew Center on Climate Change Business Environmental Leadership Council: Under this initiative, 41 companies establish emissions reduction objectives, invest in new, more efficient products, practices, and technologies and support actions to achieve cost-effective emissions reductions. See: http://www.pewclimate.org/companies_leading_the_way_belc/

Top ten consumer information system: This NGO-sponsored programme provides consumers with information on the most efficient consumer products and services available in local markets. The service is available in ten EU countries, with plans to expand to China and Latin America. See http://www.topten.info

WWF Climate Savers: The NGO World Wide Fund of Nature (WWF) has build partnerships with individual leading corporations that pledge to reduce their global warming emissions worldwide by 7% below 1990 levels by the year 2010. Six companies have entered this programme. See http://www.panda.org/about_wwf/what_we_do/climate_change/our_solutions/business_industry/climate_savers/ index.cfm

Association, together with the World Bank Carbon Finance Group/Prototype Carbon Fund have developed a validation and verification manual to be used by stakeholders involved in developing, financing, validating and verifying CDM and JI projects.

13.4.3 Litigation related to climate change

The authors of many technical articles point out that litigation is likely to be used increasingly as countries and citizens become dissatisfied with the pace of international and national decision-making on climate change (Penalver, 1998; Marburg, 2001; Weisslitz, 2002; Allen, 2003; Grossman, 2003; Verheyen, 2003; Gillespie, 2004; Thackeray, 2004; Dlugolecki, 2005; Hancock, 2005; Jacobs, 2005; Lipanovich, 2005; Mank, 2005). These authors argue that the possible causes of action in litigation include (1) customary law principle of state responsibility, (2) nuisance and the no-harm principle, (3) violation of international agreements including the WTO and the United National Convention on the Law of the Sea (UNCLOS) and the violation of human rights and (4) the abdication of authority by states to legislate on environmental issues based on the existing environmental legislation in the country concerned. However, they also emphasize that although there are often strong legal grounds for taking action, there may also be reasons for a strong defence.

Gillespie (2004) argues that if the international process is arguably not taking place in good faith, there is sound reason for requesting the International Court of Justice for an Advisory Opinion in this area, especially when the significant (potential) harm faced by small island states are taken into account. Jacobs (2005) and Verheyen (2003) analysed the potential case for a small island state actually suing the USA before the International

Court of Justice. Burns (2004) and Doelle (2004) point out that non-ratification of the Kyoto Protocol could imply illegal subsidies to national industries under the WTO and pollution of the seas under UNCLOS. Hancock (2005) sees the potential for liability suits increasing and advises companies to disclose their emissions to the Securities and Exchange Commission as a step to limit liability. Issues of causality are being dealt with in the literature (Allen, 2003) and through precedent (Lipanovich, 2005).

There are currently a number of court cases in Kyoto Party countries, both developed (Germany) and developing (Nigeria), and non-Parties (Australia and the USA). For example, in Germany, NGOs have sued the export credit support agencies for not disclosing information on the GHG emissions of the projects they support in developing countries. (See www.climatelaw.org/media/german.suit). A similar case was filed in the US District Court for the Northern District of California, on August 26, 2002 by Friends of the Earth, Greenpeace and the city of Boulder, Colorado, which have sued the Export-Import Bank and the Overseas Private Investment Corporation under the National Environmental Policy Act, alleging that these two US government agencies had provided 32 billion US$ for supporting the finance and insurance of oil fields, pipelines and coal-fired plants in developing countries over the previous 10 years without assessing the impacts on the environment including global warming. A Federal Judge in California has ruled in favour of the plaintiffs.[53]

In a case filed in Argentina, the plaintiffs allege a violation of Article 6 of the Climate Convention. In Nigeria, NGOs have sued the major oil companies and the state for continuing gas flaring, an industrial process which contributes about 70 million tonnes of CO_2 annually to global GHG emissions (Climate Justice Programme, 2005) and which is viewed as a violation of the Convention and the human rights of the local people.[54] In Australia, NGOs have filed a suit against a minister for permitting a mine expansion project without examining the GHG emissions. See www.austlii.edu.au/au/cases/vic/VCAT/2004/2029.html.

There are two law cases in the USA where a coalition of states[55] and environmental NGOs argue that the US EPA has the authority to regulate CO_2 and other GHGs as air pollutants under the Clean Air Act.[56] In addition, eight US States, New York City and two land conservation trusts initiated a lawsuit in July 2004 against the five US power companies with the largest CO_2 emissions, on the grounds that these companies contribute to a public nuisance (global warming). That case, though dismissed by the trial court, is on appeal.[57] Non-government organizations in Australia have also given notice to the major GHG emitters in the USA about their obligations under national and international law to reduce their emissions (http://www.cana.net.au/documents/legal/aus_fin_rev.doc). In July 2005, a wildlife organization sued the Australian Government for failing to protect the Great Barrier Reef (http://www.climatelaw.org/media/Australia.emissions.suit). A court case was filed in December 2005 by the Inuit people before the Inter-American Commission of Human Rights against the US government for human rights violations of the Inuit people's way of life.[58] There have also been cases that have challenged the allocation of emission allowances. With the entry into force of the EU Emissions Trading Directive,[59] there has been some litigation in Germany that has challenged the manner in which the German Government has interpreted and transposed the directive into its National Allocation Plan in 2004[60]. The courts have thus far decided that the Emission Allocation Law is in conformity with German law and with European rules on property rights.[61]

While many of the these legal cases have not yet led to interim judgments in favour of the plaintiff, they do reveal there is a decided interest in pursuing the legal route as the means to pushing for action on climate change. These cases are based on a number of different legal grounds for doing so, but it may take some years before courts decide which, if any, of these grounds are valid.

13.4.4 Interactions between private, local and non-governmental initiatives and national/international efforts

The preceding sections have touched on a number of the interactions that take place between private, sub-national and non-governmental initiatives and national and international climate change efforts. As discussed, some of these efforts have been designed, at least in part, to influence the development of

53 Order Denying Defendants' Motion for Summary Judgment, in the case of Friends of the earth, Greenpeace, Inc. and City of Boulder Colorado versus Peter Watson (Overseas Private Investment Corporation) and Phillip Lerrill (Export-Import Bank of the United States), No. C 02-4106 JSW.

54 Suit No. FHC/CS/B/126/2005; filed in the Federal High Court of Nigeria, in the Benin Judicial Division, Holden at Benin City.

55 California, Connecticut, Illinois, Maine, Massachusetts, New Jersey, New Mexico, New York, Oregon, Rhode Island, Vermont and Washington together with New York City, Baltimore, and Washington, DC.

56 Massachusetts vs. Environmental Protection Agency, 415 F.3d 50 (D.C. Cir. 2005). A petition for Supreme Court review is pending. This case concerns motor vehicle emissions. Another case has been filed in the US Court of Appeals for the District of Columbia Circuit by a coalition of states and NGOs led by New York over an EPA decision not to regulate CO_2 from power plants.

57 Connecticut, *et al*. vs. American Electric Power Company Inc., *et al*.; 406 F.Supp.2d 265 (S.D.N.Y. 2005), appeal pending in the Court of Appeals for the Second Circuit.

58 Petition to the Inter-American Commission on Human Rights Seeking Relief From Violations Resulting From Global Warming Caused by Acts and Omissions of the United States, December 7, 2005.

59 Directive 2003/87/EC of the European Parliament and the Council of 13 October 2003 (OJ L 275, 25-10-2003), establishing a scheme for GHG allowance trading within the community and amending Council Directive 96/61/EC (OJ L257, 10-10-1996); available at < http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_275/l_27520031025en00320046.pdf>

60 Gesetz über den nationalen Zuteilungsplan für Treibhausgasemissionsberechtigungen in der Zuteilungsperiode 2005-2007 (Zuteilungsgesetz 2007 - ZuG2007), Bundesgesetzblatt Jahrgang 2004, Teil I, Nr. 45, 30. August 2004.

61 Beschluss vom 1.9.2004, NVwZ2004, S.1389 ff; Beschluss vom 18.10.2004, NVwZ2005, S.112 ff; BverwG, Urteil vom 309.6.2005, NVwZ2005, S. 1178ff.

national programmes or the international climate regime. Other programmes have been designed to fill roles in these regimes that may be appropriate for private or non-governmental entities. Finally, other legal or programmatic initiatives have been launched because of the perceived inadequacy of national or international efforts.

One of the most important drivers of these interactions is the development of a global GHG emission trading market. Many of the standardization and certification efforts described above have been designed to build institutions for the emerging GHG market which in turn may also facilitate interactions between sub-national initiatives and national or international climate regimes. For example, the eight north-eastern and mid-Atlantic states in the US Regional Greenhouse Gas Initiative (RGGI) cap and trade programme will allow the use of CDM credits and EU ETS allowances under certain circumstances (RGGI, 2005). Similarly, there has been an exploration of a possible linkage between the NSW Greenhouse Gas abatement scheme and the EU ETS and Kyoto mechanisms (Fowler, 2004; Betz and MacGill, 2005).

In addition to international carbon markets, there are other frameworks that facilitate interactions between private, sub-national, and non-governmental initiatives and national and international climate change efforts. For example, NGOs, private companies and governments have formed partnerships to help implement the World Summit on Sustainable Development (WSSD). These partnerships, known as 'type II agreements' are self-organized and are formed as voluntary cooperative initiatives and have the common goal of integrating the economic, social and environmental dimensions of sustainable development. To date, more than 300 partnerships are registered. A significant number of these partnerships are climate change-related (see http://www.un.org/esa/sustdev/partnerships/partnerships.htm).

13.5 Implications for global climate change policy

This chapter has provided information on the national and international policy options available to governments and the global community to address global climate change. We note that there are many tools available and that each has its own unique advantages and disadvantages. While further studies are likely to yield additional insights, particularly with respect to the implementation of policy choices, it is unlikely that the suite of policies available to governments will grow substantially in the future.

With this in mind, it is useful to consider several questions in the light of the following background information. Since the IPCC was formed nearly 20 years ago atmospheric GHG concentrations have gone up from 354 to 385 ppm (or approximately 25% of the total increase since the pre-industrial level of 270 ppm) as the emissions of GHG have risen (see http://cdiac.ornl.gov/ftp/trends/CO_2/maunaloa. CO_2). We have measurement data that indicates that the world is warming, and we can calculate, given the data on past and current emissions, that there is at the present time approximately 0.6 degrees of additional warming 'in the bank' (See IPCC, 2007a). Therefore:

- Why has the application of policies been so modest?
- Why is the global community not on a faster implementation track?
- Why have – at the very least – hedging strategies not emerged in many more countries?
- Is the scale of the problem too large for current institutions?
- Is there a lack of information on potential impacts or on low-cost options?
- Has policy-making been influenced by the special interests of a few?

Assuming that policies have been carefully designed, there appears to be no need to delay their implementation – indeed, there is an abundance of information in climate change literature that continues to suggest the non-climate benefits of many of these policies and the potential climate benefits of many non-climate policies. Moreover, as outlined in other chapters of this report, with a few exceptions, these policies would have only a very small impact on national economic growth – albeit the impact would be large in absolute terms.

One answer to these questions may lie in the complex nature of the policy-making processes – both for climate change policy and, even more importantly, in other areas at the national and sub-national level. For example, some of the most significant emissions reductions in both developed and developing countries have occurred at this intersection of policies (e.g. the switch to gas in the UK, the Chinese energy efficiency programmes for energy security, the Brazilian development of a bio-fuel-driven transport fleet, or the trend in the 1970s and 1980s toward nuclear power). Conversely, some of the most significant increases in emissions have been the result of non-climate policy priorities which have overwhelmed climate mitigation efforts (e.g. decisions in Canada to exploit the tar sands reserves, those in Brazil to clear forests for agriculture and those in the USA to promote coal-powered electricity generation to enhance energy security). Assessing how these mega-decisions are made and how they can be linked with climate change policies is the topic of chapter 12 and may be crucial to the future.

A second answer may be linked to the over-riding drive by all governments (reflecting both corporate and individual desires) for cheap and secure energy and for economic growth, to the competitive nature of the global economy and to the perception that any step, however modest, will disadvantage some special interest. Finding a way to mitigate the impacts on the losers – as well as create new winners – may be a key to accelerating the pace of policy implementation. Most importantly perhaps, finding ways to eliminate the climate of 'fear' that prevents actions (or more aggressive actions) and to promote a climate of 'opportunity' may be crucial to moving beyond modest steps. As outlined in other chapters of this report, the impact of mitigation efforts on national economic growth is relatively small, although the economic impacts differ among countries and may be larger than the impacts of other environmental problems. Mitigation is also more complicated as it involves more political actors and greater levels of cooperation and/or coordination. In this respect, better estimates of the risks, costs and benefits of climate policies in terms of market and no-market terms as well as ethical terms may enable governments to make informed decisions.

From the literature reviewed in this chapter, it is clear that governments, companies and civil society have been actively grappling with these questions. The very diversity of the policy mix, the activism of NGOs and the wealth of modelling, research and analysis (even if, to date, these have yielded only modest changes in emissions) collectively provide a framework for taking additional steps.

New research might provide further insight into why some policies have succeeded – and why others have not. In particular, additional work is needed to bolster the currently sparse body of research addressing the concerns of developing countries. Understanding how to accelerate policy adoption may be the most important research topic for the immediate future. As this chapter and others have noted, technology and policy tools do exist for taking that significant first step in addressing climate change. Potential future agreements can take advantage of this learning to encourage economically prudent and politically feasible actions.

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