OECD DEVELOPMENT CENTRE

POLICY BRIEF No. 21

BEYOND JOHANNESBURG: POLICIES AND FINANCE FOR CLIMATE-FRIENDLY DEVELOPMENT

by

Georg Caspary and David O'Connor

- Early climate-related actions should be those with a high local economic and/or environmental payoff per unit of impact on greenhouse gases.

- Energy, transport and natural resource management policies can often be better designed to realise greenhouse gas reductions at little or no additional cost.

- In energy and transport, investment and network planning need to account for likely future emission constraints in order to avoid costly lock-in effects and premature obsolescence of capital stock.

- The local air quality and health benefits of climate policy can be sizeable in the megacities of developing countries, probably exceeding those in OECD countries that have already gone some way to delink carbon emissions from local pollution.

- A global market for climate stabilisation services is gradually taking shape in which many developing countries could expect to become net suppliers.

POLICY BRIEF No. 21

BEYOND JOHANNESBURG: POLICIES AND FINANCE FOR CLIMATE-FRIENDLY DEVELOPMENT

by

Georg Caspary and David O'Connor

DEVELOPMENT CENTRE POLICY BRIEFS

In its research activities, the Development Centre aims to identify and analyse problems the implications of which will be of concern in the near future to both Member and non-Member countries of the OECD. The conclusions represent a contribution to the search for policies to deal with the issues involved.

The *Policy Briefs* deliver the research findings in a concise and accessible way. This series, with its wide, targeted and rapid distribution, is specifically intended for policy and decision makers in the fields concerned.

The aim of this Policy Brief is threefold: to suggest a number of policy areas where developing country governments could achieve national sustainable development goals and climate mitigation simultaneously; to identify options for financing climate-friendly investments from external sources; and to provide a rough guide to climate policy makers on *what* makes sense to do *when*.

Despite setbacks, an international climate policy regime is taking shape. A key emergent feature is a global market for trading of carbon credits. Developing countries have the opportunity to participate as sellers in that market through the Clean Development Mechanism (CDM) and, for those countries with a comparative advantage in low-cost carbon abatement/capture, the prospective earnings could be sizeable.

While not bound to quantitative greenhouse gas targets as a condition for CDM participation, developing countries will still need to define plausible emissions baselines and institute effective monitoring programmes, lest the value of carbon credits be diminished and with it the interest of prospective foreign investors. Countries that start now to craft a climate policy stand a better chance of attracting early CDM investments that could yield sizeable learning economies. These would need to be weighed, together with the time value of capital, against the familiar technological improvement argument for waiting.

In one respect waiting is a pure cost. This is the case where policies can be implemented today that would yield real net economic benefits, as for instance with measures that encourage improved energy and economic efficiency and those that achieve significant improvements in local environmental quality and human health at low incremental cost.

OECD
DEVELOPMENT CENTRE
94 rue Chardon-Lagache
75016 Paris, France
Tel.: (33-01) 45.24.82.00 Fax: (33-01) 45.24.79.43
www.oecd/dev

Table of Contents

Figures and Boxes

Acknowledgements

The authors would like to thank Noreen Beg of the World Bank, Jan Corfee-Morlot of the OECD Environment Directorate, Rémy Paris of the OECD Development Co-operation Directorate, Axel Michaelowa of HWWA in Hamburg, and several colleagues at the OECD Development Centre (Colm Foy, Kii Fukasaku, Ulrich Hiemenz and Helmut Reisen) for helpful comments on earlier drafts. Naturally, none shares responsibility for any remaining errors.

The Development Centre would like to express its gratitude to the government of Switzerland for the financial support given to the progamme on "Responding to Global and Local Environmental Challenges" in the context of which this study was carried out.

Introduction

The consensus of the world scientific community is that human activities are contributing to global climate change (WGI/IPCC, 2001). There remains uncertainty about the rate of future temperature rise and its effects on climate in different regions of the globe. Still, there is widespread agreement that developing countries are among the most vulnerable, in particular those poor countries that depend heavily on agriculture and those island countries that face the prospect of inundation in the event of significant further sea level rise. It is also generally accepted that, no matter how forceful the measures agreed by the international community in coming years to slow growth of greenhouse gas (GHG) emissions, the earth is on a course to further climate change that cannot be reversed in the near to medium term. Thus, adaptation will be necessary, though how much and how soon remain unknowns.

The international community has been engaged for more than a decade in negotiation of an acceptable legal and institutional framework for addressing the climate change challenge. It is understood that, having contributed the lion's share of accumulated greenhouse gases in the atmosphere, developed countries bear a proportionately large share of responsibility for tackling the problem. At the same time, developing countries that are Parties to the United Nations Framework Convention on Climate Change (UNFCCC) (ratified so far by 186 countries) also assume a share of the responsibility for mounting a global response. For those developing country signatories that emit few greenhouse gases but are highly vulnerable to climate change, the overwhelming policy preoccupation will be one of adaptation. For many others, their present and future contribution to GHG emissions makes it essential that they play a part in efforts to slow emissions growth. The Kyoto Protocol[1], together with subsequent decisions by the Conference of the Parties (COP) elaborating specific provisions, provides the principal definition of the roles of different groups of countries in the climate change response. On its present terms, only the developed countries listed in Annex I of the UNFCCC are obliged to impose quantitative limits on future emissions to return them to some historic level, this during the first control period, 2008-12. There is little chance of non-Annex I developing countries' committing collectively to limits on their own emissions before good faith has been demonstrated by the developed ones. Still, developing country policy makers do have an incentive to reduce net GHG emissions insofar as they can gain financial resources to do so through the Clean Development Mechanism (CDM), one of the three "flexibility mechanisms" provided for in the Kyoto agreement[2], and those resources can contribute to the country's development objectives. Besides actions that generate new external resource inflows, it is possible that some policies that governments choose to implement for domestic economic, environmental or social reasons would yield climate benefits. Conversely, measures to reduce carbon emissions, or the carbon intensity of the economy, may also yield local benefits that outweigh or at least offset the costs of those measures.

The first purpose of this Policy Brief is to suggest a number of policy areas where developing country governments could possibly "kill two birds with one stone", achieving local developmental goals and climate mitigation simultaneously (next section). The discussion will focus on those measures that yield overall net benefits or, at the very least, only minimal net cost, once all relevant costs and benefits have been considered. The second purpose is to discuss the set of policy and investment options that countries would probably not choose to undertake in the absence of additional resources but that the CDM might render economically attractive (see section on Mobilising Resources for Climate Stabilisation Services). The third purpose is to provide a rough guide to developing country policy makers on *what* makes sense to do *when* in terms of climate policy (concluding section).

The Brief addresses itself primarily to measures aimed at reducing a country's net GHG emissions and only secondarily to adaptation in the face of climate change. In some cases, adaptation measures can also reduce net emissions, and it is mainly in this context that adaptation is discussed.

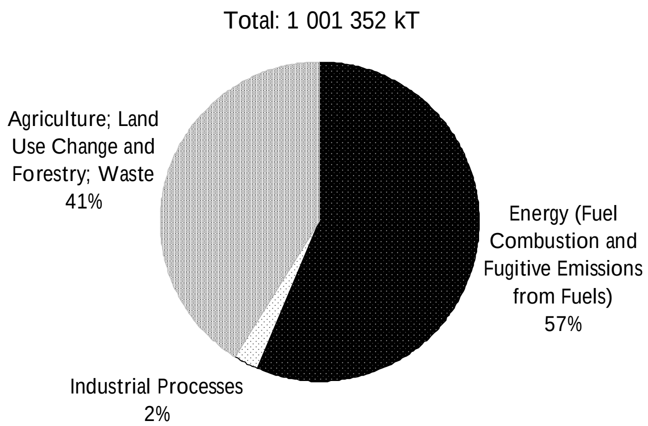
Can Climate Policy Ever Be "Painless"?

To answer this question, we need to have a clear definition of what is meant by climate policy. We are not referring simply to a discrete set of policies (like a carbon tax or tradable emission rights) that have as their sole objective the reduction of GHG emissions. Rather, we mean to include a broad range of policies that can significantly impact the carbon intensity of the economy, even if their primary objective lies elsewhere. Energy policies are the most obvious case, but transport policies and policies and institutions for the management of various natural resources (e.g. forests, agricultural lands) also fall into this category. Here we argue the utility of using a climate optic to review these policies, with a view to seeing how they might be better designed to minimise climate impacts without undermining their primary intent and without raising significantly their costs.

We do include discussion of explicit climate policies — notably carbon taxes — in order to understand better how these can contribute to addressing local environmental problems and reducing their associated costs. There is a growing literature, some theoretical but most empirical, on so-called "ancillary benefits and costs" of climate policy (cf. OECD, 2000). These are usually mediated through changes in local air quality that can have effects on people's health and longevity, on crop yields, on forests and lakes, and on building materials. Clearly if these benefits are large enough, they can outweigh the costs of GHG mitigation. This may be the case at first but, beyond some point, the economic costs of GHG reduction rise very steeply while the benefits generally show no such tendency.

Which area of policy merits the greatest attention from a climate perspective depends largely on an individual country's GHG profile. While in Annex I countries fossil fuel combustion dominates emissions, in many developing countries — including some large ones like India (see Figure 1) — agriculture and land-use changes account for an important share. Similarly, in the case of energy-related emissions, sectoral shares can vary considerably (see Figure 2): in China, for instance, electricity generation represents the single largest source of CO_2, while in Brazil (with its abundance of hydroelectric power), transport emissions figure more prominently.

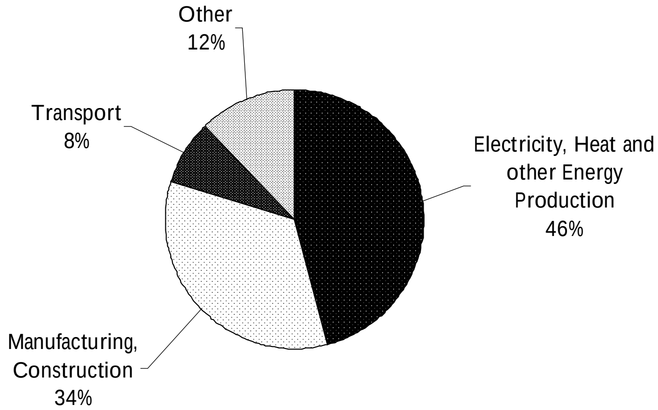
Figure 1. **Greenhouse Gas Inventory for India, 1990**
(in kilotons CO_2 equiv.)



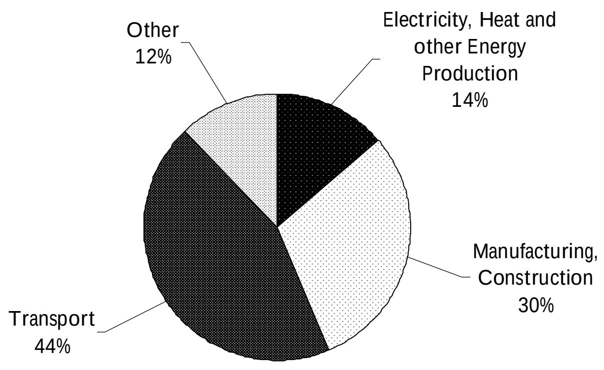
Note: Industrial processes refer primarily to cement production; emissions from fuel use for energy production by industry are included in the energy total.
Source: ADB, 1998.

Figure 2. **Fuel-Related CO_2 Emissions by Sector, 1998**
($MT\ CO_2$ and percentage shares)

China (2 806 MT)



Brazil (283 MT)



Source: IEA, 2000*a*.

The inter- and intra-sectoral pattern of GHG emissions will also affect a country's costs of reducing them. Reductions come more easily from some sources than from others. An early study by the UNEP Collaborating Centre on Energy and the Environment (UNEP, 1994) estimated marginal GHG abatement cost curves for a number of countries and found that, over some range, there was a potential for negative cost abatement options — equivalent to roughly a 7 per cent reduction from the baseline for Brazil, 11 per cent for Senegal, 17 per cent for Thailand, and 30 per cent for Zimbabwe. In most cases, the least cost (highest negative cost) options involve energy efficiency improvements in industrial processes and household fuel consumption (lighting, cooking). Electricity supply options, by contrast, are generally among the most costly, reflecting above all the high costs of prematurely scrapping generating and other capital equipment. Cogeneration of heat and power is an important exception. Moreover, where the baseline is one of expanding electricity consumption, what matters most are the costs associated with new plant and equipment. Certain transport-related technology options can also be rather costly ways of abating CO_2 (EPA, 2000). The cost-effectiveness of options involving inter-fuel substitution [e.g. compressed natural gas (CNG) for gasoline] depends heavily on fuel prices, which can vary substantially from year to year.

Economists still disagree about the prevalence of "free lunches", or the proverbial unclaimed dollar bill on the sidewalk. Few nowadays would insist that economic agents always act rationally, but even if this were a valid first approximation they may not be fully informed about all relevant costs and benefits of their decisions. Much economic analysis of the last few decades, pioneered by the 2001 Nobel laureates in economics, has sought to understand the implications of incomplete (imperfect) information for efficient resource allocation. Imperfect information can prevent businesses from taking all the actions they theoretically could to save money. Acquiring information and know-how, whether through search or through in-house R&D, is costly, and firms must weigh the costs against any expected future savings. Moreover, they may overestimate the R&D/search costs and underestimate the resultant savings (a *status quo* bias).

Another possibility is that, even if a cost-saving innovation is available and firms know about it, they do not make the necessary investment. One reason might be that they face imperfect capital markets in which they cannot raise the requisite funds. Another might be bureaucratic and organisational inertia in industries where firms face less than perfect competition. According to one review of evidence from the "Green Lights" programme in the United States, such inertia has deterred potentially profitable investments in energy-saving technologies (DeCanio, 1998). In other words, if profit-maximising companies had been faced with a more competitive market environment and had had better access to information, they would in all likelihood have adopted these energy-saving technologies. In so doing, they would also have generated climate benefits by reducing their carbon budgets.

Thus far, we have been discussing "free lunch" opportunities for private firms or other economic agents — actions that, if taken, would actually result in their saving money (raising profits or disposable income). These are instances of private "no regrets" actions. In these cases, the principal function of policy is to alert private agents to opportunities that they might otherwise overlook and to ensure that markets function efficiently to send the proper price signals.

There may also be societal (or economy-wide) "no regrets" options. Even if all firms are acting rationally and facing strong competition to lower costs, there may still be socially desirable actions that they have no incentive to take. This is the case, for example, when environmental externalities are present and are not internalised through either regulation or price-based mechanisms. Thus, if air quality standards are low, firms may pollute the air with impunity. The question is what constitutes a socially acceptable level of various pollutants in the air. Economics has an answer: policy makers are advised to set standards so as to equate marginal costs and benefits of meeting the standards. Naturally, this presupposes that they are well-informed about both costs and benefits. In practice, the benefits of pollution control have rarely been explicitly factored into the determination of standards, partly because historically they have been so difficult to measure with any precision. It is safe to say that in the vast majority of cases — whether in the OECD or in developing countries — environmental regulatory policy has been made on the basis of incomplete information. While in some cases, regulations may be too strict on cost-benefit criteria (as has been suggested, e.g. of certain health and safety regulations in the United States; cf. Kamerud, 1988, for the case of the 55 mph US speed limit), in many developing countries they are likely to be too lax, at least in terms of enforcement. Enforcement effort responds to a variety of pressures, but in many cases there is a collective action problem that prevents the effective exercise of pressure by pollution victims. The fact that the victims are disproportionately the poor (with the rich better able to take averting measures) does not help matters.

The presumption here, then, is that if developing country policy makers were able to set standards on the basis of fuller information on both costs and benefits, very often they would choose stricter standards (or stricter enforcement). Air quality is evidently poor in many cities of the developing world, and many respiratory and other health problems are a direct result. Improving air quality would clearly yield health benefits, and perhaps others as well. There are various ways of doing this, among which are measures that change the economy's energy intensity and/or fuel mix. Policy measures to reduce CO_2 emissions work precisely in this way, and so they could be expected to yield local air quality benefits. How large those benefits are and whether they offset the costs of the adjustments wrought by the policy are the crucial questions.

Designing Energy and Transport Policies with a View to Climate Impacts

Energy and transport are key elements of a country's economic infrastructure. The development benefits of power plants, roads and ports are familiar enough and do not need to be rehearsed here. One certainty is that, as developing countries grow, so too will demands upon this infrastructure and pressures to expand supply. Since, in poor countries, the bulk of energy and transport infrastructure investments will be made in the future, they have far greater flexibility than developed countries to plan infrastructure taking account of its environmental impacts. Moreover, the capital equipment used for power generation is often purchased in part from industrialised countries, so it is possible to acquire the latest, and least polluting, technology on offer. Set off against this "latecomer advantage" is the fact that, for capital-intensive investments like power plants and network infrastructure like roads and railroads, decisions in the present have long-term repercussions. It is very costly to scrap a new power plant or a fleet of buses and trucks, and it is very difficult to reconfigure a transport system after the concrete or asphalt has been poured and/or the tracks laid. In short, long-term planning is crucial to avoid costly mistakes.

Providing Cleaner Energy

The particular way in which energy services are provided varies from country to country, depending on a number of factors. By far the most important is the national endowment of different energy resources — coal deposits, oil and gas reserves, hydroelectric potential, sunlight, etc. Some countries can be expected to have low-carbon-energy economies simply by virtue of their natural endowments. On the other hand, countries like China and India have vast coal reserves. Not to exploit this abundant energy source would be economic nonsense. Still, given what we now know about coal's contribution both to local air pollution and to climate change, these countries face difficult policy dilemmas.

Can the benefits of cheap coal continue to be reaped without *i)* serious escalation of associated costs in terms of deteriorating public health and *ii)* exacerbation of global warming?

In the case of local air quality, there is no question that substantial improvements can be made while continuing to burn coal. Various end-of-stack technologies exist for scrubbing emissions from power plants of their toxic components, some more costly than others. Technologies for SO_2 and particulate removal do not remove greenhouse gases, and no comparable technologies currently exist for CO_2. Certain other measures, however, can yield important reductions in both these local pollutants and global pollutants, essentially by improving the efficiency of energy use and thus reducing the amount consumed per unit of economic output. Comparative studies of industrial processes have consistently found that average energy efficiency in China and India is well below global best practice. Thus, simply bringing industrial efficiency in these countries closer to the world frontier could yield sizeable energy savings and GHG reductions for a given industrial output. For example, a study of India's cement industry (Schumacher and Sathaye, 1999) estimates that, if all Indian cement plants had produced according to best practice[3], CO_2 emissions in 1993 would have been 0.63 tonnes per tonne of cement production instead of the actual value of 0.89, for a total sectoral CO_2 reduction of 15 million tonnes (equal to roughly 2 per cent of total Indian energy-related CO_2 emissions in that year; IEA, 1997). An earlier study of India's steel industry (Bowonder and Miyake, 1988) finds energy consumption per tonne of steel produced in several major plants to be roughly double that of the best practice Korean plant (Pohang) and even higher *vis-à-vis* the Japanese average for integrated plants. A more recent comparison of India to Brazil (OECD/IEA, 2000*b*) finds an energy intensity of integrated steel production in the former that is 50 per cent higher than in the latter, and a CO_2 emissions intensity that is almost treble Brazil's, the latter figure largely reflecting different electricity emission factors.

a) Reforming Energy Pricing

Energy subsidies have long been an instrument of industrial policy, social policy or both. This is true of OECD and non-OECD countries alike. Governments may subsidise electricity rates for favoured industries, investors or socio-economic groups. In India, for example, farmers enjoy essentially free electricity for operating their irrigation pumps. Households enjoy subsidised kerosene for cooking, and liquified petroleum gas (LPG) is also heavily subsidised. There can be a convincing rationale for these subsidies: e.g. among the benefits of subsidised kerosene and LPG are reduced indoor smoke exposure on the part of women and children and reduced pressure on forests from fuelwood scavenging.

Subsidies can, however, impose a severe fiscal burden, and very often the lion's share of benefits accrues to wealthier households and larger enterprises, since they consume larger amounts of the subsidised inputs in the first place.

In the end, electricity subsidies can be counterproductive, as the Indian experience shows. The inability of the state electricity boards to recover their costs makes them unattractive customers, and investment in generation capacity faces the prospect of a low return. Thus, installed grid capacity lags far behind demand, with industrial firms having to invest heavily in off-grid diesel generating capacity to avoid costly and frequent power interruptions. The poor state of India's electricity infrastructure is now threatening the economy's expansion, forcing the government to act. India is singled out only because it illustrates so well the problems facing the energy sector throughout much of the developing world.

When additional capacity is required, subsidised rural tariffs for grid-supplied commercial electricity can bias investment decisions against renewable sources, which are typically priced at full marginal cost (Kozloff and Shobowale, 1994). The bias against renewables is especially unfortunate in view of their generally smaller negative environmental externalities. Also, certain non-energy subsidies can distort energy investment decisions. For instance, in countries such as China and India, railway freight rates are heavily subsidised, and much rail capacity is devoted to moving coal from mines to power plants.

Subsidy reform can have sizeable demand effects. The IEA (1999) has analysed the effects of energy subsidy removal in India, finding that the fiscal savings would amount to $8.6 billion and that energy demand would be reduced by about 7.2 per cent and CO_2 emissions by 14 per cent. Most of the energy savings would come from steam coal use in industry and kerosene consumption by households. In China, the 1996 liberalisation of the price of coal from state-owned mines has served to trim demand and production from excessively high levels, with coal production falling a little over 10 per cent between 1996 and 1999 (the first such decline in a quarter century)[4] (IEA, 1999 and IEA, 2001).

Energy pricing reform is a politically sensitive issue in both developing and developed countries, not least because of potential distributional impacts. Poor people are likely to suffer particular hardship from energy subsidy removal: for them, energy expenses often represent a comparatively large share of their disposable income. In Viet Nam, for example, the household expenditure share on fuels declines consistently from the lowest to the highest expenditure quintile (GSO, 2000, Table 6.3.1). (Köhler *et al.,* 1997 document a similar relationship for EU countries.) At the same time, demand elasticity for energy is generally low, so that any price rise means an even higher energy expenditure share. Hence, governments need to consider ameliorating any regressive effects through targeted measures like lifeline electricity rates. Over the medium term, subsidy removal should have a beneficial distributive effect by generating funds for investment in extending the electricity grid to hitherto unserved poor communities.

Beyond effects on poor households, governments are often concerned with adverse effects of energy pricing reforms on specific industrial sectors — especially if serious localised unemployment is an expected result. One approach to tackle this problem is to design policies in such a way that, rather than causing serious shrinkage of a whole industry, they reward energy-efficient firms and penalise energy-inefficient ones within the industry. A prominent example from the OECD is that of the Swedish sulphur tax. This tax is levied on power generators according to the quantity of their sulphur emissions; at the same time, the tax revenue is rebated to the generators according to their electricity output. The net effect is to encourage firms to reduce the pollution intensity of power generation without imposing a financial hardship on the industry as a whole. Regional exemptions may also be warranted, as for instance when regional climatic conditions force households and businesses to spend an unusually large share of income or revenue on heating.

b) Active Technology Dissemination

There is a risk that subsidy removal on cooking fuels could induce some rural households to revert to wood stoves. In any case, in many developing countries, biomass remains the predominant cooking fuel in rural areas. Energy-efficient biomass burning stoves exist, but an active effort is needed to encourage more widespread adoption. Households can derive two sorts of concrete benefits from their use: savings of time and energy spent in collecting fuelwood, and improvements in respiratory health of women and children. Besides, reduced fuelwood demand alleviates pressure on forests, which in turn has other external benefits, both local and global. Locally, it can help with water control, limiting soil erosion and flooding; globally, it can enhance carbon sinks. Many countries have supported programmes to promote the adoption of improved cookstoves on a large scale. Relevant measures include awareness-raising campaigns, the development and production of affordable stove models, and the provision of microcredit to facilitate the acquisition of improved stoves.

Even if sustainably harvested, however, many biomass fuels are not GHG neutral over their fuel cycles because of their production of non-CO_2 GHGs and their substantial production of by-products of incomplete combustion. Moreover, recent research suggests that the health benefits from improved biomass stoves may be less than hitherto thought (Goldemberg, 2000). Another village- or household-level alternative energy source that is possibly more promising from both the health and GHG perspectives is stoves using biogas, which is produced in household or village anaerobic digesters from dung and other animal wastes. Biogas stoves have much cleaner combustion characteristics than biomass stoves, and usually lead to only about 10 per cent of greenhouse gas emissions compared to liquefied petroleum gas and a factor of 80 lower GHG emissions than the average stove burning dung directly (Holdren and Smith, 2000). Biogas programmes initiated in developing countries have so far shown mixed results. China had 5 million domestic plants operating satisfactorily in 1994; India had installed 2.8 million plants by 1998. In Africa, the biogas experience has been generally disappointing at a household level, with capital cost, maintenance and required management support having been higher than expected (Goldemberg, 2000). Overall, because of the requirements for relatively large amounts of animal dung, the scope for household biogas plants may remain limited. Poor families do not have access to enough dung, so they would need to procure a supply from better-off families with sufficient animals who, in any case, often prefer cleaner fuels and chemical fertilisers. The Nepalese Biogas Support Programme shows, however, that a combination of appropriate technical expertise with low-cost stove models and the right institutional context (e.g. an active industry association to self-police the industry) can make biogas a viable option (Box 1).

Box 1. **The Nepalese Biogas Support Programme**

The Biogas Support Programme in Nepal mainly seeks to replace biomass fuels, with their significant negative health effects. By 2000, the programme had installed more than 65 000 family-size biogas units benefiting several hundred thousand members of rural households, compared to only 6 000 biogas units installed before the programme. This substantial increase has been achieved while simultaneously reducing the costs and increasing the reliability and efficiency of biogas plants.

The initially heavy subsidy for the programme is now gradually being phased out. While at the beginning only one company was producing biogas plants, 38 more had entered the market by the end of 1998. To be eligible to receive a subsidy, all participating companies must meet strict production quality and service standards for their plants. As a result of the growing competition, technical design modifications, and better quality control measures, the overall cost of biogas plants in Nepal has declined by more than 30 per cent since 1992. While the cost of the project was estimated to be around $9.5 million for the first two phases (up to 1997), the biogas plants are estimated to displace the use of some 100 000 tonnes of fuelwood and 1.27 million litres of kerosene annually. The savings in fuelwood help to slow the rate of deforestation (a particularly severe problem in rural Nepal), while reduced use of imported kerosene helps save valuable foreign exchange.

Source: Goldemberg, 2000 and Mendis *et al.* (n.d.).

In electricity generation, low-carbon options are becoming more cost-competitive in many contexts. Among technologies that are already commercially viable are clean coal technology (which has relatively little impact on carbon emissions but sizeable local environmental benefits), cogeneration, combined cycle gas turbines, and steam-injected gas turbines. Hydro power has long been a commercially viable low-carbon option in countries with suitable natural endowments, though one with its own environmental downside. In addition, renewable energy technologies such as wind turbines, photovoltaics, microturbines and hydrogen fuel cells — while still some way from being commercially competitive — have the potential to alter radically the relationship between energy consumption and GHG emissions. While oil and gas prices are a key factor in the cost of fossil-fuel-based power generation, the cost of finance is critical to renewable energy sources. Renewable energy typically incurs a high upfront cost, but incurs extremely low ongoing costs. This means that a low cost of finance amortised over the life of the equipment/capital investment can greatly enhance the economics of renewable energy. (While photovoltaics remains far from commercially competitive in centralised power generation, it can be an attractive distributed option in rural areas with high solar irradiance where grid-based power remains inaccessible. Box 2 discusses the joint environmental-economic benefits of a rural solar electricity project.)

Box 2. **Win-Win Options for the Environment and the Poor**

A UNDP project in Sudan called Rural Solar Energy Development (RSED) shows the potential of combining cleaner energy production with poverty alleviation. Its main objective is the provision of technical assistance for the establishment of commercially viable photovoltaic technologies, allowing most of the local energy needs to be met from a non-polluting source. The "non-ecological" benefits of the project include the fact that women and women's associations can obtain technical and financial training to operate and manage the technologies. This has created an income opportunity for these women along with their social empowerment. The second main group of beneficiaries are small-scale enterprises who are given opportunities either to become solar technology suppliers or to use the power in other types of manufacturing enterprise (UNDP, 1996, quoted in Parikh, 1998).

c) Summary: Energy

While government's role in the energy sector is radically changing, it retains important regulatory and tax functions to ensure fair competition and secure the public interest, with a particular view to the welfare of low-income households.

It also has a role to play in supporting development and diffusion of more efficient energy supply and end-use technologies. In a developing country context, it may be advisable to focus initial efforts on providing cheap and clean alternatives to current biomass-burning technologies, since these are likely to yield the largest local benefits for a given impact on greenhouse gases (Wang and Smith, 1998). In planning energy development for the first half of the 21st century, policy makers in both OECD countries and developing countries do well to keep in view two broad environmental objectives: a delinking of economic growth from energy consumption (something that has already been achieved in some OECD countries; see OECD, 2001) and the progressive decarbonisation of remaining energy consumption. Finally, policy makers have to bear in mind that energy systems — like transport systems — require long lead-times to overhaul, given the network lock-in effects and the slow turnover rate of capital stock.

Improving the Environmental Record of Transport

The starting point of transport policy is the recognition that mobility of goods and people is an essential feature of a modern economy. Secular reductions in transport costs have provided a tremendous boost to the integration of national, regional and global markets. Yet, even with major advances in fuel economy and emission controls, transportation remains one of the most polluting sectors of the global economy. This is so with respect to greenhouse gases, with transport contributing a growing share of global emissions, while local pollution from transport poses major health risks in many parts of the developing world. Schipper (n.d.) notes that studies tend to find the value of external costs of transport-related CO_2 emissions to be low compared to the local external costs of transport pollution. It is the latter, therefore, that is likely to provide a stronger near-term impetus to rethinking transport policy. Changes designed to address local externalities can nonetheless have important repercussions on the sector's greenhouse gas profile.

Transportation activity (in terms of both passenger-kilometres and freight-kilometres) tends to rise rather strongly with per capita income. With economic growth in the developing world, expanding transport activity is likely to overwhelm any effect of improved fuel efficiency, resulting in steadily rising transport-related fuel consumption. While catalytic conversion may hold local emissions in check, CO_2 emissions can be expected to continue rising. Taking economic growth as a given, only a major modal shift and/or a technological shift to new power sources could tackle local and global pollution simultaneously.

At one time, lead (Pb) would have qualified as the leading transport-related health risk, but substantial progress has been made in reducing lead content of gasoline throughout much of the developing world. By far the biggest current health risk[5] is posed by particulate emissions, which are associated especially with two-stroke engines on two- and three-wheelers and diesel engines on many trucks and buses (even though diesel is more efficient than gasoline from both an energy and GHG-emissions viewpoint). That having been said, developing countries can have dramatically different mixes of gasoline-powered *vs.* diesel-powered motor vehicles: e.g. India's transport sector uses roughly six times as much diesel fuel as gasoline while in China gasoline consumption is about one-third larger than diesel consumption. There are also enormous differences among countries (even within the OECD area) in the extent of reliance on different transport modes for moving goods and people. For instance, in the late 1980s, automobiles were the overwhelmingly dominant means of passenger transport in the United States, while in Japan rail and buses combined accounted for more than a third of passenger-kilometres (p-km) (Schipper and Meyers, 1992).

Patterns of urban settlement in developing countries have usually evolved without reference to a prior public transport infrastructure. Attempting to construct such an infrastructure after the fact — as well as to expand the road infrastructure to relieve congestion — can be exceedingly costly and disruptive, as borne out by the case of Thailand's capital, Bangkok. Still, there may be few alternatives and Bangkok may be beginning to reap the benefits of its belated efforts to address what had seemed for a while a near intractable problem.

From an environmental perspective, transport policy needs to be designed so as to achieve multiple objectives: *i)* to moderate growth in demand for road transport; *ii)* to ensure that vehicles on the road have maximum fuel economy; *iii)* to ensure that vehicles are utilised as near as possible to full capacity; *iv)* to minimise harmful emissions from the fuels that are consumed; and, in the longer term, *v)* to encourage development of economical zero/low-emission transport technologies and modes. A combination of supply-side measures and transport demand management is required.

a) Supply-Side Measures

At the technological frontier, low-emissions technologies such as hydrogen fuel cells and hybrid engines are in various stages of development, largely as a result of innovation induced by "zero emission" vehicle requirements in certain key markets (e.g. the State of California). The network infrastructure needed to support widespread diffusion of such vehicles will take considerable time and expense to put in place, even in the OECD countries. Meanwhile, much simpler and less costly options can contribute significantly to reducing emissions. For instance, in the case of the large existing stock of two-stroke engines in developing countries, better maintenance, use of the correct lubricant type in reduced quantities and improved petrol quality are low-cost options for cutting exhaust of fine particles and hydrocarbons. There is substantial evidence from South Asia that such measures can lead to "win-win" outcomes by both saving drivers money and reducing emissions (Kojima *et al.*, 2000). In the medium term, another option is adoption of more efficient engine designs that reduce hydrocarbon (and in some cases lead) emissions from unburned gasoline and lubricant. Possible alternative engine types include four-stroke gasoline engines and engines powered by liquefied petroleum gas and compressed natural gas (though in the latter case the local price of gas relative to alternative fuels will be a critical determinant of economic viability).

Considering the large numbers of two-stroke engine powered vehicles on the roads of the developing world, implementing a switch to better fuel management, not to mention improved engines, is a massive undertaking. Yet, if the expected financial savings are sufficiently large, the improved practices could diffuse rapidly. One potential bottleneck is the difficulty of regulating fuel and lubricant quality at the many thousands of informal refuelling stations scattered throughout the developing world. Fuel adulteration usually comes with lower prices, which makes these dirty fuels especially attractive for low-income drivers. Educating them to the trade-off between immediate fuel cost savings and longer-term vehicle maintenance and depreciation costs would be essential.

A more fundamental supply shift would require a radical change in modal mix. Apart from a shift to non-motorised means of transport[6] (an option only for local travel), this is almost always a long-term proposition, involving major infrastructure construction. Building a nation-wide or inter-regional rail network where none previously existed takes many years. Intra-urban mass transit systems also take considerable time and money to construct.

Railways have high environmental and economic potential. A fully loaded train requires merely one-third of the energy per passenger-kilometre (p-km) of a fully loaded automobile, and little more than one-tenth as much as a fully loaded aeroplane. Two problems are, however, that high fixed costs for trains means that their commercial use is restricted to domains where high levels of track and vehicle occupancy can be reached; and that the trend in the freight market toward just-in-time logistic systems requires a degree of flexibility less achievable with rail than with road transport. There is little in the experience of the OECD countries to suggest that — outside of intra-urban transport — rail can provide anything more than a very limited alternative to road transport. Between 1970 and 1999, for example, in the EU-15 countries, the number of p-km travelled by rail nudged upward, while the number travelled by car increased two-and-a-half times[7]. By the latter year, passenger-kilometres travelled by road were roughly 10 times the number travelled by rail.

With respect to urban mass transit, while inner-city railway systems are speedy and can handle large numbers of passengers, they are only economical for the largest cities. There are, however, more economical alternatives of comparable effectiveness. One of the most successful examples is the Brazilian city of Curitiba. The local government channelled urban growth along five corridors stretching away from the city. Each of the corridors is served by a road with exclusive lanes for high-speed buses having a capacity of 300 passengers apiece (*The Economist*, 1998). Planners might also decide to protect rights-of-way at an early stage of development, to be used at a later stage either for busways or rail-based systems depending on the changing volume of expected traffic over time (World Bank, 1996). In developing countries or parts thereof where motorisation and motor vehicle-friendly land-use patterns are not yet entirely embedded, there is still an opportunity for development structured to maintain a better balance between public and private transport, motorised and non-motorised modes.

b) Travel Demand Management

Supply-side solutions alone will not suffice to slow growth of transport and related emissions. Demand management, including through price incentives, is also needed. Adjusting motor fuel prices better to reflect externalities is one option, albeit an unpopular one (as evident from recent protests in Western Europe over high fuel taxes and the longstanding resistance of US drivers to higher gasoline taxes). Congestion-deterring road pricing is another. This is rarely practised outside of Singapore and a few OECD cities, though many countries have toll roads for which user fees are collected to be put towards road maintenance. The World Bank (1996) guidelines for the appraisal of transport projects endorse the use of road-user charges that reflect externalities imposed by road-users on the rest of society (safety, air and noise pollution, congestion), proposing payment of revenues into a general urban transport fund to support expenditures on the most sustainable means of improving the performance of the urban transport system.

Experience with involving private investors in build-operate-transfer mass transit and highway construction schemes has been mixed. The passenger tariffs or tolls the investors claim they must charge to earn an attractive rate of return often prove onerous to low-income commuters, with the result that "mass transit" becomes "elite transit", capacity remains under-utilised, and non-toll road congestion is hardly affected.

c) Summary: Transport

Over time, transportation has come to be one of the major sources of both local and global air pollution in the OECD countries. As incomes rise and economic structure changes, the same is occurring in the developing world, beginning with the newly industrialised countries of Asia and Latin America. There, megacities have some of the worst air quality in the world, with transport a major contributor. The situation will almost certainly deteriorate further if present trends continue, as private motorised transport satisfies the lion's share of incremental demand. If government efforts to limit pollution damage from transport are to be equitable, they cannot be aimed solely at forcing private motorists to buy cleaner vehicles. For inevitably this will raise the costs of vehicle ownership, making it unaffordable to many low-income earners. This imposes a particular hardship if, as in many cities of the developing world, low-income communities are situated at some distance from job concentrations. A parallel emphasis is needed on improving public transport, initially through a cleaner, more efficient and more extensive bus system, but in the longer run also possibly through investment in other forms of mass transit. Assuming this transport infrastructure is in place to give commuters an alternative to private cars, it may then be possible to institute road access pricing schemes for the most heavily used routes, calibrated to the time of use and to the number of passengers per vehicle.

Managing Natural Resources for Climate Benefits

The main natural resource management objective from a climate perspective is to expand or maintain the stored carbon in vegetation, soil and wood products. Policies to conserve and manage forests sustainably are the most crucial in this regard. Others with some bearing on climate outcomes are policies affecting crop cultivation practices; coal, oil and gas extraction policies; and inland waterway and watershed management, in particular in connection with hydropower development. The focus here is principally on forestry policy.

The significance of growing forests to climate policy derives from their function as net carbon sinks. At their meeting in Bonn 2001, parties to the Kyoto Protocol agreed to the crediting (through the Clean Development Mechanism — CDM) of afforestation and reforestation projects in non-Annex I countries towards Annex I commitments during the first commitment period, albeit with a rather low cap (1 per cent of Annex I country base-year emissions, times five). The key to making such credits environmentally effective lies in ensuring against so-called "leakage" — a situation where afforestation in one area merely leads to higher deforestation in other areas. Any efforts to enforce logging laws or to monitor forest areas need to be designed and executed with the leakage problem in mind. Thus, the institution overseeing afforestation/reforestation ought to have monitoring and law enforcement authority in all the forested regions concerned.

Afforestation/reforestation are activities that may serve the dual function of enhancing carbon sinks (hence climate mitigation) while at the same time helping countries adapt to anticipated climate change. The latter purpose could be served, e.g. if the impact of climate change in a given area were to reduce the extent of existing forest or other vegetation, e.g. through reduced rainfall and, in the worst case, desertification. In that event, however, afforestation/reforestation could prove quite costly, unless drought-resistant species were to be introduced. In the event that climate change were to bring heavier rainfall, afforestation/reforestation could have the salutary effect of helping to diminish risk from flooding and the rate of soil erosion.

Ownership and tenure arrangements in forested areas are an important determinant of management practices. If forest occupants lack tenure security, they also lack incentives to manage the resource sustainably. Given the long growing cycles of many tree species, long-term leases are essential. In many forested areas of developing countries, property rights are not clearly defined and resource conflicts result. Ethnic minorities often inhabit upland areas, but encroachment by lowland commercial loggers is commonplace. The latter, in turn, often have powerful political sponsors, which makes policing them extremely difficult. Thus, more generous financial incentives to sustainable management (see discussion below of the CDM) need to be combined with tougher policing of illegal logging. Local communities in the vicinity of protected forests need to share in the financial rewards of sustainable management. For instance, if slash-and-burn cultivation is to be discouraged, downstream beneficiaries need to be willing to compensate upland agriculturalists for the service of watershed protection and flood control that they provide by forgoing such practices (see Box 3). Given the difficulties of arranging bilateral payments for such services, where beneficiaries are many and benefits widely variable, governments may prefer to finance payment out of general tax revenue, though this too may have its inequities if watersheds do not coincide closely with tax jurisdictions.

Box 3. **Natural Resource Management and Income Generation**

Well-designed natural resource management programmes can help to generate income for local people, thus creating win-win opportunities on the poverty-environment front. A UNDP project in Burkina Faso illustrates this. The project's main aim is to set out and implement management plans for natural forests covering 100 000 ha. around Ouagadougou with the active participation of the villagers concerned. While the forest is thus preserved or restored, villagers see their incomes rise through sustainable firewood production for sale on the Ouagadougou market. What is possibly most important about the project is its achievement of the mutually beneficial integration of silviculture (through forest preservation, use management and reforestation, with consequent income from wood production) with livestock breeding and agriculture (with improvements in livestock and crop yields from increases in soil moisture and through shelterbelts) (UNDP, 1993, quoted in Parikh, 1998).

A rather more pessimistic view of potential synergies between natural forest conservation and poverty alleviation is provided by Wunder (2001), who argues, first, that while natural forests frequently serve as "safety nets" for the rural poor, it has proven difficult to increase producer benefits significantly. Those who subsist from them generally remain poor. Secondly, urban-consumer benefits from forests are limited and seldom favour the poor, since forestry is capital-intensive, absorbing few unskilled workers[8]. This analysis does not, however, take into account the possibility of reaping financial gains from forest-based carbon storage activities, which could alter somewhat the calculus of income benefits to the poor, assuming the corresponding projects are designed to ensure poor people's maximum participation.

Estimating Ancillary Benefits/Costs of Climate Policies

Climate protection policies — e.g. in the form of carbon taxes or tradable emissions permits — can (and usually do) alter emissions of pollutants other than greenhouse gases, in the process generating positive (or in some instances negative[9]) impacts on public health, crop yields, materials, visibility, etc. (see Box 4). When policy makers — whether in OECD or non-OECD countries — contemplate various climate policy options, they ought as a matter of course to take into account these so-called ancillary benefits and costs. Until quite recently, however, most analyses of climate policy have neglected them, so they have had minimal impact on policy debates.

Box 4. **Common Types of Ancillary Benefits/Costs**

Health: Reductions in conventional pollutants from energy combustion can lead to a decreased incidence of respiratory-related deaths and illnesses. Other potentially important health risks associated with energy use include occupational health and safety risks from coal mining and the nuclear fuel cycle. Health effects typically account for 70-90 per cent of the total value of ancillary benefits in studies of multiple effects (OECD, 2000) and so deserve special attention in ancillary effects analysis.

Ecological: Many of these will arise in response to a reduction in airborne emissions (e.g. reduced acid rain with positive effects on forests and acidified lakes). Rothman (2000) suggests that the greatest ecological ancillary benefits from GHG emissions reduction are likely to be through decreased waste residuals — e.g. in the form of solid waste from coal-fired power plants.

Other: Reduced crop damage from regional ozone and haze can be important in some cases; reduced transport congestion and accidents; reduced materials damage (e.g. to historic and cultural monuments, bridges, building facades, etc.); improved visibility.

One reason for their neglect is that most climate policy analyses based on global models look several decades into the future, over which time it is very difficult to predict what measures might be taken independently to control local pollution in various regions of the globe. By focusing on the relative near term — i.e. the first commitment period of the Kyoto Protocol (2008-12) — and on specific countries, we can more reasonably project future pollution levels and how they would likely be affected by climate policy. This is what the Development Centre has done in a series of developing country studies undertaken over the past few years.

Studies of ancillary benefits of climate policy for OECD countries suggest that they are non-negligible: on a conservative estimate, they could offset as much as one-third of abatement costs for moderate GHG reductions (OECD, 2000). Studies for developing countries suggest that, in terms of physical health impacts (premature deaths and disease avoided), the benefits of climate policy are likely to be even greater than in OECD countries (O'Connor, 2000; Dessus and O'Connor, 2001; Bussolo and O'Connor, 2001). This stems from the fact that, in developing countries, measures to control local air pollution are often still rudimentary, so there has been little delinking of local air pollutants from greenhouse gas emissions. In consequence, a given measure to control the latter has a larger impact on the former than in most OECD countries. Also, human exposure to harmful local air pollutants tends to be higher in the megacities of the developing world than in many OECD cities, as population densities are often higher and fewer people are able to afford defensive expenditures (like air conditioning). While, in monetary terms, the ancillary health benefits of climate policy may be relatively small in those developing countries with low per capita incomes, they may still be larger as a share of GNP than for high-income OECD countries. They may also be relatively large in comparison with carbon abatement costs if — as most global models suggest — those costs are low in developing countries by comparison with developed ones.

Box 5 summarises results of a few ancillary benefits studies for developing countries. Estimation of ancillary benefits can be of use to climate policy making in determining: *i)* whether or not *any* policy action is economically worthwhile; and *ii)* whether total benefits of the policy can be increased through better design (Pearce, 2000).

Box 5. **Measuring Ancillary Benefits in Chile, China and India**

Several recent studies have estimated the ancillary health benefits to developing countries of measures to limit their greenhouse gas emissions.

In one study for *Chile*, Cifuentes *et al.* (2000) find that "no regrets" energy efficiency and fuel substitution measures could, by 2020, result in a reduction of carbon equivalent emissions of around 4 million tonnes a year (roughly 14 per cent of baseline) and avert each year some 305 premature deaths, 2 150 cases of chronic bronchitis, and 8.8 million restricted activity days from fine particulate exposure (EPA, 2000). The average social benefit of the health improvements is estimated at $104 per tonne of carbon (1997 US$), with almost all control measures yielding *per-tonne* average benefits in excess of their associated costs. Dessus and O'Connor (2001) get comparable results using an economy-wide model.

For *China*, Garbaccio *et al.* (2000) assess the effect of a 10 per cent reduction in annual carbon emissions from the baseline. This is associated, in 2010, with a 5.5 per cent reduction in total particulate emissions and, consequently, a reduction in premature deaths and incidence of chronic bronchitis of about 6.9 per cent. This translates into roughly 50 000 premature deaths averted, or roughly 300 lives saved per million tonnes of carbon abated. Bussolo and O'Connor (2001) find a similar result for *India* — 330 premature deaths averted per MtC in 2010 — for a 15 per cent reduction in CO_2 emissions from baseline. In the Indian case, on a conservative estimate, CO_2 emissions could be cut by slightly more than 12 per cent from the baseline 2010 level at negative or zero net cost, i.e. with "no regrets". This abstracts from any distributional effects, which policy makers would no doubt want to address.

Ancillary benefits estimates are plagued by underlying uncertainties about the values of some key variables. For example, what are people willing to pay to reduce somewhat their chances of premature death or of chronic respiratory illness from pollution? This is not a readily observable value but must be derived from other observables or hypotheticals. For instance, workers normally expect to be compensated for doing risky jobs, and the wage premium they receive can be seen as a proxy measure of the "price of health risk". Among the problems with using such wage premia is that exposure to pollution is not quite comparable to exposure to on-the-job risk: the former is involuntary and the latter voluntary (assuming workers are well-informed). Other approaches use surveys to elicit willingness to pay for hypothetical risk reductions. These have their own drawbacks, notably a weak link to actual behaviour. Finally, use of forgone earnings as a measure of losses from premature mortality or illness has the shortcoming of assigning no value to effects on those not currently in active employment. That having been said, presenting results based on a range of values — preferably one that corresponds to a statistically defined confidence interval — can give policy makers a more realistic picture, one that accounts for underlying estimation uncertainties.

A simpler approach than using a cost-benefit framework would be to identify the major sources of ancillary effects using a standard checklist. Davis *et al.* (2000) classify ancillary effects in a way that could provide the basis for such a checklist (see also Markandya, 1998). Through country-specific case studies, more detailed checklists could be developed. One could furthermore try to estimate the likely magnitude of different kinds of benefits through existing studies, while also identifying the different factors giving rise to the benefits and estimating their relative importance (Davis *et al.*, 2000). Given the tendency for ministries and other governmental institutions to focus on a single set of issues, and even within ministries for issues to be compartmentalised, this could be combined with an institutional approach to support efforts towards more integrated decision making. This is especially important in the context of ancillary benefits, given that often the divisions of government making decisions on climate policy differ from those deciding about local air quality (Pearce, 2000). Moreover, neither makes key decisions about energy development that have major implications for both. Since the institutional steps to support ancillary effects analysis are similar to those required for environmental impact assessment (EIA), governments may want to consider using approaches tested in the EIA-policy context in their attempts to incorporate ancillary benefits analysis into decision making (Davis *et al.*, 2000).

Mobilising Resources for Climate Stabilisation Services

Thus far, the emphasis has been on measures that yield joint benefits (e.g. local and global environmental benefits; environmental improvement and cost savings to enterprises; forest protection and income for the poor) that outweigh — or at least balance — any associated costs. Here the focus is on measures that would become attractive to developing country policy makers only if additional external financial resources were forthcoming. The discussion centres around the Clean Development Mechanism (CDM) — one of the three "flexibility mechanisms" of the Kyoto Protocol — which is designed for resource transfers between developed and developing countries in exchange for emission offsets (or credits) but has yet to become operational. First, however, we briefly review existing international financing mechanisms for global public (environmental) goods.

Existing Funds: the GEF, Capacity 21 and the Prototype Carbon Fund

Among existing funds providing resources for climate mitigation projects in developing countries, probably the best known and certainly the best financed is the Global Environmental Facility (GEF), administered by the World Bank and implemented, in addition to the Bank, by the UN Development Programme and UN Environment Programme. At its second replenishment in 1998, 36 nations pledged a total of $2.75 billion. The GEF is designed to fund investments and technical assistance projects for provision of four priority global environmental public goods, of which climate mitigation is one. It provides grant financing to countries to undertake activities that generate global benefits (such as reduced GHG emissions). Normally, these are projects in which the country would not otherwise have invested or ones for which project redesign would yield global benefits but only at some incremental cost (to be financed through GEF). In other words, without GEF funding, these projects would not have been "no regrets" options for the country concerned. Another funding source for climate-related technical assistance is UNDP's Capacity 21 Programme, designed to support effective implementation of UNCED's (United Nations Conference on Environment and Development) Agenda 21. Given that most funding is for "software" rather than hardware, the sums involved for specific projects tend to be rather small.

Finally, in early 2000 the World Bank established a Prototype Carbon Fund (PCF) designed as a pilot activity to demonstrate how project-based emission credit transactions could work. It seeks to generate "high quality" project-based GHG emissions reductions that could qualify as offsets within the Kyoto Protocol control regime. The resources for the PCF have come from both the public and the private sector, with contributors entitled to a *pro rata* share of any emissions reductions generated. Approximately half of the investments made by the PCF will be in economies-in-transition as a way of catalysing joint implementation (another of the Kyoto flexibility mechanisms), and the other half will be in developing countries to facilitate the CDM. The major emphasis will be placed on renewable energy and energy efficiency projects, which are thought to have a great potential for replication and for reducing GHG emissions at a reasonable cost. The PCF is time-bound and small-scale: it does not endeavour to compete in an eventual emission reductions market; it is restricted to $180 million and is scheduled to terminate in 2012 — i.e. at the end of the first Kyoto control period (World Bank, n.d.).

All of the funds mentioned so far are quite limited in scope. If emission control measures are to be applied on a scale large enough to have a tangible impact, much larger sources of funding will have to be mobilised. This is where the CDM comes into play.

The Clean Development Mechanism

The CDM allows the fulfilment of industrialised countries' greenhouse gas (GHG) emissions targets through both public and private investments in GHG-reduction or carbon sequestration activities in developing countries. It was introduced into the global climate regime through the 1997 Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC). The concept bears a close resemblance to "joint implementation" (JI), another project-based Kyoto flexibility mechanism but one reserved to Annex I countries. A pilot phase (known as AIJ for "activities implemented jointly"), wherein small carbon mitigation projects were undertaken by OECD countries in both Annex I transitional economies and non-Annex I countries, offers possible lessons for design of both the CDM and JI. Once the CDM becomes operational, which could happen in the near future, any certified emission reductions (CERs) earned in advance of the first Annex I commitment period (2008-12) should be bankable for later drawdown or sale.

In November 2001, the Marrakech Conference of the Parties agreed in principle to full integration of all three Kyoto flexibility mechanisms, in the sense that a CDM-based credit would be tradable in the same market as a JI-based credit or any other tradable carbon credit. In effect, then, emergent global climate policy regime is laying the legal and institutional foundations for a world carbon-equivalent (or GHG) market. As with any other market opportunity, countries will eventually reveal their comparative advantage, or not, as exporters. Those developing countries with abundant, low-cost GHG abatement options are clearly the best placed to earn export revenues.

The CDM is meant to promote sustainable development in developing countries while providing Annex I project sponsors with a cost-effective way of meeting their own GHG reduction commitments by reducing emissions where it is cheapest to do so. One reason why developing countries are expected to enjoy numerous low-cost abatement options is that they are still installing new energy generation and production capacity that tends to be less energy- and carbon-intensive on average than the older stock of OECD countries. Also, with new investment, the range of choice is wider with respect to fuel mix and generation technology, transport modal mix, etc. Estimates of the potential size of the CDM market in 2010 (Zhang, 2000) range from 132 million tonnes of carbon (MtC) on the low side to 723 MtC on the high side. At the oft-quoted hypothetical world carbon price of $20 per tC, this represents between $2.6 billion and $14.5 billion, from which one would need to deduct actual costs of the carbon reductions in developing countries to get net sales.

Specific examples of projects that were financed by Annex I countries in the pilot AIJ phase mentioned above are provided in Box 6, while Box 7 enumerates potential CDM projects for Brazil, China and India identified in an exploratory study by the World Resources Institute (Austin *et al.* 1999).

Box 6. **AIJ in Action: A Sample of Australian-Financed Projects**

On 26 August 2000, the Australian Minister for Industry, Science and Resources announced the launch of several new Australian-financed projects for GHG-emissions reduction in developing countries.

In ***Chile***, the Australian Gas Light Company will set up a gas distribution network. It will use a nylon gas pipe technology that will reduce the leakage of gas. Furthermore, the project aims at a switch from oil/coal based fuels to a less carbon-intensive one. At full operation, the project is expected to reduce emissions by 1 300 tonnes of CO_2-equivalent annually.

In ***Mauritius***, Australia launched a project which aims at improving the efficiency of electricity generation from oil by placing a fuel catalyst in a power station. The consequent reduction in fuel consumption will reduce CO_2 emissions by 910 tonnes per year.

The project set up by the Australian International Centre for the Application of Solar Energy in Sulawesi, ***Indonesia***, is designed to capture methane (a potent GHG) from major landfill projects and to use the gas for electricity generation. Expected emissions reduction is 62 000 tonnes of CO_2-equivalent per year.

Finally, the ***Solomon Islands*** will see two micro-hydroelectric power schemes established in rural villages. Thus, kerosene and local timber will not have to be used for power generation, resulting in an expected CO_2 emission reduction of 683 tonnes per annum.

Source: Joint Implementation Quarterly, 2000.

Box 7. **Selected CDM Abatement and Sink Enhancement Opportunities**

Conventional Power Generation

– Combined-cycle gas turbines
– Improved coal technologies

Fuel Switching

– Recovery and use of coalbed methane
– Electricity cogeneration from chemical plants
– Fuelwood gasification with pulp residues
– Bagasse-based electricity cogeneration

Industrial Applications

– Wide range of efficiency improvements possible in boilers, motors and other equipment
– Modern, energy-saving processes in cement, iron and steel industries

Use of Renewables

– Plantation-based biomass fuel
– Wind energy
– Solar thermal and solar photovoltaic applications
– Small-scale hydropower
– Wind-pumps for irrigation

Forestry Options

– Silvicultural plantations for pulp, sawlog and charcoal
– Sustainable forest management on private and public lands
– Community woodlots and agroforestry projects

Source: based on Brazil, China and India case studies summarised in Austin *et al*., 1999.

Designing CDM to Sustain Innovation Incentives

Some developing country participants in global climate negotiations have expressed reservations about the CDM on the grounds that CDM projects undertaken in the near future would exhaust the cheap reduction options ("lowhanging-fruit") such that when emission targets are established for their countries at a later date, these targets can only be reached at a higher cost. This risk would be even greater if the CDM were to have the effect of reducing the incentive for R&D into emissions reduction technologies in the industrialised countries. Thus, unlimited access to the flexibility mechanisms might lead to low overall cost of meeting emission targets in the first commitment period, but sharply rising costs thereafter — i.e. precisely when developing countries might be expected to join the control regime.

The key to avoiding this eventuality is to ensure that CDM and the flexibility mechanisms in general are designed to encourage, not deter, innovation. One rationale for the imposition of a cap on the use of flexibility mechanisms to meet Kyoto targets is to maintain some innovation incentives in Annex I countries. Naturally, this comes at a near-term cost in forgone low-cost abatement opportunities, but the potential gains may also be large. R&D can yield big technological leaps as well as incremental improvements. While there is a large element of uncertainty in the R&D process, what is fairly certain is that if no resources are devoted to finding and developing new low-carbon energy technologies, any major new discoveries would be purely serendipitous.

Exploitation of differences in marginal abatement costs is possible without hampering innovation through a gradual phasedown of crediting of non-Annex I country emission reductions while raising domestic carbon taxes in industrialised countries. This has the combined advantage that investors can get full credit for CDM-based greenhouse gas reductions in the beginning while they still have an incentive to invest in long-term emission reduction measures in anticipation of tightening domestic controls (Michaelowa and Schmidt, 1997). The downside of this approach is that developing countries would enjoy smaller resource transfers than otherwise.

It should also be borne in mind that the *first* control period is just that. Annex I countries can expect to be held to more stringent reduction targets in subsequent periods, so there is unlikely to be much relief from pressure to find low-carbon alternatives. Indeed, if accumulating scientific evidence points to the need for more drastic near-term action (as was the case for instance with the Montreal Protocol on ozone depleting substances), Annex I countries might well have to consider adopting stricter targets even during the first control period. If the amount of interest shown by leading energy multinationals is any indication, private R&D investment in low-carbon energy seems set to increase in the future irrespective of whether restrictions are placed on use of the flexibility mechanisms.

Making Sure CDM Contributes to Sustainable Development

A key stipulation of the Kyoto Protocol *Article 12* that defines CDM is that it "assist Parties not included in Annex I in achieving sustainable development" (para. 2). This means that projects must have demonstrable benefits beyond the reduction in greenhouse gases *per se.* Just how large those benefits need to be and what form they ought to take are left to the discretion of the host country governments, since they are final arbiters of whether or not to authorise specific CDM investments (with assistance as needed by an expert group on technology transfer and "national needs assessments"). Transparent and simple criteria need to be devised for the purpose of evaluating sustainable development contributions if prospective CDM project sponsors are not to be deterred by high transaction costs. Box 8 presents one view of the sorts of conditions developing country governments could impose with respect to technology transfer through CDM to ensure enduring development contributions.

Box 8. **Technology Transfer and the CDM**

Since technology transfer is one of the major benefits developing countries hope to get from the CDM, host country policy makers should take measures to ensure that the benefits from technology transfer do in fact materialise. These could include the following (Parikh and Parikh, 2001):

i) *Operation and Maintenance:* The CDM project will need to provide training to operate the new technology — in the past, much technology imported from OECD countries has not been properly maintained owing to lack of skills and spare parts.

ii) *Replication:* The recipient developing country needs to be given the opportunity to replicate the technology to some degree. For this purpose, developing country policy makers should push in the international climate negotiations for higher credit to be given for those CDM projects involving significant technology transfer (for which purpose objective, measurable criteria would need to be devised).

iii) Even more credit might be given to those CDM projects that *build host country capacity* for further innovation and technology development.

The latter two proposals raise questions about how far private innovators — mostly multinational corporations — could be expected to forgo innovation rents as the price for gaining additional carbon reduction credits. The measurement of technology transfer is also a far from trivial problem — inevitably an input-based measure would have to be used, but input does not necessarily translate into innovative output.

Estimates of Local Developmental and Environmental Benefits from CDM

A recent comparative assessment of CDM investment opportunities for Brazil, China and India (Austin *et al.,* 1999) concludes that many of the potential projects offer both low GHG abatement costs and significant benefits in terms of local sustainable development such as improved water and air quality, employment creation and local energy efficiency (although some local impacts could be negative). A qualitative assessment of a number of sustainable development indicators concludes that the impacts of most CDM projects on sustainable development would be either positive or neutral.

Two particular lessons from the AIJ pilot phase stand out. First, the scope for the CDM in countries at different levels of development could be vastly different. Middle-income countries have attracted the bulk of AIJ projects. Second, certain project types are more likely to entail positive externalities than others.

Costa Rica is a particularly outstanding example of the first lesson. It has a relatively high level of economic and social development, a strong, democratic institutional structure and a well-developed environmental policy. Its knowledge base is high and capacity building almost unnecessary. The framework for the CDM in Costa Rica can therefore be described as ideal compared to many other developing countries. Even though only a portion of the AIJ projects proposed actually received funding, Costa Rica has shown that it is possible to attract a substantial level of funding while maintaining strong requirements regarding the benefits that need to accrue to the host country. When the Costa Rican OCIC *(Oficina Costaricense de Implementación Conjunta)* decides about project approval, it applies a host of criteria — based on domestic priorities — that projects must not contravene:

- enhancement of income opportunities for Costa Rican civil society;
- minimised or acceptably low level of adverse consequences of the project through site selection, scale adjustment, timing, attenuation and mitigating measures;
- local community support;
- local capacity building such as the transfer and adaptation of know-how (OCIC, 1998).

Sub-Saharan Africa presents a contrasting picture. It has been largely bypassed in the AIJ pilot phase. As of early 2002, the UNFCCC's list of projects that had been accepted, approved, or endorsed by the designated national authorities for AIJ contained only eight projects in sub-Saharan Africa, out of a total of 157 (http://unfccc.int/program/aij/aijproj.html). This is not inevitable. It may be, however, that means need to be found to lower the transaction costs of initiating CDM projects in low-income countries. Also, the allowance for inclusion of afforestation/reforestation projects (albeit with a cap) in CDM financing should broaden somewhat the scope for participation of low-income, resource-based economies.

Regarding the second lesson, some CDM options are preferable to others in that they yield clearer-cut benefits for both sustainable development and climate mitigation. For instance, renewable energy generates no emission of harmful local pollutants while fuel substitution still results in some, albeit reduced, emissions. Forest protection projects and afforestation are unlikely to entail significant technology transfer, though they may transfer managerial skills. Large-scale projects are more likely to disrupt local life and displace people than small-scale ones. On the other hand, a single large-scale project can sometimes have very large positive welfare effects — e.g. where a large hydro dam allows for widespread electrification, irrigation and flood control. As with any other climate initiative, there may be losers whose interests must be considered in project preparation (e.g. displaced communities) and, assuming the project is implemented, these parties need to receive fair compensation.

The more host countries accumulate experience with the specific local benefits and costs associated with different kinds of projects, the more they will be able to adapt their policy towards approving only the kinds of projects that suit their developmental needs. Reduction of local pollutants can be an attractive positive spillover for densely populated countries in transition and newly industrialising countries. Costa Rica, whose foreign currency inflow depends to a significant degree on ecotourism, has focused heavily on extension of national parks through AIJ funds and would presumably continue to enhance carbon sinks under the CDM (Dutschke and Michaelowa, 1998). Host country policy makers can get support in their efforts to devise a financially attractive, development-oriented CDM portfolio from the World Bank's National Strategy Study Programme, which identifies potential investment projects and develops national policies regarding the CDM.

Finally, while not every policy initiative can be explicitly "pro-poor", it is desirable to devise climate strategies through which the poor can benefit from CDM projects. Reforestation and afforestation schemes could well fall into this category, and various small-scale fuel-efficiency and renewable energy schemes could also fit the bill. The above-mentioned introduction of more efficient wood burning stoves and/or biogas cookers to rural households is an example of a project with potentially large health benefits to poor people. The challenge for developing country proponents is to design a project that provides well-defined performance benchmarks in terms of technology uptake, so that resultant carbon credits are verifiable, hence attractive to potential investors.

Even if governments are the ultimate Parties to the Kyoto Protocol, the CDM and other flexibility mechanisms should be designed to permit maximum private sector involvement in the interest of holding down transaction costs and encouraging the development of competitive project proposals (World Resources Institute, 2000). Government involvement should be principally to set broad eligibility criteria for CDM projects; to ensure that they generate an acceptable social return — perhaps defined as a target level of non-carbon benefits; to monitor projects to ensure that they proceed within the boundaries of the rules laid down (though this function can be delegated to a third party); to oversee the certification of qualified independent auditors who would be charged with verification of the integrity of carbon credits.

By Way of Beginning: A Phased Approach to Climate Policy

Free rider problems abound in international climate policy making. Until the challenge is resolved of how to secure the co-operation of all the important Annex I countries, the incentives for poor developing countries to take measures to control their own emissions are likely to remain weak. At the very least, governments can be expected to act strategically, considering how any measures taken voluntarily at this stage might affect the future costs of (possibly mandatory) controls. All of which would seem to be a case for *business as usual* in non-Annex I countries.

Yet, as this Policy Brief has sought to show, there may be good economic reason to take measures now that would yield climate benefits in terms of slower growth of GHG emissions. These include measures that would, by a more efficient use of energy, save enterprises and consumers money — the proverbial "free lunch". Estimates of the magnitude of these opportunities vary widely, and it has not been our main purpose here to endorse one or another set of estimates. Rather, the Brief simply argues the utility of re-examining some familiar and important areas of economic policy — notably energy, transport and natural resource management — through a climate lens. In this way, some cost-saving opportunities that had previously been overlooked could be brought into sharper focus. In other cases, opportunities may be identified for supplementing existing resources for energy and other investments from international financing mechanisms like the Clean Development Mechanism.

Here we set out a rough guide to priority setting for climate policy makers in developing countries[10], with an accompanying suggestion of the timing of each task.

Conducting a Greenhouse Gas Inventory

This is a first requirement for understanding the nature and scope of the challenge a country faces in relation to climate change. As discussed above, government needs to know, first, what sectors and activities are the principal emissions sources at present and over the foreseeable future. An assessment of a country's vulnerability to climate change is also important, making use of the best available integrated assessment models to construct plausible climate scenarios. For some developing countries, priority will almost certainly need to be given to adaptation, with mitigation a minor concern. This is the case for the many small, poor countries that are marginal contributors to greenhouse gas emissions but that could face catastrophic consequences from certain scenarios of climate change.

At the invitation of national governments, a number of multilateral and bilateral donors have already sponsored such GHG inventories in non-Annex I countries[11]. At present, some 80 non-Annex I countries have submitted initial national communications to the secretariat of the UNFCCC, and most of these provide at least a rough inventory of emissions and of measures aimed to regulate them. This leaves another 70 non-Annex I countries that have yet to make a formal submission.

Assessing Sectoral Policies and Their Climate Implications

"Nothing is permanent but change" (Heraclitus). For almost two decades now, developing countries have been engaged in a variety of macroeconomic and structural reforms designed (usually with support from the international financial institutions — IFIs) to make their economies more market-driven and outwardly oriented. The IFIs and national governments have also committed large sums to building up the infrastructure to sustain economic growth over the long run, including electricity, roads and ports, telecommunications, etc. Normally, multilaterally financed infrastructure development projects also involve discussions of needed pricing and regulatory reforms to ensure sustainability over time. In the past decade, project design has been somewhat more responsive to environmental impacts as well.

Still, there has seldom been explicit consideration of how sectoral pricing, regulatory or other reforms are likely to affect greenhouse gas emissions. Understanding such impacts is a first step to possibly redesigning policies, though any additional costs or trade-offs with other objectives will need to be weighed in the balance. There are various tools available to map and assess sectoral policy impacts — the "Action Impact Matrix" summarised in Munasinghe (2001) being one of the more familiar, the World Bank's Global Overlays[12] another — and policy makers will want to choose the one(s) best suited to their specific circumstances. Clearly the approach chosen will depend on the degree of detail and of quantification desired. In the limit, an extended cost-benefit analysis of sectoral policies, programmes or projects could be undertaken, but only if a preliminary impact identification warrants it.

In any sectoral policy reassessment, the focus should be on identifying the main "no regrets" policy reform opportunities. A key element of the analysis would need to be the social equity implications of any "climate-sensitive" reforms. If energy subsidies, for example, have been designed to provide access to the poor, how will subsidy reform affect them and how can adverse effects be minimised or avoided?

Laying the Analytical, Institutional and Policy Foundation to Avail of CDM

Governments need to begin exploring even now what opportunities the Clean Development Mechanism may hold out for obtaining supplementary financial and technical resources to support their sustainable development goals. This is because the CDM is due to enter into force as soon as the Kyoto Protocol has been ratified by sufficient Parties[13], with early CDM credits bankable for use in the first commitment period[14]. This requires an inventory of potentially attractive investment projects — i.e. ones that generate large numbers of carbon credits at low cost per credit. As explained above, preliminary inventories of this sort have already been conducted (under the auspices of WRI) for Brazil, China and India. These inventories (summarised in Austin *et al.* 1999) could provide a useful model for other developing countries. Those projects and technologies assessed to yield both low-cost GHG credits and significant local development benefits would be shortlisted for more thorough pre-feasibility and perhaps eventually feasibility studies.

While compiling a CDM investment portfolio, governments need to be putting in place simultaneously an institutional and policy framework designed to ensure the integrity and additionality of carbon credits, thereby reassuring prospective investors. This involves a few critical elements:

— establishing credible sectoral emissions baselines against which project-induced changes could be assessed (OECD/IEA, 2000*a,b,c* provide a useful starting point);

— putting in place institutional mechanisms for estimating sectoral emissions over time and for monitoring, reporting and validating project-specific net emissions;

— devising policy and institutional safeguards to provide reasonable assurance that CDM-linked emission reductions are not simply displaced to other domestic sources with no net reduction — i.e. there is "additionality".

In effect, availing of the CDM will almost certainly require of non-Annex I country governments a more pro-active climate policy stance. Without this, the signal to prospective CDM investors could be too weak to be detected.

Assessing Climate Policy's Direct and Indirect Economic Impacts

Only at a somewhat later date are most developing country governments likely to contemplate explicit climate policies like carbon taxes, tradable permits or other explicit limitations on GHG emissions. At that point, economic models will likely prove useful in tracing through policy impacts on different sectors and different types of household. Ideally, the models would incorporate indirect benefits and costs of the policy — e.g. the local environmental and health effects of changes in air pollution levels. Progress has been made in recent years in incorporating these "ancillary benefits/costs" into economy-wide models (see O'Connor, 2001 for a review).

Once again, even if a full cost-benefit analysis points to some scope for "no regrets" GHG abatement, the distributional implications of the instrument chosen need to be carefully considered. In the case of a carbon tax, for example, the formula used for recycling revenue can have an important bearing on who bears how big a burden. In the case of tradable permit system, the permit allocation mechanism is crucial. For instance, the distributional implications of "grandfathering" permits free-of-charge to existing polluters could be quite different from a permit auction whose proceeds would be used to cushion adjustment costs of vulnerable groups (whether small-scale enterprises or poor households).

Developing country governments that would like to begin thinking beyond simple "no regrets" measures but without yet being bound by multilaterally agreed quantitative restrictions are in a position to experiment with approaches that may not be options for Annex I countries. These include the combination of a quantitative target (as in a tradable permit scheme) with a permit trigger price that would act as a safety valve if the costs of controlling emissions should prove to be too high (see Morgenstern, 2002 for a discussion of the proposal, which is based on an idea advanced by Roberts and Spence, 1976)[15]. This would also serve two useful purposes: revealing domestic abatement costs, which would help determine the scope for CDM investments, and laying the domestic policy groundwork for eventual full participation in the Kyoto flexibility mechanisms.

While for many developing countries the decision about the sorts of explicit climate policy instruments they would like to employ may lie some way in the future, the economic modelling work and analysis required to inform those decisions would need to begin much earlier.

Notes

1. As of 18 February 2002, only 47 countries had ratified or acceded to the Kyoto Protocol. The Protocol has been criticised on various grounds. One of the most forceful recent critiques is Cooper (2001), who argues that no scheme based on binding national targets can succeed in dealing with climate change within the foreseeable future, so that the approach most likely to succeed is international agreement on common actions (in particular agreed taxes on GHG emissions). In light, however, of the considerable potential difficulties in negotiating such taxes internationally, not to mention their unknown effects on actual greenhouse gas emissions, Cooper holds that countries should also prepare for adaptation to climate change and emergency actions if threatened by climate catastrophe. Despite the criticisms of Kyoto, it is currently the "only game in town" and so we assume in this Brief that this agreement will continue for the foreseeable future to provide the relevant international framework for developing country decisions on climate policy.

2. The other two being emissions trading among Annex I countries and "joint implementation" of carbon mitigation/sequestration projects, also among Annex I countries.

3. Defined on p. 30 of Schumacher and Sathaye (1999).

4. Sinton (2001) cautions that, since the government campaign began in 1998 to close small coal mines, coal output is underestimated by official statistics.

5. The safety risk, from transport accidents, is also very high in many developing countries.

6. The World Bank (1996) suggests that, to encourage non-motorised transport, governments need to provide routes and parking for bicycles and give proper recognition to slow-moving vehicles within traffic management schemes.

7. See http://europa.eu.int/comm/energy_transport/etif/transport_passenger_a/performance_graph.html.

8. Wunder acknowledges, however, that at the national or subnational level there may be successful cases of sustainable, forestry-led poverty reduction, citing Canada, Finland and Sweden as examples.

9. A few instances where climate policy may involve indirect costs are if: a switch to natural gas-fired cogeneration in urban areas lowers CO_2 emissions while raising NOx levels; a switch to hydro power damages river ecosystems and causes inequitable population resettlement; a switch from gasoline to diesel in transport fuel lowers CO_2 emissions at the expense of higher fine particle emissions (Beg, 2001).

10. We also refer the interested reader to a classic work on the subject of climate policy, Jepma and Munasinghe (1998), for a more detailed treatment.

11. Among the major inventory programmes are those of the Asian Development Bank (ALGAS), the GEF and the US Agency for International Development.

12. The World Bank commissioned a series of "global carbon overlay" studies that provide a framework for "integrating greenhouse gas externalities into the Bank's economic and sector work". Specific studies cover energy, forestry and transport as well as macroeconomic policies. See the following website for details of the global overlays: http://lnweb18.worldbank.org/ESSD/essdext.nsf/46ByDocName/ToolkitsGlobalOverlay.

13. I.e. at least 55 Parties to the UNFCCC including Annex I countries accounting for at least 55 per cent of total 1990 industrial CO_2 emissions from this group.

14. This could be as early as 2002, as the EU has committed its own members to ratify before the World Summit on Sustainable Development in Johannesburg, scheduled for August 2002.

15. For an argument to use this mixed cap-and-price system globally as an alternative to the Kyoto Protocol's cap-and-trade, see Victor (2001).

Bibliography

ADB (1998), *Asia Least-cost Greenhouse Gas Abatement Strategy: India*, Asian Development Bank, Manila.

AUSTIN, D., P. FAETH, R. SEROA DA MOTTA, C. FERRAZ, C.E.F. YOUNG, Z. JI, J. LI, M. PATHAK, L. SRIVASTAVA and S. SHARMA (1999), "How Much Sustainable Development Can We Expect from the Clean Development Mechanism?" World Resources Institute, Washington, D.C.

BEG, N. (2001), "Ancillary Benefits of Climate Change Policies: A Synthesis", Background Paper prepared for Working Party on Global and Structural Policies, OECD, Paris, August, processed.

BOWONDER, B. and T. MIYAKE (1988), "Measurement of Technology at Industry Level: A Case Study of the Steel Industry in India and Japan", *Science and Public Policy*, Vol. 15, No. 4.

BUSSOLO, M. and D. O'CONNOR (2001), *Clearing the Air in India: The Economics of Climate Policy with Ancillary Benefits*, OECD Development Centre Technical Paper No. 182, November, Paris.

CIFUENTES, L.A., E. SAUMA and H. JORQUERA (2000), "Preliminary Estimation of Potential Ancillary Benefits for Chile", *in Ancillary Benefits and Costs of Greenhouse Gas Mitigation*, OECD, Paris.

COOPER, R.N. (2001), "The Kyoto Protocol: A Flawed Concept", *Environmental Law Reporter*, December, 31ELR11484-31ELR11492.

DAVIS, D., A. KRUPNICK and G. MCGLYNN (2000), "Ancillary Benefits and Costs of Greenhouse Gas Mitigation: An Overview", *in Ancillary Benefits and Costs of Greenhouse Gas Mitigation*, OECD, Paris.

DECANIO, S.J. (1998), "The Efficiency Paradox: Bureaucratic and Organizational Barriers to Profitable Energy-Saving Investment", *Energy Policy*, 26(5).

DESSUS, S. and D. O'CONNOR (2001), "Climate Policy without Tears: CGE-Based Ancillary Benefits Estimates for Chile", under revision for *Environmental & Resource Economics*.

DUTSCHKE, M. and A. MICHAELOWA (1998), "Interest Groups and Efficient Design of the Clean Development Mechanism under the Kyoto Protocol", *International Journal for Sustainable Development*, 1(1), 1998.

ECONOMIST, THE (1998), "Development and the Environment Survey", 346 (8060), London.

EPA (2000), *Developing Country Case-Studies: Integrated Strategies for Air Pollution and Greenhouse Gas Mitigation*, US Environmental Protection Agency, Progress Report for the International Co-Control Benefits Analysis Program, Washington, D.C., November.

GARBACCIO, R.F., M.S. HO and D.W. JORGENSON (2000), "The Health Benefits of Controlling Carbon Emissions in China", *in Ancillary Benefits and Costs of Greenhouse Gas Mitigation,* OECD, Paris.

GOLDEMBERG, J. (2000), "Rural Energy in Developing Countries", *in World Energy Assessment — Energy and the Challenge of Sustainability,* UNDP, New York, N.Y.

GSO (2000), *Viet Nam Living Standards Survey 1997-1998*, Statistical Publishing House, Hanoi.

HOLDREN, J.P. and K.R. SMITH (2000), "Energy, the Environment and Health", *in World Energy Assessment — Energy and the Challenge of Sustainability,* UNDP, New York, N.Y.

IEA (1997), *World Energy Outlook 1997*, International Energy Agency, Paris.

IEA (1999), *World Energy Outlook 1999 Insights. Looking at Energy Subsidies: Getting the Prices Right*, International Energy Agency, Paris.

IEA (2000*a*), *CO_2 Emissions from Fuel Combustion 1971-1998*, International Energy Agency, OECD, Paris.

IEA (2000*b*), *World Energy Outlook 2000*, International Energy Agency, Paris.

IEA (2001), *Energy Balances of Non-OECD Countries 1998-99,* International Energy Agency, OECD, Paris.

JEPMA, C.J. and M. MUNASINGHE (1998), *Climate Change Policy — Facts, Issues and Analyses*, Cambridge University Press, Cambridge.

Joint Implementation Quarterly, 2000.

KAMERUD, D.B. (1988), "Benefits and Costs of the 55 mph Speed Limit: New Estimates and Their Implications", *Journal of Policy Analysis and Management*, Vol.7, No.2.

KÖHLER, J., H.-J. LUHMANN and A. WADESKOG (1997), "Expenditure on Environmentally Sensitive Goods and Services: Household Spending Across the EU", University of Cambridge, Department of Applied Economics, Environmental Fiscal Reform Project, Working Paper No. 1.

KOJIMA, M., C. BRANDON and J. SHAH (2000), "Improving Urban Air Quality in South Asia by Reducing Emissions from Two-Stroke Engine Vehicles", ESMAP Programme, processed, World Bank, Washington, D.C.

KOZLOFF, K. and O. SHOBOWALE (1994), *Rethinking Development Assistance for Renewable Electricity*, World Resources Institute, Washington, D.C.

MARKANDYA, A. (1998), "The Indirect Costs and Benefits of Greenhouse Gas Limitations", *Economics of Greenhouse Gas Limitations: Handbook Reports*, UNEP Collaborating Centre for Energy and the Environment, Risø National Laboratory, Denmark.

MENDIS, M.S. and W.J. VAN NES (N.D.): "Biogas in Rural Household Energy Supply — The Nepal Biogas Support Program", processed, Dutch Ministry of Foreign Affairs, The Hague.

MICHAELOWA, A. and H. SCHMIDT (1997), "A Dynamic Crediting Regime for Joint Implementation to Foster Innovation in the Long Term", *Mitigation and Adaptation Strategies for Global Change*, 2.

MORGENSTERN, R.D. (2002), "Reducing Carbon Emissions and Limiting Costs", *Resources for the Future*, processed, Washington, D.C., February.

MUNASINGHE, M. (2001), "Sustainable Development and Climate Change: Applying the Sustainomics Transdisciplinary Meta-framework", *International Journal of Global Environmental Issues*, 1(1).

OCIC (1998), "Costa Rican National Programme for JI under the Pilot Phase", Oficina Costarricense de Implentación Conjunta, San José.

O'CONNOR, D. (2000), "Ancillary Benefits Estimation in Developing Countries: A Comparative Assessment", *in* OECD (2000), *op.cit*.

O'CONNOR, D. (2001), "Estimating Ancillary Benefits of Climate Policy Using Economy-Wide Models: Theory and Application in Developing Countries", Paper presented at the Biennial Researchers' Workshop of the Economy and Environment Program for South-East Asia (EEPSEA), Hanoi, 21-22 November.

OECD (2000), *Ancillary Benefits and Costs of Greenhouse Gas Mitigation. Proceedings of an IPCC Co-Sponsored Workshop, held on 27-29 March 2000, in Washington, D.C.*, Paris.

OECD (2001), *OECD Environmental Indicators: Towards Sustainable Development*, Paris.

OECD/IEA (2000*a*), "An Initial View on Methodologies for Emission Baselines: Electricity Generation Case Study", *OECD and IEA Information Paper*, June, Paris.

OECD/IEA (2000*b*), "An Initial View on Methodologies for Emission Baselines: Iron and Steel Case Study", *OECD and IEA Information Paper*, June, Paris.

OECD/IEA (2000*c*), "Framework for Baseline Guidelines", *OECD and IEA Information Paper*, June, Paris.

PARIKH, K.S. (1998), "Poverty and Environment — Turning the Poor into Agents of Environmental Degradation", United Nations Development Programme Working Paper Series, New York, N.Y.

PARIKH, J.K. and K. PARIKH (2001), "Climate Change — India's Perceptions, Positions, Policies and Possibilities", Paper presented at the OECD workshop *Climate Change and Sustainable Development Strategies: An Agenda for Long Term Action,* Paris.

PEARCE, D. (2000), "Policy Frameworks for the Ancillary Benefits of Climate Change Policies", *in Ancillary Benefits and Costs of Greenhouse Gas Mitigation*, OECD, Paris.

ROBERTS, M.J. and M. SPENCE (1976), "Effluent Charges and Licenses under Uncertainty", *Journal of Public Economics*, V (April/May), 193-208..

ROTHMAN, D.S. (2000), "Estimating Ancillary Impacts, Benefits and Costs on Ecosystems from Proposed GHG Mitigation Policies" *in Ancillary Benefits and Costs of Greenhouse Gas Mitigation,* OECD, Paris.

SCHIPPER, L. (N.D.), "'People on the Move': Human Factors and Carbon-Dioxide in Industrialized Countries", Lawrence Berkeley Laboratory, California, Panel 5-ID 55.

SCHIPPER, L. and S. MEYERS (1992), *Energy Efficiency and Human Activity: Past Trends, Future Prospects*, Cambridge University Press, Cambridge, UK.

SCHUMACHER, K. and J. SATHAYE (1999), "India's Cement Industry: Productivity, Energy Efficiency and Carbon Emissions", Environmental Energy Technologies Division, Ernest Orlando Lawrence Berkeley National Laboratory, LBNL-41842, processed.

SINTON, J.E. (2001), "Accuracy and Reliability of China's Energy Statistics", *China Economic Review*, 12, 373-383.

UNDP (1993), "Management of Natural Forests (Burkina Faso)", UNDP Project Document BKF/93/003, United Nations Development Programme, New York, N.Y.

UNDP (1996), *Terminal Project Performance Evaluation Report of Rural Solar Energy Development in Sudan*, New York, N.Y.

UNEP (1994), *UNEP Greenhouse Gas Abatement Costing Studies*, Collaborating Centre on Energy and the Environment, Risø, Denmark.

VICTOR, D.G. (2001), *The Collapse of the Kyoto Protocol and the Struggle to Slow Global Warming*, Princeton University Press, Princeton, N.J.

WANG, X. and K.R. SMITH (1998), "Near-term Health Benefits of Greenhouse Gas Reductions: A Proposed Method for Assessment and Application to China", WHO/ EHG/98.12, World Health Organisation, Geneva.

WGI/IPCC (2001), *Climate Change 2001: The Scientific Basis. Summary for Policy makers and Technical Summary of the Working Group I Report*, WMO/UNEP, Geneva.

WORLD BANK (1996), "Sustainable Transport — Priorities for Policy Reform", Washington, D.C.

WORLD BANK (N.D.), *Prototype Carbon Fund: Mobilizing Private and Public Resources to Combat Climate Change,* Washington. D.C.

WORLD RESOURCES INSTITUTE (WRI) (2000), "Financing Sustainable Development with the Clean Development Mechanism", Washington D.C.

WUNDER, S. (2001), "Poverty Alleviation and Tropical Forests — What Scope for Synergies?", *World Development*, Vol. 29, No. 11, 1817-1833.

ZHANG, Z. (2000), "Estimating the Size of the Potential Market for the Kyoto Flexibility Mechanisms", processed, University of Groningen, Netherlands.

Other Titles in the Series

Adjustment and Equity (No. 1)
by Christian Morrisson (January 1992)

Managing the Environment in Developing Countries (No. 2)
by David O'Connor and David Turnham (January 1992)

Privatisation in Developing Countries: Reflections on a Panacea (No. 3)
by Olivier Bouin (April 1992)

Towards Capital Account Convertibility (No. 4)
by Bernhard Fischer and Helmut Reisen (April 1992)

Trade Liberalisation: What's at Stake? (No. 5)
by Ian Goldin and Dominique van der Mensbrugghe (May 1992)

Towards Sustainable Development in Rural Africa (No. 6)
by David Turnham, with Leif E. Christoffersen and J. Thomas Hexner (January 1993)

Employment Creation and Development Strategy (No. 7)
by David Turnham (July 1993)

The Disarmament Dividend: Challenges for Development Policy (No. 8)
by Jean-Claude Berthélemy, Robert S. McNamara and Somnath Sen (April 1994)

Pension Fund Investment from Ageing to Emerging Markets (No. 9)
by Bernhard Fischer and Helmut Reisen (January 1995)

What Institutional Framework for the Informal Sector? (No. 10)
by Christian Morrisson (October 1995)

The Policy Challenges of Globalisation and Regionalisation (No. 11)
by Charles Oman (June 1996)

Policies for Economic Take-off (No. 12)
by Jean-Claude Berthélemy and Aristomène Varoudakis (September 1996)

The Political Feasibility of Adjustment (No. 13)
by Christian Morrisson (October 1996)

Biotechnology Policy for Developing Country Agriculture (No. 14)
by Carliene Brenner (April 1997)

Pension Reform: Lessons from Latin America (No. 15)
by Monika Queisser (January 1999)

After the Great Asian Slump: Towards a Coherent Approach to Global Capital Flows (No. 16)
by Helmut Reisen (January 1999)

Participatory Governance: The Missing Link for Poverty Reduction (No. 17)
by Hartmut Schneider (April 1999)

Multilateral Tariff Liberalisation and the Developing Countries (No. 18)
by Sébastien Dessus, Kiichiro Fukasaku and Raed Safadi (September 1999)

Health, Education and Poverty Reduction (No. 19)
by Christian Morrisson (October 2001)

The New Regionalism in Sub-Saharan Africa: More Than Meets the Eye? (No. 20)
by Andrea Goldstein (March 2002)