
FUNFZIG SCHILLING
ÖTEZER FORINT
5000 FORINT
MAGYAR NEMZETI BANK
TWENTY DOLLARS
TWENTY HONGKONG DOLLARS
港幣貳拾元
壹圓
TWO DOLLARS
SINGAPORE
SUID-AFRIKAANSE RESERWEBANK
BANCA D'ITALIA
Banque de France
ONE HUNDRED DOLLARS
NARODOWY
PIĘĆDZIESIĄT ZŁOTYCH
SUOMEN PANKKI
CANADA
PADESÁT KORUN ČESKÝCH
TEN DOLLARS
CINQ CENTS FRANCS
RÉPUBLIQUE FRANÇAISE
TEN POUNDS
STO KORUN ČESKÝCH
ZEHN DEUTSCHE MARK
HUNDERT DEUTSCHE MARK

CHAPTER 6

Generating the Funding Needed for Mitigation and Adaptation

Developed countries must take the lead in combating climate change. But mitigation will be neither effective nor efficient without abatement efforts in developing countries. Those are two key messages of earlier chapters. But there is a critical third dimension to meeting the climate challenge: equity. An equitable approach to limiting global emissions of greenhouse gases has to recognize that developing countries have legitimate development needs, that their development may be jeopardized by climate change, and that they have contributed little, historically, to the problem.

Flows of climate finance, both fiscal transfers and market transactions, from developed to developing countries represent the principal way to reconcile equity with effectiveness and efficiency in dealing with the climate problem. Financial flows can help developing countries reduce their greenhouse gas emissions and adapt to the effects of climate change. In addition, there will be financing needs related to developing and diffusing new technologies. Mitigation, adaptation, and the deployment of technologies have to happen in a way that allows developing countries to continue their growth and reduce poverty. This is why additional financial flows to developing countries are so crucial.

The funding required for mitigation, adaptation, and technology is massive. In developing countries mitigation could cost $140 to $175 billion a year over the next 20 years (with associated financing needs of $265 to $565 billion); over the period 2010 to 2050 adaptation investments could average $30 to $100 billion a year (in round numbers). These figures can be compared with current development assistance of roughly $100 billion a year. Yet efforts to raise funding for mitigation and adaptation have been woefully inadequate, standing at less than 5 percent of projected needs.

At the same time, existing financing instruments have clear limits and inefficiencies. Contributions from high-income country governments are affected by fragmentation and the vagaries of political and fiscal cycles. Despite all its success, the Clean Development Mechanism (CDM), the main source of mitigation finance to date for developing countries, has design shortcomings and operational and administrative limits. The scope for raising adaptation funding through the CDM, now the main source of income for the Adaptation Fund, is thus also limited.

So new sources of finance will have to be tapped. Governments will have to step in, but it will be equally important to develop

Key messages

Climate finance provides the means to reconcile equity with effectiveness and efficiency in actions to reduce emissions and adapt to climate change. But current levels fall far short of estimated needs—total climate finance for developing countries is $10 billion a year today, compared with projected annual requirements by 2030 of $30 to $100 billion for adaptation and $140 to $175 billion (with associated financing requirements of $265 to $565 billion) for mitigation. Filling the gap requires reforming existing carbon markets and tapping new sources, including carbon taxes. Pricing carbon will transform national climate finance, but international financial transfers and trading of emission rights will be needed if growth and poverty reduction in developing countries are not to be impeded in a carbon-constrained world.

new innovative funding mechanisms and to leverage private finance. The private sector will have a key role in financing mitigation through carbon markets and related instruments. But official flows or other international funding will be an important complement to build capacity, correct market imperfections, and target areas overlooked by the market. Private finance will also be important for adaptation, because private agents—households and firms—will carry much of the adaptation burden. But good adaptation is very closely linked to good development, and those most in need of adaptation assistance are the poor and disadvantaged in the developing world. This means public finance will have a key role.

In addition to raising new funds, using available resources more effectively will be crucial. This calls both for exploiting synergies with existing financial flows, including development assistance, and for coordinating implementation. The scale of the financing gaps, the diversity of needs, and differences in national circumstances require a broad range of instruments. Concerns with effectiveness and efficiency mean that finance for climate change must be raised and spent coherently.

Financing needs are linked to the scope and timing of any international agreement on climate change. The size of the adaptation bill will depend directly on the effectiveness of the agreement. For mitigation, chapter 1 shows that delayed implementation of emission reductions, whether in developed or developing countries, risks hugely increasing the cost of limiting global warming. The overview chapter shows that on a global least-cost path for climate stabilization, a large fraction (65 percent or more)[1] of the needed mitigation would occur in developing countries. The cost of limiting global warming can thus be substantially reduced if high-income countries provide enough financial incentives for developing countries to switch to lower carbon paths. As other chapters emphasize, however, finance will need to be combined with access to technology and capacity building if developing countries are to shift to a lower-carbon development path.

This chapter deals with raising enough finance to reduce emissions and cope with the impacts of unavoidable changes. It assesses the gap between the projected needs for mitigation and adaptation finance compared with sources of finance available up to 2012. It looks at inefficiencies in the existing climate-finance instruments and discusses potential funding sources beyond the ones currently available (table 6.1). And it presents models for increasing the effectiveness of existing schemes, particularly the Clean Development Mechanism, and for allocating

Table 6.1 Existing instruments of climate finance

Type of instrument	Mitigation	Adaptation	Research, development, and diffusion
Market-based mechanisms to lower the costs of climate action and create incentives	Emissions trading (CDM, JI, voluntary), tradable renewable energy certificates, debt instruments (bonds)	Insurance (pools, indexes, weather derivatives, catastrophe bonds), payment for ecosystem services, debt instruments (bonds)	
Grant resources and concessional finance (levies and contributions including official development assistance and philanthropy) to pilot new tools, scale up and catalyze action, and act as seed money to leverage the private sector.	GEF, CTF, UN-REDD, FIP, FCPF	Adaptation Fund, GEF, LDCF, SCCF, PPCR and other bilateral and multilateral funds	GEF, GEF/IFC Earth Fund, GEEREF
Other instruments	Fiscal incentives (tax benefits on investments, subsidized loans, targeted tax or subsidies, export credits), norms and standards (including labels), inducement prizes and advanced market commitments, and trade and technology agreements		

Source: WDR team.

Note: CDM = Clean Development Mechanism; CTF = Clean Technology Fund; FCPF = Forest Carbon Partnership Facility; FIP = Forest Investment Program; GEEREF = Global Energy Efficiency and Renewable Energy Fund (European Union); GEF = Global Environment Facility; IFC = International Finance Corporation; JI = Joint Implementation; LDCF = Least Developed Country Fund (UNFCCC/GEF); PPCR = Pilot Program for Climate Resilience; SCCF = Strategic Climate Change Fund (UNFCCC/GEF); UN-REDD = UN Collaborative Program on Reduced Emissions from Deforestation and forest Degradation.

adaptation finance. Throughout the focus is on financing needs in developing countries, where the questions of effectiveness, efficiency, and equity all come together.

The financing gap

Successfully tackling climate change will cost trillions. How many depends on how ambitious the global response is, how it is structured, how the measures are timed, how effectively they are implemented, where mitigation takes place, and how the money is raised. Bearing the costs will be the international community, national governments, local governments, firms, and households.

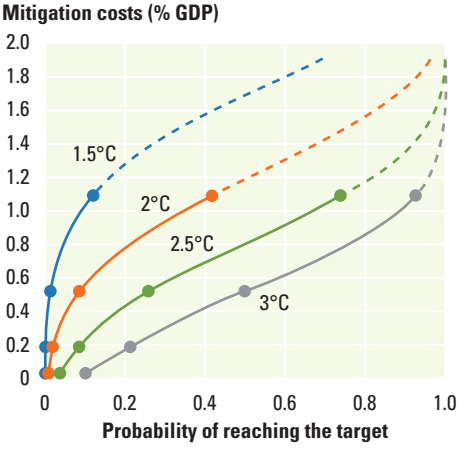
The need for finance

According to the Intergovernmental Panel on Climate Change (IPCC), which reviewed cost estimates in its fourth assessment, the cost of cutting global greenhouse gas emissions by 50 percent by 2050 could be in the range of 1–3 percent of GDP.[2] That is the minimum cut most scientists believe is needed to have a reasonable chance of limiting global warming close to 2°C above preindustrial temperatures (see overview).

But mitigation costs are sensitive to policy choices. They increase steeply with the stringency of the emission reduction target and with the certainty of reaching it (figure 6.1). Global mitigation costs will also be higher if the world deviates from the least-cost emission reduction path. As earlier chapters explain, not including developing countries in the initial mitigation effort would increase global costs significantly (a consideration that led to the establishment of the Clean Development Mechanism under the Kyoto Protocol). Similarly, not considering all mitigation opportunities would markedly increase overall costs.

It is also important to distinguish between mitigation costs (the incremental costs of a low-carbon project over its lifetime) and incremental investment needs (the additional financing requirement created as a result of the project). Because many clean investments have high up-front capital costs, followed later by savings in operating costs, the incremental financing requirements tend to be higher than the lifetime costs reported in mitigation models. The difference could be as much as a factor of three (table 6.2).

Figure 6.1 Annual mitigation costs rise with the stringency and certainty of the temperature target



Source: Schaeffer and others 2008.

For fiscally constrained developing countries these high up-front capital costs can be a significant disincentive to invest in low-carbon technologies.

Table 6.2 reports both incremental costs and associated financing requirements for the mitigation efforts needed to stabilize atmospheric concentrations of CO_2e (all greenhouse gases summed up and expressed in terms of their carbon dioxide equivalent) at 450 parts per million (ppm) over the next decade, as well as the adaptation investments estimated to be required in 2030. Focusing on the 450 ppm target, mitigation costs in developing countries range between $140 billion and $175 billion a year by 2030 with associated financing needs of $265 to $565 billion a year. For adaptation the most comparable estimates are the medium-term figures produced by the United Nations Framework Convention on Climate Change (UNFCCC) and the World Bank, which range from $30 billion to $100 billion.

Many, but not all, of the identified adaptation needs would require public expenditures. According to the UNFCCC secretariat,[3] private funding would cover about a quarter of identified investment, although this estimate is unlikely to capture the full private investment in adaptation.

These numbers give a rough indication of the adaptation cost, but they are neither particularly accurate nor fully comprehensive. Most were derived from rules of

Table 6.2 Estimated annual climate funding needed in developing countries
2005 $ billions

Source of estimate	2010–20	2030	
Mitigation costs			
McKinsey & Company		175	
Pacific Northwest National Laboratory (PNNL)		139	
Mitigation financing needs	**2010–20**	**2030**	
International Institute for Applied Systems Analysis (IIASA)	63–165	264	
International Energy Agency (IEA) Energy Technology Perspectives	565[a]		
McKinsey & Company	300	563	
Potsdam Institute for Climate Impact Research (PIK)		384	
Adaptation costs	**2010–15**	**2030**	**Included measures**
Short term			
World Bank	9–41		Cost of climate-proofing development assistance, foreign and domestic investment
Stern Review	4–37		Cost of climate-proofing development assistance, foreign and domestic investment
United Nations Development Programme	83–105		Same as World Bank, plus cost of adapting Poverty Reduction Strategy Papers and strengthening disaster response
Oxfam	>50		Same as World Bank plus cost of National Adaptation Plan of Action and nongovernmental organization projects
Medium term			
United Nations Framework Convention on Climate Change (UNFCCC)		28–67	2030 cost in agriculture, forestry, water, health, coastal protection, and infrastructure
Project Catalyst		15–37	2030 cost for capacity building, research, disaster management and the UNFCCC sectors (most vulnerable countries and public sector only)
World Bank (EACC)		75–100	Average annual adaptation costs from 2010 to 2050 in the agriculture, forestry, fisheries, infrastructure, water resource management, and coastal zone sectors, including impacts on health, ecosystem services, and the effects of extreme-weather events.

Sources: For mitigation, IIASA 2009 and additional data provided by V. Krey; IEA 2008; McKinsey & Company 2009, and additional data provided by McKinsey (J. Dinkel) for 2030, using a dollar-to-Euro exchange rate of $1.25 to €1.00; PNNL figures from Edmonds and others 2008, and additional data provided by J. Edmonds and L. Clarke; PIK figures from Knopf and others, forthcoming, and additional data provided by B. Knopf; for adaptation, all figures from Agrawala and Fankhauser 2008, except World Bank EACC (Economics of Adaptation to Climate Change) from World Bank 2009; and Project Catalyst 2009.

Note: Estimates are for stabilization of greenhouse gases at 450 ppm CO_2e, which would provide a 40–50 percent chance of staying below 2°C warming by 2100.

a. IEA figures are annual averages through 2050.

thumb, dominated by the cost of climate-proofing future infrastructure. They underestimate the diversity of the likely adaptation responses and ignore changes in behavior, innovation, operational practices, or locations of economic activity. They also ignore the need for adaptation to nonmarket impacts such as those on human health and natural ecosystems. Some of the omitted options could reduce the adaptation bill (for example, by obviating the need for costly structural investments); others would increase it.[4] The estimates also do not consider residual damages beyond effective adaptation. A recent attempt to encompass these complexities in measuring adaptation costs is reported in box 6.1.

Adaptation cost estimates also ignore the close links between adaptation and development. Although few studies are clear on this point, they measure the extra spending to accommodate climate change over and above what would have been spent on climate-sensitive investments anyway, such as those accommodating the consequences of income and population growth or correcting an existing adaptation deficit. But, in practice, the distinction between adaptation funding and development funding is not easy. Investments in education, health,

BOX 6.1 *Costing adaptation to climate change in developing countries*

A World Bank study published in 2009 on the economics of adaptation to climate change provides the most recent and comprehensive estimates of adaptation costs in developing countries, covering both country case studies and global estimates of adaptation costs. Key elements of the design of the study include:

Coverage. The sectors studied comprise agriculture, forestry, fisheries, infrastructure, water resource management, and coastal zones, including impacts on health and ecosystem services, and the effects of extreme weather events. Infrastructure is broken down into transport, energy, water and sanitation, communications, and urban and social infrastructure.

Baseline. The estimates do not include the existing "adaptation deficit"—the extent to which countries are incompletely or suboptimally adapted to existing climate variability.

Level of adaptation. For most sectors the study estimates the cost of restoring welfare to the level that would exist without climate change.

Uncertainty. To capture the extremes of possible climate outcomes the study uses results from general circulation models spanning the wettest and driest climate projections, under the IPCC's A2 scenario of possible socioeconomic and emissions trajectories.

Based on these design elements, the study arrives at bottom-line estimates of the global cost of adaptation to climate change in developing countries of $75 to $100 billion a year on average from 2010 to 2050.[a]

Source: World Bank 2009.
a. Expressed in constant 2005 dollars.

sanitation, and livelihood security, for example, constitute good development. They also help reduce socioeconomic vulnerability to both climatic and nonclimatic stress factors. Certainly in the short term, development assistance is likely to be a key complement to close adaptation deficits, to reduce climate risks, and to increase economic productivity. But new adaptation finance is also needed.

Mitigation finance available to date

Over the coming decades trillions of dollars will be spent to upgrade and expand the world's energy and transport infrastructure. These massive investments present an opportunity to decisively shift the global economy onto a low-carbon path—but they also raise the risk of a high-carbon lock-in if the opportunity is missed. As earlier chapters show, new infrastructure investments need to be steered to low-carbon outcomes.

Both public and private flows will be needed to fund these investments. Many instruments already exist (table 6.1). All will have a role in catalyzing climate action: mobilizing additional resources; reorienting public and private flows toward low-carbon and climate-resilient investments; and supporting the research, development, and deployment of climate-friendly technologies.

The public sector will provide capital mostly for big infrastructure projects, but a large part of the investment to create a low-carbon economy—from energy-efficient machinery to cleaner cars to renewable energy—will come from the private sector. Currently, governments account for less than 15 percent of global economywide investment, although they largely control the underlying infrastructure investments that affect the opportunities for energy-efficient products.

There are various ways to encourage private investment in mitigation,[5] but the most prominent market instrument involving developing countries has been the Clean Development Mechanism. It has triggered more than 4,000 recognized emission reduction projects to date. Other similar mechanisms, such as Joint Implementation (the equivalent mechanism for industrial countries) and voluntary carbon markets, are important for some regions (transition countries) and sectors (forestry) but are much smaller. Under the CDM, emission reduction activities in developing countries can generate "carbon credits"—measured against an agreed baseline and verified by an independent entity under the aegis of the UNFCCC—and trade them on the carbon market. For example, a European power utility may acquire emission reductions (through direct purchase or financial support) from a Chinese steel plant embarking on an energy-efficiency project.

The financial revenues the CDM generates are modest relative to the amount of mitigation money that will have to be raised. But they constitute the largest source of

mitigation finance to developing countries to date. Between 2001, the first year CDM projects could be registered, and 2012, the end of the Kyoto commitment period, the CDM is expected to produce some 1.5 billion tons of carbon dioxide equivalent (CO_2e) in emission reductions, much through renewable energy, energy efficiency, and fuel switching. This could raise $18 billion ($15 billion to $24 billion) in direct carbon revenues for developing countries, depending on the price of carbon (table 6.3).[6] In addition each dollar of carbon revenue leverages on average $4.60 in investment and possibly up to $9.00 for some renewable energy projects. It is estimated that some $95 billion in clean energy investment benefited from the CDM over 2002–08.

Table 6.3 Potential regional CDM delivery and carbon revenues (by 2012)

By region	Millions of certified emission reductions[a]	$ millions	Percentage of total
East Asia and Pacific	871	10,453	58
China	786	9,431	52
Malaysia	36	437	2
Indonesia	21	252	2
Europe and Central Asia	10	119	1
Latin America and the Caribbean	230	2,758	15
Brazil	102	1,225	7
Mexico	41	486	3
Chile	21	258	1
Argentina	20	238	1
Middle East and North Africa	15	182	1
South Asia	250	3,004	17
India	231	2,777	16
Sub-Saharan Africa	39	464	3
Nigeria	16	191	1
Developed countries	85	1,019	6
By income			
Low income	46	551	3
Nigeria	16	191	1
Lower middle income	1,127	13,524	75
China	786	9,431	53
India	231	2,777	16
Indonesia	21	252	2
Upper middle income	242	2,906	16
Brazil	102	1,225	7
Mexico	41	486	3
Malaysia	36	437	2
Chile	21	258	1
Argentina	20	238	1
High income	85	1,019	6
Korea, Rep. of	54	653	4
Total	**1,500**	**18,000**	**100**

Source: UNEP 2008.

Note: Volumes include withdrawn and rejected projects.
a. 1 million certified emission reductions = 1 million tons of CO_2e.

In comparison, official development assistance for mitigation was about $19 billion over 2002–07,[7] and sustainable energy investment in developing countries totaled approximately $80 billion over 2002–08.[8]

Donors and international financial institutions are establishing new financing vehicles to scale up their support for low-carbon investment in the lead-up to 2012 (table 6.4). Total finance under these initiatives amounts to $19 billion up to 2012, although this figure combines mitigation and adaptation finance.

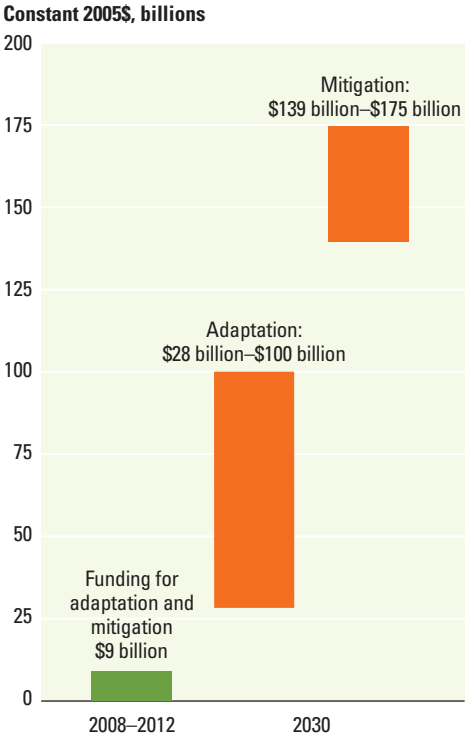
The current inadequacy of mitigation funding is obvious (figure 6.2). Combining the donor funds in table 6.4 (and counting them as if committed solely to mitigation) with the projected CDM finance to 2012 produces mitigation finance of roughly $37 billion up to 2012, or less than $8 billion a year. This falls far short of the estimated mitigation costs in developing countries of $140 to $175 billion a year in 2030, and even farther short of the associated financing requirements ($265 to $565 billion).

Adaptation finance available to date

Funding for adaptation started to flow only recently. The main existing source of adaptation funding is international donors, channeled either through bilateral agencies or through multilateral institutions like the Global Environment Facility (GEF) and the World Bank.

The establishment of the Adaptation Fund in December 2007, a funding mechanism with its own independent source of finance, was an important development. Its main income source is the 2 percent levy on the CDM, a novel financing source (discussed in more detail later) that could raise between $300 million and $600 million

Figure 6.2 The gap is large: Estimated annual climate funding required for a 2°C trajectory compared with current resources



Source: For 2030 values, see table 6.2; for 2008–2012 values, see text.

over the medium term, depending on the carbon price (see table 6.4 and endnote 7).

Excluding private finance, $2.2 billion to $2.5 billion is projected to be raised for adaptation from now to 2012, depending on what the Adaptation Fund raises. The potential adaptation finance now available is less than $1 billion a year, against funding requirements of $30 to $100 billion a year over the medium term (see table 6.2). Figure 6.2 compares the annual climate finance available over 2008–12 (both mitigation and adaptation, roughly $10 billion a year), with the projected medium-term financing needs.

Inefficiencies in existing climate-finance instruments

Inefficiency could take what is already projected to be a very large and costly endeavor and make it even more expensive. So there is an obvious case for ensuring that climate finance is generated and spent efficiently. Three aspects of the efficiency of climate finance are considered below: the fragmentation of climate finance into multiple funding sources, the limitations of carbon offset markets for mitigation, and the potential costs of taxing certified emission reductions (CERs) to finance the Adaptation Fund.

Table 6.4 New bilateral and multilateral climate funds

Fund	Total amount ($ millions)	Period
Funding under UNFCCC		
Strategic Priority on Adaptation	50 (A)	GEF 3-GEF 4
Least Developed Country Fund	172 (A)	As of October 2008
Special Climate Change Fund	91 (A)	As of October 2008
Adaptation Fund	300–600 (A)	2008–12
Bilateral initiatives		
Cool Earth Partnership (Japan)	10,000 (A+M)	2008–12
ETF-IW (United Kingdom)	1,182 (A+M)	2008–12
Climate and Forest Initiative (Norway)	2,250	
UNDP-Spain MDG Achievement Fund	22 (A) / 92 (M)	2007–10
GCCA (European Commission)	84 (A) / 76 (M)	2008–10
International Climate Initiative (Germany)	200 (A) / 564 (M)	2008–12
IFCI (Australia)	160 (M)	2007–12
Multilateral initiatives		
GFDRR	15 (A) (of $83 million in pledges)	2007–08
UN-REDD	35 (M)	
Carbon Partnership Facility (World Bank)	500 (M) (140 committed)	
Forest Carbon Partnership Facility (World Bank)	385 (M) (160 committed)	2008–20
Climate Investment Funds, includes	6,200 (A+M)	2009–12
Clean Technology Fund	4,800 (M)	
Strategic Climate Fund, including	1,400 (A+M)	
Forest Investment Programme	350 (M)	
Scaling up renewable energy	200 (M)	
Pilot Program for Climate Resilience	600 (A)	

Source: UNFCCC 2008a plus updates by authors.

Note: For a number of bilateral initiatives, part of the funds will be distributed through multilateral initiatives (for example, some pledges to the Climate Investment Funds or the Forest Carbon Partnership Facility). This leads to some double counting and makes it difficult to draw an accurate picture of upcoming climate change resources in developing countries. The Climate Investment Funds are managed by the World Bank and implemented by all multilateral development banks. All data for the Climate Investment Funds are as of July 2009—$250 million of the Strategic Climate Fund was unallocated at that time, and the Scaling up Renewable Energy fund will require minimum pledges of $250 million before it becomes operational. A = funding devoted to adaptation; M = funding devoted to mitigation; ETF-IW = Environmental Transformation Fund-International Window; GCCA = Global Climate Change Alliance; IFCI = International Forest Carbon Initiative; UN-REDD = UN Collaborative Program on Reduced Emissions from Deforestation and forest Degradation; GFDRR = Global Facility for Disaster Reduction and Recovery. Pledges to the Climate and Forest Initiative (Norway) stood at $430 million in June 2009.

Fragmentation of climate finance

There is a risk of proliferation, illustrated in table 6.4, of special-purpose climate funds. Fragmentation of this sort threatens to reduce the overall effectiveness of

climate finance, because as transaction costs increase, recipient country ownership lags, and alignment with country development objectives becomes more difficult. Each new source of finance, whether for development or climate change, carries with it a set of costs. These include transaction costs (which rise in aggregate as the number of funding sources increases), inefficient allocation (particularly if funds are narrowly defined), and limitations on scaling up. The current fragmentation and the low level of resources highlights the importance of the ongoing negotiations about a climate-financing architecture adequate to mobilize resources at scale and to deliver efficiently across a wide range of channels and instruments.

While there is not an exact parallel between climate finance and development aid, some of the lessons from the aid-effectiveness literature are highly relevant to climate finance. Concern about the negative effects of aid fragmentation was one of the key drivers of the Paris Declaration on Aid Effectiveness. In that declaration, most recently reaffirmed in the Accra Agenda for Action, both aid donors and recipients committed to incorporate the key tenets of ownership, alignment, harmonization, results orientation, and mutual accountability into their development activities.

The Paris Declaration raises important issues for financing climate investments in developing countries, many of which are widely accepted and reflected in negotiation documents, such as the Bali Action Plan:[9]

- *Ownership*. Building a shared consensus that climate change is a development issue, a central tenet of this Report, will be key in building country ownership. This consensus view must then be built into country development strategies.
- *Alignment*. Ensuring alignment between climate actions and country priorities is the second critical step in increasing the effectiveness of climate finance. Moving from the project to the sector and program level can facilitate this process. Predictability and sustainability of finance is another key aspect of alignment. Stop-start climate-action programs, driven by the volatility of finance, will reduce overall effectiveness.
- *Harmonization*. To the extent that the various climate funds have divergent purposes, this fragmentation of climate finance presents a great challenge to harmonizing different sources of finance and exploiting synergies among adaptation, mitigation, and development finance.
- *Results*. The results agenda for climate action is not substantially different from those of other development domains. Designing and implementing meaningful outcome indicators will be key to maintaining public support for climate finance and building country ownership for climate action.
- *Mutual accountability*. Weak progress toward Kyoto targets by many developed countries puts their accountability for climate action in the spotlight. An essential part of any global agreement on climate change must be a framework that holds high-income countries accountable for moving toward their own emission targets and for providing climate finance, and that also holds developing countries accountable for climate actions and uses of climate finance, as established in the Bali Action Plan. Beyond provision of resources, monitoring and reporting of climate finance flows and verification of results are a central topic of the ongoing climate negotiations.

In addition to the sources of finance, an important question is what investments climate funds should finance and the associated financing modalities. While some climate investments will be for individual projects—low-carbon power plants, for example—efficiencies can, in many instances, be gained by moving to the sector or program level. For adaptation, finance at the country level should in most cases be commingled with overall development finance, not used for specific adaptation projects.

More generally, rather than being overly prescriptive, climate finance could emulate the poverty reduction strategy approach now implemented in many low-income countries. This entails linking aid resources targeted at reducing poverty to a poverty reduction strategy prepared by the recipient country. Based on an analysis of poverty and a definition of country priorities, as validated by

participatory processes with civil society, the strategy becomes the basis for broad budget support by donors to finance a program of action aimed at reducing poverty. Individual projects become the exception rather than the rule. If countries integrate climate action into their development strategies, a similar approach to climate finance should be feasible.

Inefficiencies of the Clean Development Mechanism

The principal instrument for catalyzing mitigation in developing countries is the CDM. It has grown beyond initial expectations, demonstrating the ability of markets to stimulate emission reductions, provide essential learning, raise awareness, and build capacity. But the CDM contains some inherent inefficiencies, raising questions about the overall process and its efficiency as a financing instrument:

Questionable environmental integrity. The long-term success of the CDM can be best assessed by its contribution to measurably reducing greenhouse gas emissions. In order not to dilute the environmental effectiveness of the Kyoto Protocol, CDM emission reductions must be additional to the reductions that would have occurred otherwise. The extent of additionality provided by the CDM has been debated vigorously.[10] The additionality of individual projects is difficult to prove and even more difficult to validate, because the point of reference is by definition a counterfactual reality that can never be incontrovertibly argued or conclusively proven. Because debates on baseline and additionality concerns continue to plague the CDM process, it is time to explore alternative, and simpler, approaches to demonstrate additionality. Approaches such as benchmarks and a positive list of specific desired activities should be explored further to streamline project preparation and monitoring. Revisiting additionality will not only address major inefficiencies in CDM operation but can also help to increase the credibility of the mechanism.

Insufficient contribution to sustainable development. The CDM was created with two objectives: the global mitigation of climate change; and the sustainable development of developing countries. But the CDM has been more effective in reducing mitigation costs than in advancing sustainable development.[11] A project is deemed to contribute to sustainable development if national authorities sign off on it, acknowledging a wide range of local co-benefits in line with their development priorities (box 6.2). While many critics accept this broad definition,[12] some nongovernmental organizations have found flaws both in the acceptance of certain project types (such as hydropower, palm oil plantations, and the destruction of industrial gases) and in implementation. A closer look at the CDM project pipeline suggests that the treatment of sustainable development in project documents is sketchy and uneven and that project developers display only a rudimentary concern for or understanding of the concept.

Weak governance and inefficient operation. The CDM is unique in regulating a market dominated by private players through an executive board—essentially a United Nations committee—that approves the calculation methods and projects that create the market's underlying asset. The credibility of the CDM depends largely on the robustness of its regulatory framework and the private sector's confidence in the opportunities the mechanism provides.[13] Complaints are mounting about the continuing lack of transparency and predictability in the board's decision making.[14] At the same time, the CDM architecture has begun to show some weaknesses that are signs of it being a victim of success. There have been copious complaints about yearlong delays in the approval of methodologies[15] and the one- to two-year time lag in the assessment of projects.[16] These are significant constraints to the continuing growth of the CDM as a key instrument to support mitigation efforts in developing countries.

Limited scope. CDM projects are not evenly distributed. A full 75 percent of sales revenues from offsets accrue to Brazil, China, and India (see table 6.3). The CDM has pretty much bypassed low-income countries, which have received only 3 percent of carbon revenues, a third of them for

BOX 6.2 *Assessing the co-benefits of the CDM*

The Clean Development Mechanism produces three broad categories of potential host-country co-benefits (apart from the financial flow from carbon credit sales): the transfer and dissemination of technologies; the contribution to employment and economic growth; and the contribution to environmentally and socially sustainable development.

The extent to which projects contribute to these three objectives can be gauged by looking at project design documents, which can be searched for keywords associated with different co-benefits. This approach was used by Haites, Maosheng, and Seres to assess the technology transfer benefits of the CDM and by Watson and Fankhauser to assess contributions to economic growth and sustainable development.

Haites, Maosheng, and Seres found that only about a third of CDM projects claim to transfer technology, by passing on equipment, know-how, or both. A closer look reveals that they are predominantly projects involving foreign sponsors. Only a quarter of projects developed unilaterally by the host country claim to transfer technology. Technology transfer is also associated with larger projects. Although only a third of projects transfer technology, they account for two-thirds of emission reductions. Projects explicitly labeled and processed as "small" projects lead to technology transfer in only 26 percent of the cases.

But technology transfer is a difficult concept to define. For mitigation, it tends to be not so much proprietary technology that is shared but operational and managerial know-how of how to run a particular process. A study by Dechezleprêtre and colleagues that specifically looked at the transfer of technologies protected by patent found that the Kyoto Protocol did not accelerate technology flows, though it may have stimulated innovation more generally.

Watson and Fankhauser found that a full 96 percent of projects claim to contribute to environmental and social sustainability, but most of these claims relate to contributions to economic growth and employment in particular. Just over 80 percent of projects claim some employment impact, and 23 percent contribute to a better livelihood. There are relatively lower employment benefits from industrial gas projects (hydrofluorocarbon, perfluorocarbon, and nitrous oxide reduction—18 percent) and fossil-fuel switching projects (43 percent) than with other sectors, where at least 65 percent of projects state employment benefits.

Applying a more traditional and narrower definition of sustainable development, 67 percent of projects claim training or education benefits (increasing human capital), 24 percent reduce pollution or produce environmental co-benefits (increasing natural capital), and 50 percent have infrastructural or technology benefits (increasing manmade capital).

Sources: Haites, Maosheng, and Seres 2006; Watson and Fankhauser 2009; Dechezleprêtre and others 2009.

three gas-flaring projects in Nigeria. There is a similar concentration in sectors, with much of the abatement action concentrated in a fairly small number of industrial gas projects. The CDM has not supported any increased efficiencies in the built and household environments or transportation systems, which produce 30 percent of global carbon emissions[17] and are the fastest-growing sources of carbon emissions in the emerging markets.[18] Nor has the CDM supported sustainable livelihoods or catalyzed energy access for the rural and peri-urban poor.[19] The exclusion of deforestation emissions from the CDM leaves the largest emission source of many tropical developing countries untapped.[20]

Weakness of the incentive, reinforced by uncertainty about market continuity. The CDM has not moved developing countries onto low-carbon development paths.[21] The incentive of the CDM has been too weak to foster the necessary transformation in the economy, without which carbon intensities in developing countries will continue to increase.[22] The CDM's project approach structure and lack of leverage have restricted it to a fairly small number of projects. Uncertainty about the continuation of the carbon offset market beyond 2012 is also having a chilling effect on transactions.

The efficiency cost of adaptation funding

An important source of adaptation finance, and the key revenue source of the Adaptation Fund, is a 2 percent levy on the CDM, a tax that could be extended to include other trading schemes, such as Joint Implementation. This is a promising route to raising financial resources for the Adaptation Fund, which offers clear additionality. But it also raises some basic economic issues. Perhaps the most important objection is that the CDM levy is taxing a good (mitigation finance) rather than a bad (emissions). More generally, the levy raises two basic questions:

- What is the scope for raising additional adaptation finance through the levy, and

what is the loss in economic efficiency (or deadweight loss, in economic jargon) associated with the tax?

- How is the tax burden distributed between the sellers (developing countries) and buyers (developed countries)?

Analysis based on the U.K. government's GLOCAF model shows that the ability of an extended carbon trading scheme to raise additional adaptation revenues will depend on the type of global climate deal that is agreed.[23] Revenues will vary depending on the expected demand, particularly whether demand will be constrained by supplementary restrictions to promote domestic abatement, and to a lesser extent on the expected supply, including whether a future regime could encompass credits from avoided deforestation and from other sectors and regions that currently produce little carbon trade.

Revenues will also depend on the tax rate. At the current rate of 2 percent the levy could be expected to raise around $2 billion a year in 2020 if demand is unconstrained but less than half that amount if restrictions are placed on the purchase of credits (table 6.5). To raise $10 billion a year the tax rate would have to increase to 10 percent and all supplementary restrictions would have to be abolished. Even at this higher rate the economic cost of the tax would be fairly minor, particularly in relation to the overall gains from trade.

Like all taxes, the cost of the levy is shared between the buyers and sellers of carbon credits depending on their responsiveness to price changes (the price elasticities of supply and demand). In the scenarios where demand is constrained, buyers do not respond strongly to the tax, and much of the tax burden is thus passed on to them. But this response changes if constraints on demand are eased. At that point the tax incidence shifts decidedly against developing countries, which have to shoulder more than two-thirds of the tax burden to keep the price of their credits competitive. That is, developing countries would make the main contribution to the Adaptation Fund (through forgone carbon market revenues). Rather than transferring funds from developed to developing countries, the CDM levy would transfer resources from the big CDM host countries (Brazil, China, India —see table 6.3) to the vulnerable countries eligible for adaptation funding.

Increasing the scale of climate-change finance

To close the financing gap, financing sources have to be diversified, and the existing instruments have to be reformed to increase their efficiency and permit the required scale-up. This section highlights some of the main challenges in this respect, arguing for the following:

- Harnessing new sources of revenue to support adaptation and mitigation by national governments, international organizations, and dedicated financing mechanisms like the Adaptation Fund.
- Increasing the efficiency of carbon markets by reforming the CDM as a key vehicle to promote private mitigation funding.
- Expanding performance-based incentives to land use, land-use change, and forestry to change the balance between private and public funding in this important area.
- Leveraging private sector funding for adaptation.

Countries will also have to consider the fiscal framework for climate action. Government action on climate mitigation and adaptation can have important fiscal

Table 6.5 The tax incidence of an adaptation levy on the Clean Development Mechanism (2020)
$ millions

Tax rate	Revenue raised	Deadweight loss	Burden to developing countries
2 percent			
Restricted demand and low supply	996	1	249
Unrestricted demand and high supply	2,003	7	1,257
10 percent			
Restricted demand and low supply	4,946	20	869
Unrestricted demand and high supply	10,069	126	6,962

Source: Fankhauser, Martin, and Prichard, forthcoming.

Note: Under restricted demand, regions can buy up to 20 percent of their target through credits; there is completely free trading in the unrestricted demand scenario. In the low-supply scenario the CDM operates in the same sectors and regions as it does now. In the high-supply scenario carbon trading is expanded in regional and sectoral scope, including credits from Reduced Emissions from Deforestation and forest Degradation (although, as noted, the latter emissions are not currently in the CDM). The total market volume (excluding secondary transactions) is around $50 billion in the restricted-demand, low-supply case and around $100 billion in the unrestricted-demand, high-supply case.

BOX 6.3 *Carbon taxes versus cap-and-trade*

The principal market-based instruments used for climate mitigation are carbon taxes and cap-and-trade schemes. By eschewing fixed quotas or technology standards (the usual regulatory instruments employed by governments), these instruments leave individual firms and households free to find the least-cost way to meet a climate target.

A carbon tax is a price instrument and typically operates by taxing the carbon content of fuel inputs, thus creating an incentive either to switch to lower-carbon fuels or to use fuel more efficiently. However, because governments have imperfect information about the costs of fuel switching or increasing energy efficiency, there is corresponding uncertainty about how much abatement will actually occur for a given tax level. If a government has an emission cap under a global agreement, then it may need to adjust the tax rate iteratively to keep emissions within the cap.

Under a cap-and-trade scheme, governments issue emission permits representing a legal right to emit carbon—these permits are freely tradable between scheme participants. Because firms and sectors will differ in their marginal costs of fuel switching or energy efficiency, the potential for gains from trade exists. For example, if one firm has a high marginal cost of mitigation while another has a much lower cost, then the firm with the lower cost can sell a permit at a price above its marginal cost of mitigation, reduce its emissions accordingly, and make a profit—and as long as the price of the permit is below the marginal mitigation cost of the buyer, then this is a profitable trade for the buyer as well. Because cap-and-trade is a quantitative instrument, there is high certainty that a country will stay within its cap (assuming that enforcement is effective), but there may be a corresponding uncertainty about the level and stability of permit prices.

The two instruments differ in important ways:

Efficiency

Because of imperfect information about mitigation costs, there is a risk with any market instrument of abating emissions, either too much or not enough, engendering either excess costs or excess damages. A famous result by Weitzman shows that the choice of instrument under uncertainty depends on the relative slope of the damage and abatement cost functions. What this means in the case of climate change is unclear, since the shape of the damage function is highly uncertain. However, because greenhouse gases are stock pollutants, many have argued that, in the short-term, damages are likely to be fairly constant per marginal ton, which would favor a tax.

Price volatility

While cap-and-trade creates certainty about the quantity of emissions, it may lead to uncertainty about price. For example, if there is a shift in the business cycle or in the relative prices of low-carbon and high-carbon fuels, then permit prices will be directly affected. Price volatility not only makes it difficult to plan abatement strategies, it also reduces the incentive to invest in research and development on new abatement technologies. Banking and borrowing of allowances are two simple mechanisms that can help dampen price volatility.

Recycling revenues

A carbon tax is a direct source of fiscal revenue, and governments have the option of either using the tax to finance expenditures or recycling the revenues by lowering or eliminating other taxes. To the extent that recycling increases the overall efficiency of the tax system, there is a "double dividend"—but a double dividend is not guaranteed if the carbon taxes themselves exacerbate existing inefficiencies in the tax system. If emission permits are auctioned by the government, then these too become a source of fiscal revenue.

Political economy

Because the world has a fixed carbon budget for any chosen climate target, the certainty associated with a quantitative instrument may be appealing to some groups. And everyone, whether firms or individuals, dislikes taxes. This line of reasoning may seem to favor cap-and-trade, but tax aversion also means that firms will resist auctioning of permits and may instead lobby for their allocation of free permits. In general the process of allocating permits, if not done through auction, leads to rent seeking and potentially corrupt behavior.

Administrative efficiency

The cost of administering climate policy and the institutional and human capital required are particularly important considerations in developing countries. A tax on the carbon content of fuels is potentially very cost-effective because it could piggyback on existing administrative systems for levying excise taxes on fuels. In contrast setting up a market for auctioning and trading permits could be highly complex, and a regulator would be required to monitor the exercise of market power by participants. In addition, a permit system would require monitoring and enforcement at the level of individual emitters, while monitoring of a carbon tax potentially could be done much more cheaply at the level of fuel wholesalers.

Carbon taxes and cap-and-trade are not necessarily mutually exclusive. The European Union has opted for emissions trading to address emissions from large sources (utilities, heat production, large energy-intensive industrial facilities, and aviation, to be phased in in 2011), covering about 40 percent of EU emissions. Other instruments (including a carbon tax in several European countries) target emissions from other sectors, notably residential and services, transport, waste management, and agriculture. In contrast in Australia and the United States cap-and-trade is emerging as the main instrument to regulate economywide greenhouse gas emissions (with a set of accompanying policies and measures, like renewable energy portfolio standards).

Sources: Bovenberg and Goulder 1996; Weitzman 1974; Aldy, Ley, and Parry 2008; Newell and Pizer 2000.

consequences for revenues, subsidies, and flows of international finance. Key elements of this framework include the following.

Choice of mitigation instrument. Taxes or tradable permits will be more efficient instruments than regulation, and each can generate significant fiscal revenues (assuming that permits are auctioned by the government). Box 6.3 highlights the key characteristics of carbon taxes versus cap-and-trade approaches.

Fiscal neutrality. Countries have the option of using carbon fiscal revenues to reduce other distorting taxes, which could have major growth and welfare consequences. But treasuries in developing countries typically have a weak revenue base, which may reduce the incentives for complete fiscal neutrality.

Administrative simplicity and cost. Carbon taxes, because they can be placed on the carbon content of fuels, offer the simplicity of building on existing fuel excise regimes. Cap-and-trade systems can entail large administrative costs for allocating permits and ensuring compliance.

Distributional impacts. Any price instrument for mitigation will have distributional consequences for different income groups depending on the carbon intensity of their consumption and whether they are employed in sectors that shrink as a result of carbon taxes or caps; offsetting fiscal actions may be required if low-income households are disproportionately affected.

Policy coherence. Existing subsidy schemes, particularly on energy and agriculture, may run counter to actions to mitigate and adapt to climate change. Subsidies on goods that will become scarcer under climate change, such as water, also risk perverse effects.

Box 6.4 highlights the efforts of the Indonesian Ministry of Finance to incorporate climate issues into overall macroeconomic and fiscal policy.

Generating new sources of finance for adaptation and mitigation

Public institutions—national governments, international organizations, and the official financing mechanisms of the UNFCCC—are among the key drivers of climate-smart

BOX 6.4 *Indonesian Ministry of Finance engagement on climate change issues*

Indonesia's Finance Ministry has recognized that mitigating and adapting to climate change require macroeconomic management, fiscal policy plans, revenue-raising alternatives, insurance markets, and long-term investment options. With development as the priority, Indonesia is trying to balance economic, social, and environmental goals. The country could benefit from investing in development with climate-friendly technology for a cleaner, more efficient growth path. Benefits would include potential payments from carbon markets for the reductions in emissions achieved from a cleaner energy path or from reductions in the annual rate of deforestation. The Ministry of Finance will play an essential role in the financing, development, and implementation of climate-change policies and programs. To mobilize the financing needed, Indonesia envisions a mix of mechanisms paired with integrated national policies, a strong enabling framework, and long-term incentives to attract investment.

The Finance Ministry's comparative advantage is in considering the allocation and incentive decisions that affect the whole economy. In managing climate-financing opportunities, the ministry acknowledges the importance of investor and donor confidence in its approaches and institutions. Recognizing that donor funds—whether grants or soft loans—will always be small relative to private investment in energy sector development, infrastructure, and housing, Indonesia will continue to need sound policies and incentives to attract and leverage private investment toward sustainable development and lower-carbon outcomes.

Indonesia has already taken steps to rationalize energy pricing by reducing fossil-fuel subsidies in 2005 and 2008, to reduce deforestation through improved enforcement and monitoring programs, and to provide incentives for import and installation of pollution control equipment through tax breaks. The Finance and Development Planning ministries have established a national blueprint and budget priorities for integrating climate change into the national development process. The Finance Ministry is examining fiscal and financial policies to stimulate climate-friendly investment, move toward lower-carbon energy options including renewables and geothermal, and improve fiscal incentives in the forestry sector.

Source: Ministry of Finance (Indonesia) 2008.

development. So far they have relied almost exclusively on government revenues to finance their activities. But it is unlikely that climate-change costs rising into the tens or hundreds of billions of dollars a year could be predominantly covered through government contributions. Although additional funds will be forthcoming, the experience with development assistance suggests that there are constraints on the amount of traditional donor finance that can be raised. Moreover, there is a worry from developing countries that contributions from developed countries may not be fully additional to existing development assistance.

Other sources of finance will therefore have to be tapped, and there are several proposals, particularly for adaptation. These include:

Internationally coordinated carbon tax. Proposals for a nationally administered but globally levied carbon tax have the appeal that the tax base would be broad and the revenue flow fairly secure. Moreover, unlike the CDM levy, the tax would be aimed at emissions rather than emission reductions. Rather than impose a deadweight loss, the tax would have a desirable and beneficial corrective effect. The main drawback is that an internationally coordinated tax could impinge on the tax authority of sovereign governments. Gaining international consensus for this option may thus be difficult.

Tax on emissions from international transport. A tax more narrowly focused on international aviation or shipping would have the advantage of targeting two sectors that so far have not been subject to carbon regulation and whose emissions are growing fast. The international nature of the sector might make a tax more palatable for national finance ministers, and the tax base would be large enough to raise considerable amounts. But the global governance of the sectors is complex, with considerable power in the hands of international bodies, such as the International Maritime Organization. So the administrative hurdles of setting up such a tax might be considerable.

Auctioning assigned amount units. The emission reduction commitments of parties under the Kyoto Protocol are expressed in assigned amount units (AAUs)—the amount of carbon a country is permitted to emit. An innovative approach, put forward originally by Norway, would set aside a fraction of each country's AAU allocation and auction it to the highest bidder, with revenues earmarked for adaptation.

Domestic auction revenues. Earmarking auction revenues relies on the assumption that most developed countries will soon have fairly comprehensive cap-and-trade schemes and that most of the permits issued under the schemes would be auctioned rather than handed out for free. With schemes already running or under consideration in practically all developed countries, this is a reasonable expectation. But earmarking auction revenues would encroach on the fiscal autonomy of national governments just as much as an internationally coordinated carbon tax and may therefore be similarly difficult to implement.

Each of these options has its advantages and disadvantages.[24] What is important is that the chosen options provide a secure, steady, and predictable stream of revenues of sufficient size. This suggests that finance will have to come from a combination of sources. Table 6.6 presents a range of potential sources of finance as proposed by developed and developing countries.

In the short term some impetus may also come from international efforts to overcome the current economic slump and kick-start the economy through a fiscal stimulus (see chapter 1).[25] Globally, well over $2 trillion has been committed in various fiscal packages, chief among them the $800 billion U.S. package and the $600 billion Chinese plan. Some 18 percent of this, or about $400 billion, is green investment in energy efficiency and renewable energy, and also, in the Chinese plan, adaptation.[26] Deployed over the next 12–18 months these investments could do much to shift the world toward a low-carbon future. At the same time, the packages are by their very nature geared toward stimulating domestic activity. Their effect on international climate finance to developing countries will at best be indirect.

Table 6.6 Potential sources of mitigation and adaptation finance

Proposal	Source of funding	Note	Annual funding ($ billions)
Group of 77 and China	0.25–0.5 percent of gross national product of Annex I Parties	Calculated for 2007 gross domestic product	201–402
Switzerland	$2 a ton of CO_2 with a basic tax exemption of 1.5 ton CO_2e per inhabitant	Annually (based on 2012 projections)	18.4
Norway	2 percent auctioning of AAUs	Annually	15–25
Mexico	Contributions based on GDP, greenhouse gases, and population and possibly auctioning permits in developed countries	Annually, scaling up as GDP and emissions rise	10
European Union	Continue 2 percent levy on share of proceeds from CDM	Ranging from low to high demand in 2020	0.2–0.68
Bangladesh, Pakistan	3–5 percent levy on share of proceeds from CDM	Ranging from low to high demand in 2020	0.3-1.7
Colombia, least developed countries	2 percent levy on share of proceeds from Joint Implementation and emissions trading	Annually, after 2012	0.03–2.25
Least developed countries	Levy on international air travel (IATAL)	Annually	4–10
Least developed countries	Levy on bunker fuels (IMERS)	Annually	4–15
Tuvalu	Auction of allowances for international aviation and marine emissions	Annually	28

Source: UNFCCC 2008a.

Note: AAU: assigned amount unit; IATAL: international air travel adaptation levy; IMERS: international maritime emission reduction scheme. Annex I Parties include the high-income countries that were members of the OECD in 1992, plus countries with economies in transition. Annex I countries have committed themselves specifically to the aim of returning individually or jointly.

It takes more than finance: Market solutions are essential but additional policy tools are needed

With more national or regional initiatives exploring emissions trading, the carbon market will likely be significant in catalyzing and financially supporting the needed transformation of investment patterns and lifestyles. Through purchasing offsets in developing countries, cap-and-trade systems can finance lower-carbon investments in developing countries. Carbon markets also provide an essential impetus to finding efficient solutions to the climate problem.

Looking forward, stabilizing temperatures will require a global mitigation effort. At that point carbon will have a price worldwide and will be traded, taxed, or regulated in all countries. Once an efficient carbon price is in place, market forces will direct most consumption and investment decisions toward low-carbon options. With global coverage many of the complications affecting the current carbon market—additionality, leakage, competitiveness, scale—will fall away. They matter enormously today, and in addressing them the need for a smooth transition to an ultimately global carbon market must not be forgotten. However, some market failures will remain, and governments will need to intervene to correct them.

Decisions that help the emergence of a long-term, predictable, and adequate carbon price are necessary for effective mitigation but, as chapter 4 shows, not sufficient. Some activities, such as risky research and development or energy-efficiency improvements, are hindered by market or regulatory failures; others, such as urban planning, are not directly price sensitive. The forest and agriculture sectors present significant additional potential for emission reduction and sequestration in developing countries but are too complex, with intricate social issues, to rely exclusively on market incentives. Many climate actions will require complementary finance and policy interventions—for example, to overcome energy-efficiency barriers, reduce perceived risks, deepen domestic financial and capital markets, and

accelerate the diffusion of climate-friendly technologies.

Increasing the scale and efficiency of carbon markets

The absence of market continuity beyond 2012 is the biggest risk to the momentum of today's carbon market. Considerable uncertainties remain about the very existence of a global carbon market beyond 2012, with questions about the ambition of mitigation targets, the resulting demand for carbon credits, the degree of linking of different trading schemes, and the role for offsets across various existing and upcoming regimes. Defining a global mitigation goal for 2050 supported by intermediate targets (to be determined through the UNFCCC process) would provide long-term carbon price signals and certainty to the private sector as major investment decisions with long-lasting impact on emission trajectories are made over the coming years.

The next phase in constructing a global carbon market must put developed countries onto a low-carbon path and provide the financial and other resources needed to assist the transition of developing countries to a lower-carbon development path. One of the main challenges for a climate agreement is to define a framework that supports and promotes this transformation and facilitates the transition to a more comprehensive system where more countries assume emission reduction targets. As discussed in chapter 5, a gradual incorporation process can be envisaged, with transitions toward more stringent steps depending on responsibility and capacity: adopting climate-friendly policies (a stage many developing countries have already reached), limiting emissions growth, and setting emission reduction targets. To support this gradual progress, various models using carbon finance have been proposed.[27]

But demand for international offsets from Annex I countries will likely remain for quite some time at levels well below what would be needed to reward all mitigation achievements in developing countries while simultaneously maintaining a sufficiently high carbon price. Setting more ambitious targets for Annex I countries[28] will create the incentive for greater cooperation with developing countries in scaling up mitigation, provided a credible supply of offsets can be built at scale.

Concern about the effectiveness and efficiency of the CDM has led to a broad array of proposals on how to enhance, expand, or evolve the mechanism. Broadly speaking, these could be organized along two lines of suggestions. One track would aim at streamlining the CDM to make it more appropriate for a growing market dominated by the private sector by improving efficiency and governance along the project cycle as well as by reducing transaction costs. Another track would aim at scaling up the transformational impact of CDM and carbon finance beyond the limited scope of a project approach, focusing on investment trajectories and affecting emission trends.

It is probably not realistic to attain anything more than incremental changes to the CDM by 2012. Some practitioners clamor for big improvements. But many countries are still learning the ropes of the instrument, and their first projects have just begun to enter the pipeline in the past few months. Others are focused on the agreement and tools for scaling up post-2012 mitigation. There is little or no political space to undertake immediate major revisions to the CDM before 2012, a point emphasized by developing countries that have argued that most of those revisions would require an amendment to the Kyoto Protocol. So, to organize the steps in a possible evolution, it may help to distinguish two levels of improvements or changes to the current CDM, which would ultimately result in two financial mechanisms, operating in parallel and complemented by a nonmarket mechanism funded by public sources.

An activity-based CDM. There is a case to continue operating the current activity-based CDM within its existing rules, with some targeted improvements. In the current system the baseline and additionality are determined for the individual project activity, and the rules seek to differentiate and reward individual efforts that are better than the norm (rather than promoting a better norm). Most medium-to-large installations in small countries can be effectively submitted as individual CDM projects, and microtechnologies such as light bulbs

and cooking stoves now have the option of being registered as organized programs of activities under the current CDM (thus cutting down on transaction costs through aggregation). Most small or least developed countries have more urgent demands on scarce institutional capacity than the development of complex greenhouse gas accounting schemes. This means that for some developing countries, perhaps most, there is no need for another set of rules to supply their mitigation potential into the market.

Key administrative improvements would target, for example, improving the quality, relevance, and consistency of information flows within the CDM community; engagement of a professional, full-time staff for the CDM Executive Board and consideration of how to make it more representative of practitioners; and increasing the accountability of the process, potentially including a mechanism that provides an opportunity for project participants to appeal board decisions. In parallel, countries would have to create a business environment conducive to low-carbon investment in general.

A trend-changing market mechanism. This new mechanism would seek to reduce long-term emission trends much more comprehensively. Set up either in or outside the current CDM, it would support the enactment of policy changes that put developing countries onto a low-carbon path. It would recognize and promote emission reductions achieved by adopting particular policies or programs that lead to emission reductions at multiple sources. A programmatic CDM could be a first step toward a trend-changing market mechanism, allowing for the aggregation of unlimited similar activities resulting from the implementation of a policy across time and space. Proposals to support a sectoral shift can be classified in two broad groups: those that stem from an agreement among industries that operate in the same sector but are located across different countries; and those that evolve from a national government's decision to implement a specific policy or program.

There have been many thoughts on how CDM and carbon finance could support climate-friendly policies in developing countries. The proposed options all consider a mechanism for carbon finance to reward the measurable outcomes of a policy (in reduced emissions). Variants pertain to the policy and country commitment under an international agreement (mandatory or flexible), the geographical scale (regional or national), or the sectoral scope (sectoral or cross-sectoral). Among these options sectoral no-lose targets, whereby a country could sell carbon credits for emission reductions below an agreed target (which would lie below business-as-usual levels), while not being penalized for not achieving the target, have attracted a great deal of interest. Such a mechanism would be adapted to developing countries needing to significantly scale up private sector investment—beyond the reach of the CDM in its current form—in line with their sustainable development priorities.

Creating financial incentives for REDD

A particular concern for developing countries is the lack of financial incentives for Reduced Emissions from Deforestation and forest Degradation (REDD). In 2005, nearly one fourth of emissions in developing countries came from land-use change and forestry, so this is a substantial exclusion.[29] But land use, land-use change, and forestry have always been problematic and contentious in the climate negotiations. There was great opposition to their inclusion in the Kyoto Protocol. As a result,

Table 6.7 National and multilateral initiatives to reduce deforestation and degradation

Initiative	Total estimated funding ($ millions)	Period
International Forest Carbon Initiative (Australia)	160	2007–12
Climate and Forest Initiative (Norway)	2,250	2008–12
Forest Carbon Partnership Facility (World Bank)	300	2008–18
Forest Investment Program (part of Climate Investment Funds)	350	2009–12
UN-REDD Program	35	2008–12
Amazon Fund	1,000	2008–15
Congo Basin Forest Fund	200	Uncertain

Source: UNFCCC 2008b.

Note: Names in parentheses are countries or institutions that championed the proposal.

BOX 6.5 *Conserving agricultural soil carbon*

The mitigation potential in the agricultural sector could be significant, estimated to be around 6 gigatons of carbon dioxide equivalent (CO_2e) a year by 2030, with soil carbon sequestration being the main mechanism. Many mitigation opportunities (including cropland management, grazing land management, management of organic soils, restoration of degraded land, and livestock management) use current technologies and can be implemented immediately. In addition, these options are also cost competitive: assuming a price of less than $20 a ton of CO_2e, the global economic mitigation potential in the agricultural sector is close to 2 gigatons of CO_2e a year by 2030.

Extending the scope of carbon markets to include agricultural soil carbon would allow carbon finance to play more of a role in sound land management practices. Agricultural carbon sequestration can help increase agricultural productivity and enhance farmers' capacity to adapt to climate change. Increased soil carbon improves soil structure, with corresponding reduction in soil erosion and nutrient depletion. Soils with increased carbon stocks retain water better, thereby improving the resilience of agricultural systems to drought. These positive biophysical impacts of soil carbon sequestration lead directly to increased crop, forage, and plantation yields and land productivity. However, issues of monitoring and verification of the increased storage and the permanence of the carbon sequestration need to be resolved.

Source: IPCC 2007.

only afforestation and reforestation were allowed within the CDM, but the European Union Emission Trading Scheme excludes them.

Initial attention to REDD was focused on countries where deforestation is occurring (table 6.7). But some heavily forested countries have little deforestation, and they seek support to manage and conserve their forests sustainably, especially if REDD activities in other countries shift logging and agricultural expansion across national borders (leakage). Other countries already have policies and measures to bring their forests under sustainable management, and they seek recognition of their efforts in reducing emissions through market-based solutions akin to payments for environmental services. As discussed in chapter 3, conserving soil carbon (box 6.5) through performance-based mechanisms is also gaining traction, but discussions are at a less advanced stage than for REDD.

REDD touches on many groups and other societal goals, often with a mix of potential positive and negative effects. It could provide a new source of income to indigenous peoples, but they are rightly concerned that REDD mechanisms may be used to threaten their rights of access and their use of traditional lands. REDD may provide resources to bring areas of high biodiversity value under better protection, but it could also displace logging and land clearing across international borders to high biodiversity areas (another example of leakage).

It is generally recognized that before forest countries can receive financial incentives for REDD, they need to establish building blocks in the policy, legal, institutional, and technical areas—referred to as REDD-readiness. The key components of REDD-readiness ought to be carried out at the national level (not at the project level) to respond to the systemic causes of deforestation and forest degradation and to contain leakage.

The Forest Carbon Partnership Facility (FCPF) has been designed to help forest countries in tropical and subtropical regions prepare for REDD and pilot performance-based incentives. In the FCPF, REDD-readiness consists of a national REDD strategy and implementation framework; a national reference scenario for emissions from deforestation and forest degradation; and a national monitoring, reporting, and verification system. The UN-REDD, a joint initiative of the Food and Agriculture Organization, the United Nations Development Programme, and the United Nations Environment Programme, is a similar program.

In its national REDD strategy a country would assess its land use and forest policy to date, identifying the drivers of deforestation and forest degradation. Next, it would conceive strategic options to address these drivers and would assess these options from the point of view of cost-effectiveness, fairness, and sustainability. This would be followed by an assessment of the legal and institutional arrangements needed to implement the REDD strategy, including the body (or bodies) responsible for coordinating REDD at the national level, promoting REDD, and raising funds; benefit-sharing mechanisms for the financial flows expected from REDD; and a national carbon registry to manage REDD activities (both the emission reductions generated and the corresponding revenue flows). In addition, the country

would evaluate the investment and capacity building needed to implement the strategy and would assess the environmental and social impacts of the various strategy and implementation options (the benefits, risks, and risk-mitigation measures).

REDD-ready countries need to develop a national reference scenario. The scenario should include a retrospective part, calculating a recent historical average of emissions, and could also include a forward-looking component, forecasting future emissions based on economic growth trends and national development plans.

A national monitoring, reporting, and verification (MRV) system is central to a system of performance-based payments. The MRV system could include the payments' impacts on biodiversity and livelihoods as well as on carbon levels. The roles of remote-sensing technology and ground-based measurements must be defined as part of the MRV system. Experience from community-based natural resource management initiatives has shown that involvement of local people, including indigenous peoples, in participatory monitoring of natural resources can also provide accurate, cost-effective, and locally anchored information on forest biomass and natural resource trends.[30] Natural resource stocks, benefit sharing, and wider social and ecological effects of REDD schemes can be monitored by local communities. Participatory approaches have the potential to greatly improve the governance and management of REDD schemes.

Before large-scale, performance-based payments for REDD can begin, most forest countries will need to adopt policy reforms and undertake investment programs. Investments may be needed to build institutional capacity, improve forest governance and information, scale up conservation and sustainable management of forests, and relieve pressure on forests through, say, relocating agribusiness activities away from forests or improving agricultural productivity. To assist countries in these activities several initiatives have been launched or are under design (see table 6.7). In addition the World Bank has proposed a forest investment program under the Climate Investment Funds, and the Prince's Rainforest Project and the Coalition for Rainforest Nations have recently proposed that financial institutions issue bonds to raise significant resources to help forest countries finance forest conservation and development programs. This example illustrates how a mix of instruments is required to steer a transformation of behaviors and investment decisions: a combination of upfront finance (concessional and innovative finance) and performance-based incentives are needed to promote policy reforms, build capacity, and undertake investment programs. The example also highlights the crucial role of public finance as a catalyst for climate action.

Leveraging private finance for adaptation

Compared with mitigation, where the emphasis has been on private finance from carbon markets, adaptation finance has a strong focus on official flows. This is not surprising, given that adaptation is closely linked to good development and that many adaptation measures are public goods—for example, the protection of coastal zones (a local public good) and the provision of timely climate information (a national public good).

Despite the emphasis on public finance, much of the adaptation burden will fall on individuals and firms. Insurance against climate hazards, for example, is provided primarily by the private sector. Similarly, the task of climate-proofing the world's capital stock—private dwellings, factory buildings, and machinery—will fall predominantly on private owners, although the state will have to provide flood protection and disaster relief. Private companies also own or operate some of the public infrastructure that will have to be adapted to a warmer world—seaports, electric power plants, and water and sewage systems.

For governments the challenge of involving the private sector in adaptation finance is threefold: getting private players to adapt; sharing the cost of adapting public infrastructure; and leveraging private finance to fund dedicated adaptation investments.

Getting private players to adapt effectively. Most consumption and business decisions

are affected, directly or indirectly, by climate factors—from the clothes people wear to the planting decisions farmers make to the way buildings are designed. People are used to making these implicit adaptation decisions. The main role for governments will be to provide an economic environment that facilitates these decisions. This can take the form of economic incentives (tax breaks for adaptation investments, property taxes differentiated by risk, differentiated insurance premiums), regulation (zone planning, building codes) or simply education and better information (long-term weather forecasts, agricultural extension services).

These measures will entail an economic cost, such as meeting stricter building regulation, using different seed varieties, or paying higher insurance premiums. That cost will be borne by the economy and spread across sectors as producers pass on higher costs to their clients and as insurance schemes help to pool risks. There will be little need to draw on dedicated adaptation funding, except perhaps to meet the government's administrative costs or to protect vulnerable groups from the adverse effects of a policy.

Sharing the costs of adapting public infrastructure. A large part of the public adaptation bill involves climate-proofing a country's transport infrastructure, electric power networks, water systems, and communication networks. Whether these services are provided by public, private, or commercialized public entities, the bill will need to be funded either by taxpayers (domestic, or foreign if adaptation assistance is provided) or by users (through higher tariffs).

For infrastructure service providers climate change (and climate policy) will become another risk factor to take into account alongside other regulatory, commercial, and macroeconomic risks.[31] It would therefore be wise to build responsibility for adaptation into the regulatory regime as early and predictably as possible. The greater physical uncertainty also requires building more flexibility into the regulatory system because ex ante regulation is ill suited to situations with unpredictable changes. New and innovative approaches to regulation offer promising alternatives. A good example is the model adopted by the U.K. energy regulator, which can act as an auditor and leave investment decisions to the key actors in the government and the private sector.[32]

Leveraging private finance to fund dedicated adaptation investments. For several reasons the scope for private participation in dedicated adaptation infrastructure is probably limited. Given that dedicated adaptation investments typically do not create commercial revenues for private operators, they must be remunerated from the public purse. This creates a debt-like liability for the government that needs to be recorded in the public accounts. Nor does the efficiency argument look compelling.[33] Adaptation structures such as flood defenses are fairly cheap and simple to operate and so offer little scope for operational efficiency gains by a private manager. There may be more scope for efficiency gains in the construction and design phase, but these can be captured equally well through appropriate procurement mechanisms.

More generally private flows have amounted to a small share of the overall infrastructure funding needs of developing countries and are likely to remain modest for the duration of the current financial crisis.[34] For this and the reasons discussed above, infrastructure experts have warned not to expect too much from public-private partnerships in raising climate-change finance.[35]

Ensuring the transparent, efficient, and equitable use of funds

However successful the attempts at raising additional funds may be, climate finance will be scarce, so funds have to be used effectively and allocated transparently and equitably.

On the mitigation side, fund allocation will be dominated by efficiency considerations. Mitigation is a global public good, and its benefits are the same wherever abatement takes place (although the allocation of mitigation costs raises equity issues). With the right framework in place—essentially a carbon market that allows the exploration of abatement opportunities on a global scale while protecting

host-country interests—a combination of carbon markets, other performance-based systems, and public funds aimed at niches overlooked by the market can allocate capital fairly effectively.

The allocation of adaptation finance, by contrast, raises important questions of fairness as well as efficiency. Unlike that for mitigation the allocation of adaptation resources has strong distributional implications. Money spent protecting small island states is no longer available for African farmers. The question of how to classify adaptation finance is still debated, and the controversy spills over to how to allocate this finance. Developing countries are inclined to view adaptation finance as compensation for damages, invoking a global polluter-pays principle. From the developing-country viewpoint, therefore, the question of how adaptation finance is used is beyond the purview of high-income countries. But the latter countries feel strongly that scarce financial resources should be used efficiently, whatever the justification for or provenance of the funds.

It can certainly be argued that the efficient and equitable allocation and use of adaptation finance are in everybody's interest. Wasteful use of resources can undermine public support for the whole climate agenda. That makes the transparent, efficient, and equitable allocation of adaptation funding paramount. As an example of how development institutions have handled the allocation of finance, consider the approach taken by the International Development Association (IDA), which constructs an index combining the need for finance, the absorptive capacity of the government, and the performance of the central government (box 6.6). The IDA approach is not without its faults. Because the formula is uniform across countries, it essentially imposes the same development model on all countries.[36] This is already problematic for standard development issues and may be even more so for climate change, where much less is known about the right adaptation model. Even so, an empirical approach to allocating adaptation finance that aims to address these concerns could serve at least three purposes: it could reduce transaction costs if lobbying and negotiation are not part of the allocation process; it could support the results agenda with an allocation process based on empirical measures; and it could support mutual accountability through transparency in allocations.

The measure of need for finance should be closely related to the concept of climate vulnerability. As conceived by the IPCC, vulnerability is a function of the capacity to adapt, the sensitivity to climate factors, and the exposure to climate change.[37] The measure of need for finance could thus be some population-weighted index of sensitivity and exposure, perhaps with a poverty weight as well. For large countries in particular, the distribution of impacts and differences in vulnerability between localities would also have to be taken into account.

BOX 6.6 *Allocating concessional development finance*

The International Development Association (IDA) allocation formula offers a possible model for allocating concessional finance in a transparent and empirically driven way. This evolving model of resource allocation, with 10 years of progressive refinement, has allocated roughly $10 billion of concessional finance a year to the world's poorest countries.

The IDA allocation formula breaks down into three basic indexes, one of *need* for concessional finance, one of *absorptive capacity,* and one of *performance of the central government*. On need, the basic criterion is the average poverty level in each country, weighted to favor the poorest countries, times the number of people in the country. Absorptive capacity is measured by World Bank portfolio performance—delays in disbursement and cancellations of loans or credits are clear indicators of poor ability to absorb additional finance. Based on results from the aid-effectiveness literature, the formula is weighted toward countries with the strongest governance because the evidence suggests that these countries most successfully translate aid resources into economic growth. Performance of central government in turn has two subindexes: *quality of macroeconomic, structural, and social policies and institutions* and *quality of governance*, derived from the World Bank Country Policy and Institutional Assessment.

The formula gives weights of 68 percent to governance; 24 percent to macroeconomic, social, and structural policies; and 8 percent to absorptive capacity. The composite of these scores is then multiplied by the number of people in the country, weighted by the average income of the population (to capture need) to derive the final score that drives the allocation of concessional finance.

Because this formula could penalize some of the neediest countries, a portion of the annual supply of finance is allocated off the top: each country receives a minimum allocation; countries coming out of conflict and with extremely fragile institutions are given additional assistance; and allowance is made for natural disasters. In addition IDA finance is capped for "blend" countries, which have access to commercial finance.

Sources: IDA 2007; Burnside and Dollar 2000.

Central government performance and absorptive capacity for flows of finance clearly determine a country's capacity to adapt, but they are not the only critical performance factors in climate adaptation. What might be called "social capacity" would appear important in determining the severity of local climatic impacts, including such factors as inequality (Gini coefficient), depth of financial markets, dependency ratio, adult literacy rate, and female education.

In sum, an allocation index for adaptation finance could consist of the following factors:

Allocation index =
- Central government performance
- × Absorptive capacity
- × Lack of social capacity
- × Climate sensitivity
- × Climate change exposure
- × Population weight
- × Poverty weight

Actually constructing such an index presents several challenges. Information about the vulnerability of developing countries is still sketchy. Difficulties emerge from the complicated, and often undefined, pathways that translate potential impacts, themselves uncertain, into vulnerability. Compounding the uncertainty in linking environmental to socioeconomic impacts is the further uncertainty inherent in future climate scenarios. Models rely on a limited number of defined socioeconomic predictions, and each model has a range of potential changes. So most studies relating to future climatic scenarios focus on expected impacts within sectors or relate to specific outcomes, such as changes in health and losses because of sea-level rise. Few studies have attempted to translate these outputs into an assessment of vulnerability on the ground.[38]

As with IDA allocations, there is a risk that a climate adaptation allocation index will penalize poor countries with high climate sensitivity and exposure but very weak institutions. If an allocation formula is pursued, allowances for extremely fragile countries should be part of the overall allocation framework.

Some tentative first steps toward constructing a vulnerability index are shown in box 6.7, which plots a composite index of projected physical impacts against a composite index of social capacity. The results of this stylized exercise are indicative only, but they suggest that the countries with the highest vulnerability are predominantly in Sub-Saharan Africa.[39] Box 6.8 scatters the same projected impact index against a measure of country performance (combined central government capacity and ability to absorb finance) derived from the IDA allocation formula. Again Sub-Saharan Africa exhibits the combination of projected high impacts and low capacity to adapt.

Matching financing needs and sources of funds

Combating climate change is a massive socioeconomic, technological, institutional, and policy challenge. Particularly for developing countries it is also a financing challenge. By about 2030 the incremental investment needs for mitigation in developing countries could be $140 to $175 billion (with associated financing requirements of $265 to $565 billion) a year. The financing needs for adaptation by that time could be $30 to $100 billion a year. This is additional funding beyond baseline development finance needs, which also remain essential and will help in part to close existing adaptation gaps.

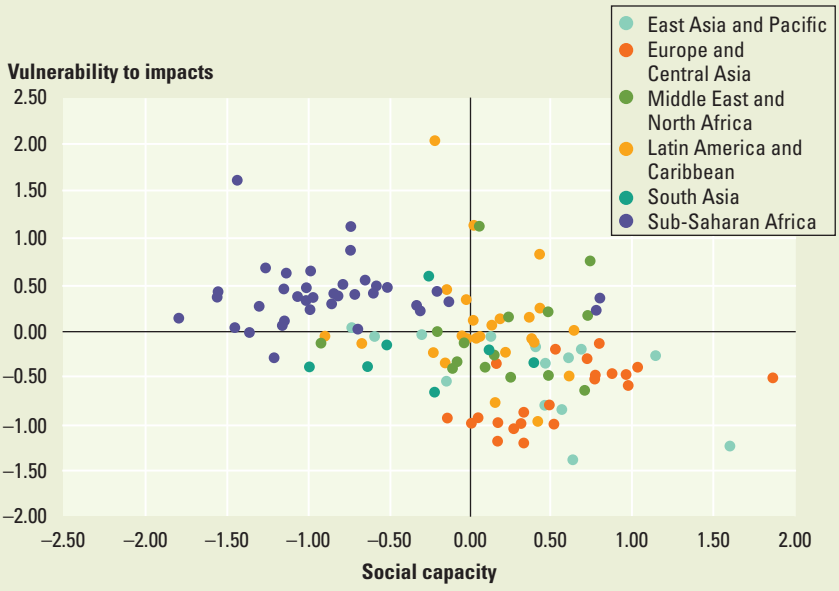
Though growing, current climate-related financial flows to developing countries cover only a tiny fraction of the estimated needs. No single source will provide that much additional revenue, and so a combination of funding sources will be required. For adaptation funding might come from the current adaptation levy on the CDM, which could raise around $2 billion a year by 2020 if extended to a wider set of carbon transactions. Proposals like the sale of AAUs, a levy on international transport emissions, and a global carbon tax could each raise around $15 billion a year.

For mitigation at the national level the majority of funding will have to come from the private sector. But public policy will need to create a business environment conducive to low-carbon investment, including but not limited to an expanded,

BOX 6.7 *Climate vulnerability versus social capacity*

The figure plots a composite index of physical impact (taken as a function of climate sensitivity and climate-change exposure and derived from a number of global impact studies) against a composite index of social capacity (derived from a number of socioeconomic indicators).

Social capacity and vulnerability, as measured by projected impacts, are composite indexes of the indicators described in the table below.



	Indicator	Metric	Source	Assumptions
Impact	Sea-level rise	Percent population affected by 1 meter rise	Dasgupta and others 2007	Landlocked countries assumed to experience zero impact
	Agriculture	Percent yield loss in 2050, IPCC SRES scenario A2b	Parry and others 2004	Decreasing yields represent decreasing welfare for country. Increased yields from climate change represent increasing welfare. Farm-level adaptation present
	Health	Percent additional deaths in 2050	Bosello, Roson, and Tol 2006	Additional deaths representative of all health impacts from climate change
	Disaster	Percent population killed by disasters (historical data set)	CRED 2008	Current disaster patterns to represent future areas at risk
Social capacity	Literacy	Percent population, aged >15 years, literate (1991–2005)	World Bank 2007c	The higher the literacy rate, the higher the social capacity
	Age dependency ratio	Ratio of dependent population to working population (2006)	World Bank 2007c	The lower the age dependency ratio, the higher the social capacity
	Primary completion rate (female)	Percent female population completing primary education (1991–2006)	World Bank 2007c	The higher the completion rate, the higher the social capacity
	Gini	Gini coefficient (latest available year)	World Bank 2007c	The lower the inequality, the higher the social capacity
	Domestic credit to private sector	Domestic credit to private sector, as percent of GDP (1998–2006)	World Bank 2007c	The greater the investment, the higher the social capacity
	Governance	WGI (World Governance Indicator) voice and accountability	Kaufman, Kraay, and Mastruzzi 2008	The higher the WGI score, the higher the social capacity

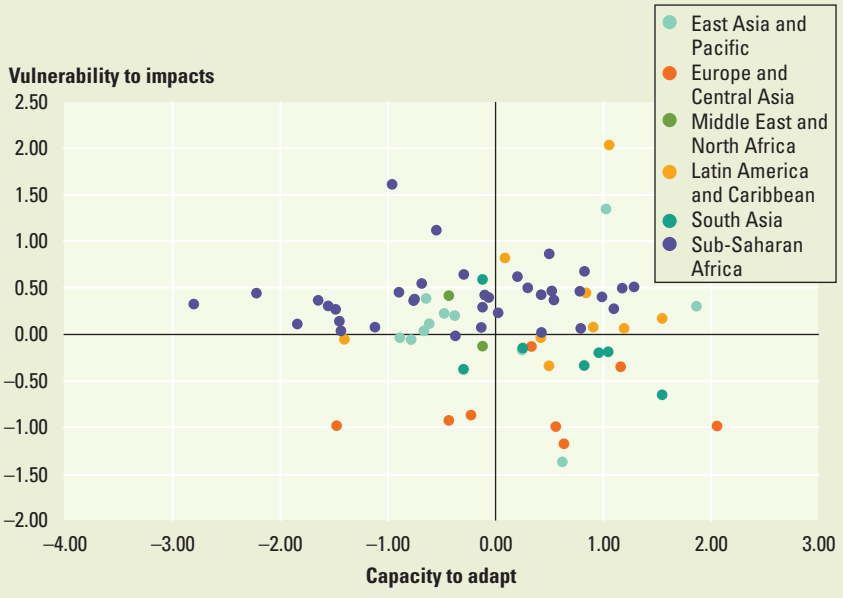
BOX 6.8 *Climate vulnerability versus capacity to adapt*

The figure plots the impact index against a measure of country performance (combined central government capacity and ability to absorb finance) derived from the International Development Association allocation formula.

Capacity to adapt is a composite index of the indicators described in the table below, and it is calculated by the formula:

Country performance = 0.24*average (*CPIAa, CPIAb and CPIAc*) + 0.68**CPIAd* + 0.08**ARPP*,

where CPIA = Country Policy and Institutional Assessment and ARPP = Annual Report on Portfolio Performance.



	Indicator	Metric (year)	Source	Assumptions
Capacity to adapt	Economic management	CPIAa (2007)	World Bank	The higher the country performance, the higher the capacity to adapt
	Structural policies	CPIAb (2007)	World Bank	
	Policies for social inclusion and equity	CPIAc (2007)	World Bank	
	Public sector management and institutions (governance)	CPIAd (2007)	World Bank	
	Capacity to absorb finance	ARPP (2007) World Bank portfolio at risk (age-discounted)	World Bank	

Sources: CPIA figures http://go.worldbank.org/S2THWI1X60. For details on the calculation of CPIA scores, see World Bank 2007b. ARPP scores are reported in World Bank 2007a.

efficient, and well-regulated carbon market. Complementary public funding—most likely from fiscal transfers—may be required to overcome investment barriers (such as those related to risk) and to reach areas the private sector is likely to neglect. Stringent emission targets will also be required—initially in high-income countries, eventually for many others—to create enough demand for offsets and to support the carbon price.

Once the majority of countries have emission caps under an international climate agreement, markets can autonomously generate much of the needed national mitigation finance as consumption and production decisions respond to carbon prices, whether through taxes or cap-and-trade. But national carbon markets will not automatically generate international flows of finance. Flows of mitigation finance to developing countries can come from fiscal flows, from linking national emission trading schemes, or potentially from trading AAUs. Flows from developed to developing countries can thus be achieved in several ways. But these flows

are central to ensuring that an effective and efficient solution to the climate problem is also an equitable solution.

Notes

1. See the overview chapter for details.
2. Barker and others 2007.
3. UNFCCC 2008a.
4. Agrawala and Fankhauser (2008) review the adaptation cost literature; Klein and Persson (2008) discuss the link between adaptation and development. Parry and others (2009) critique the UNFCCC adaptation cost estimate, suggesting that the true costs could be 2–3 times higher.
5. Besides carbon markets, tradable green and white certificates schemes (targeting respectively the expansion of renewable energy sources or the improvement of energy efficiency through demand-side management measures) are other examples of market-based mechanisms with potential mitigation benefits. Other instruments include financial incentives (taxes or subsidies, price support, tax benefits on investment, or subsidized loans) and other policy and measures (norms, labels).
6. The financial benefit to host countries is lower than the overall size of the CDM market for two reasons. First a vast majority of CDM transactions on the primary market are forward purchase agreements with payment on delivery of emission reductions. Depending on project performance, the amount and schedule of carbon delivery may prove quite different. Project developers tend to sell forward credits at a discount that reflects these delivery risks. Second CDM credits are bought and sold several times on a secondary market until they reach the end user. The financial intermediaries active on the secondary market that take on the delivery risk are compensated with a higher sell-on price if the risk does not materialize. These trades do not directly give rise to emission reductions, unlike transactions in the primary market. The secondary CDM market continued to grow in 2008 with transactions in excess of $26 billion (a fivefold increase over 2007). In contrast the primary CDM market declined in value for the first time, to $ 7.2 billion (down 12 percent from 2007 levels), under the weight of the economic downturn and amid lingering uncertainty about market continuity after 2012. See Capoor and Ambrosi 2009.
7. OECD/DAC, Rio Marker for climate change, http://www.oecd.org/document/11/0,3343,en_2649_34469_11396811_1_1_1_1,00.html (accessed May 2009).
8. UNEP 2009. Estimates of clean energy investments that benefit from CDM tend to be higher than actual sustainable energy investment in developing countries because many CDM projects are at an early stage (not operational or commissioned or at financial closure) when certified emission reductions are transacted.
9. See Decision 1/CP.13 reached at the 13th Conference of the Parties of the UNFCCC in Bali, December 2007, http://unfccc.int/resource/docs/2007/cop13/eng/06a01.pdf#page=3 (accessed July 3, 2009).
10. Michaelowa and Pallav (2007) and Schneider (2007), for example, claim that a number of projects would have happened anyway. In contrast, business organizations complain about an excessively stringent additionality test (IETA 2008; UNFCCC 2007).
11. Olsen 2007; Sutter and Parreno 2007; Olsen and Fenhann 2008; Nussbaumer 2009.
12. Cosbey and others 2005; Brown and others 2004; Michaelowa and Umamaheswaran 2006.
13. Streck and Chagas 2007; Meijer 2007; Streck and Lin 2008.
14. IETA 2005; Stehr 2008.
15. IETA 2008.
16. Michaelowa and Pallav 2007; IETA 2008.
17. Barker and others 2007.
18. Sperling and Salon 2002.
19. Figueres and Newcombe 2007.
20. Eliasch 2008.

"The ice is melting because of rising temperature. The boy sits upset. A bird has fallen—another victim of polluted air. Flowers grow near the trash can. They die before the boy could take them to the bird. To reverse these phenomena my appeal to world leaders is keep nature clean, use solar and wind energies, and improve technologies."

—Shant Hakobyan, Armenia, age 12

21. Figueres, Haites, and Hoyt 2005; Wara 2007; Wara and Victor 2008.

22. Sterk 2008.

23. See Fankhauser, Martin, and Prichard, forthcoming.

24. See Müller 2008 for a discussion.

25. Barbier 2009; Bowen and others 2009.

26. Robins, Clover, and Magness 2009, as discussed in chapter 1.

27. These include models under which emission reductions would be rewarded in relation to particular sectors or that are built on various forms of targets, such as intensity or absolute or relative emission reduction. Crediting achievements could take place on the national level only or involve project activities. Crediting could be based on an initial allocation of allowances (cap-and-trade) or ex post (baseline-and-credit). And it could be linked or separated from existing carbon markets. Mechanisms that build on emissions trading can be directly or indirectly linked to other carbon markets and can create credits that are fully, partly, or not fungible with existing carbon markets.

28. If achieved, the total reductions of the various proposals of high-income countries would reduce emissions in aggregate only 10–15 percent below 1990 emissions levels by 2020. This is far short of the 25–40 percent reductions below 1990 levels that have been called for by the IPCC in the 2020 time frame; see Howes 2009.

29. WRI 2008; Houghton 2009.

30. Danielsen and others 2009.

31. Vagliasindi 2008.

32. Pollitt 2008.

33. Agrawala and Fankhauser 2008.

34. Investment commitments through public-private partnerships have amounted to 0.3–0.4 percent of developing countries' GDP over the 2005–07 period (Private Participation in Infrastructure Database, http://ppi.worldbank.org/). In contrast, infrastructure investment needs are estimated to range from 2 percent to 7 percent of GDP, with fast-growing countries like China and Vietnam investing upward of 7 percent of GDP a year. Estache and Fay 2007.

35. Estache 2008.

36. Kanbur 2005.

37. Füssel 2007.

38. Impact and vulnerability studies include, for instance, Bättig, Wild, and Imboden (2007); Deressa, Hassan, and Ringler (2008); Diffenbaugh and others (2007); and Giorgi (2006). Other studies have focused on sectoral losses or case study/country specific vulnerability: see Dasgupta and others (2007) on coastal zones; Parry and others (1999) and Parry and others (2004) on changes in global agricultural yields; Arnell (2004) and Alcamo and Henrichs (2002) for water availability changes; Tol, Ebi, and Yohe (2006) and Bosello, Roson, and Tol (2006) for health.

39. In boxes 6.7 and 6.8, composite indexes are calculated by transforming individual indicators to *z*-scores then taking an unweighted average of the resulting scores.

References

Agrawala, S., and S. Fankhauser. 2008. *Economic Aspects of Adaptation to Climate Change: Costs, Benefits and Policy Instruments*. Paris: Organisation for Economic Co-operation and Development.

Alcamo, J., and T. Henrichs. 2002. "Critical Regions: A Model-based Estimation of World Water Resources Sensitive to Global Changes." *Aquatic Sciences* 64 (4): 352–62.

Aldy, J. E., E. Ley, and I. Parry. 2008. *A Tax-Based Approach to Slowing Global Climate Change*. Washington, DC: Resources for the Future.

Arnell, N. W. 2004. "Climate Change and Global Water Resources: SRES Emissions and Socio-Economic Scenarios." *Global Environmental Change* 14 (1): 31–52.

Bättig, M. B., M. Wild, and D. M. Imboden. 2007. "A Climate Change Index: Where Climate Change May Be Prominent in the 21st Century." *Geophysical Research Letters* 34 (1): 1–4.

Barbier, E. B. 2009. *A Global Green New Deal*. Geneva: United Nations Environment Programme.

Barker, T., I. Bashmakov, L. Bernstein, J. E. Bogner, P. R. Bosch, R. Dave, O. R. Davidson, B. S. Fisher, S. Gupta, K. Halsnaes, B. Heij, S. Khan Ribeiro, S. Kobayashi, M. D. Levine, D. L. Martino, O. Masera, B. Metz, L. A. Meyer, G.-J. Nabuurs, A. Najam, N. Nakićenović, H.-H. Rogner, J. Roy, J. Sathaye, R. Schock, P. Shukla, R. E. H. Sims, P. Smith, D. A. Tirpak, D. Urge-Vorsatz, and D. Zhou. 2007. "Technical Summary." In *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* ed. B. Metz, O. R. Davidson, P. R. Bosch, R. Dave, and L. A. Meyer. Cambridge, UK: Cambridge University Press.

Bosello, F., R. Roson, and R. S. J. Tol. 2006. "Economy-Wide Estimates of the Implications of Climate Change: Human Health." *Ecological Economics* 58 (3): 579–91.

Bovenberg, A. L., and L. Goulder. 1996. "Optimal Environmental Taxation in the Presence of Other Taxes: General Equilibrium Analyses." *American Economic Review* 86 (4): 985–1000.

Bowen, A., S. Fankhauser, N. Stern, and D. Zenghelis. 2009. *An Outline of the Case for a "Green" Stimulus*. London: Grantham Research Institute on Climate Change and the Environment and the Centre for Climate Change Economics and Policy.

Brown, K., W. N. Adger, E. Boyd, E. Corbera-Elizalde, and S. Shackley. 2004. "How Do CDM Projects Contribute to Sustainable Development?" Tyndall Centre for Climate Change Research Technical Report 16, Norwich, UK.

Burnside, C., and D. Dollar. 2000. "Aid, Policies and Growth." *American Economic Review* 90 (4): 847–68.

Capoor, K., and P. Ambrosi. 2009. *State and Trends of the Carbon Market 2009*. Washington, DC: World Bank.

Cosbey, A., J. Parry, J. Browne, Y. D. Babu, P. Bhandari, J. Drexhage, and D. Murphy. 2005. *Realizing the Development Dividend: Making the CDM Work for Developing Countries*. Winnipeg: International Institute for Sustainable Development.

CRED (Centre for Research on the Epidemiology of Disasters). 2008. "EM-DAT: The International Emergency Disasters Database." Université Catholique de Louvain, Ecole de Santé Publique, Louvain.

Danielsen, F., N. D. Burgess, A. Balmford, P. F. Donald, M. Funder, J. P. Jones, P. Alviola, D. S. Balete, T. Blomley, J. Brashares, B. Child, M. Enghoff, J. Fieldsa, S. Holt, H. Hubertz, A. E. Jensen, P. M. Jensen, J. Massao, M. M. Mendoza, Y. Nqaqa, M. K. Poulsen, R. Rueda, M. Sam, T. Skielboe, G. Stuart-Hill, E. Topp-Jorgensen, and D. Yonten. 2009. "Local Participation in Natural Resource Monitoring: a Characterization of Approaches." *Conservation Biology* 23 (1): 31–42.

Dasgupta, S., B. Laplante, C. Meisner, D. Wheeler, and J. Yan. 2007. "The Impact of Sea Level Rise on Developing Countries: A Comparative Analysis." Policy Research Working Paper 4136, World Bank, Washington, DC.

Dechezleprêtre, A., M. Glachant, I. Hascic, N. Johnstone, and Y. Meniérè. 2008. *Invention and Transfer of Climate Change Mitigation Technologies on a Global Scale: A Study Drawing on Patent Data*. Paris: CERNA.

Deressa, T., R. M. Hassan, and C. Ringler. 2008. "Measuring Ethiopian Farmers' Vulnerability to Climate Change Across Regional States." Discussion Paper 00806, International Food Policy Research Institute, Washington, DC.

Diffenbaugh, N. S., F. Giorgi, L. Raymond, and X. Bi. 2007. "Indicators of 21st Century Socio-climatic Exposure." *Proceedings of the National Academy of Sciences* 104 (51): 20195–98.

Edmonds, J., L. Clarke, J. Lurz, and M. Wise. 2008. "Stabilizing CO_2 Concentrations with Incomplete International Cooperation." *Climate Policy* 8 (4): 355–76.

Eliasch, J. 2008. *Climate Change: Financing Global Forests: The Eliasch Review*. London: Earthscan.

Estache, A. 2008. *Public-Private Partnerships for Climate Change Investments: Learning from the Infrastructure PPP Experience*. Brussels: European Center for Advanced Research in Economics and Statistics.

Estache, A., and M. Fay. 2007. "Current Debates on Infrastructure Policy." Policy Research Working Paper 4410, World Bank, Washington, DC.

Fankhauser, S., N. Martin, and S. Prichard. Forthcoming. "The Economics of the CDM Levy: Revenue Potential, Tax Incidence, and Distortionary Effects." Working paper, London School of Economics.

Figueres, C., E. Haites, and E. Hoyt. 2005. *Programmatic CDM Project Activities: Eligibility, Methodological Requirements and Implementation*. Washington, DC: World Bank Carbon Finance Business Unit.

Figueres, C., and K. Newcombe. 2007. "Evolution of the CDM: Toward 2012 and Beyond." Climate Change Capital, London, UK.

Füssel, H. M. 2007. "Vulnerability: A Generally Applicable Conceptual Framework for Climate Change Research." *Global Environmental Change* 17 (2): 155–67.

Giorgi, F. 2006. "Climate Change Hot-Spots." *Geophysical Research Letters* 33(8):L08707–doi:10.1029/2006GL025734.

Haites, E., D. Maosheng, and S. Seres. 2006. "Technology Transfer by CDM Projects." *Climate Policy* 6: 327–44.

Houghton, R. A. 2009. "Emissions of Carbon from Land Management." Background note for the WDR 2010.

Howes, S. 2009. *Finding a Way Forward: Three Critical Issues for a Post-Kyoto Global Agreement on Climate Change*. Canberra: Crawford School of Economics and Government, Australian National University.

IDA (International Development Association). 2007. *IDA's Performance Based Allocation System: Simplification of the Formula and Other Outstanding Issues*. Washington, DC.

IEA (International Energy Agency). 2008. *Energy Technology Perspective 2008: Scenarios and Strategies to 2050*. Paris: IEA.

IETA (International Emissions Trading Association). 2005. *Strengthening the CDM: Position Paper for COP 11 and COP/MoP 1*. Geneva: IETA.

———. 2008. *State of the CDM 2008: Facilitating a Smooth Transition into a Mature Environmental Financing Mechanism*. Geneva: IETA.

IIASA (International Institute for Applied Systems Analysis). 2009. "GGI Scenario Database." Laxenburg, Austria.

IPCC (Intergovernmental Panel on Climate Change). 2007. *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press.

Kanbur, R. 2005. "Reforming the Formula: A Modest Proposal for Introducing Development Outcomes in IDA Allocation Procedures." Centre for Economic Policy Research Discussion Paper 4971, London.

Kaufman, D., A. Kraay, and M. Mastruzzi. 2008. *World Governance Indicators 2008*. Washington, DC: World Bank.

Klein, R. J. T., and A. Persson. 2008. "Financing Adaptation to Climate Change: Issues and Priorities." European Climate Platform Report 8, Centre for European Policy Studies, Brussels.

Knopf, B., O. Edenhofer, T. Barker, N. Bauer, L. Baumstark, B. Chateau, P. Criqui, A. Held, M. Isaac, M. Jakob, E. Jochem, A. Kitous, S. Kypreos, M. Leimbach, B. Magné, S. Mima, W. Schade, S. Scrieciu, H. Turton, and D. van Vuuren. Forthcoming. "The Economics of Low Stabilisation: Implications for Technological Change and Policy." In *Making Climate Change Work for Us*, ed. M. Hulme and H. Neufeldt. Cambridge, UK: Cambridge University Press.

McKinsey & Company. 2009. *Pathways to a Low-carbon Economy: Version 2 of the Global Greenhouse Gas Abatement Cost Curve*. McKinsey & Company.

Meijer, E. 2007. "The International Institutions of the Clean Development Mechanism Brought before National Courts: Limiting Jurisdictional Immunity to Achieve Access to Justice." *NYU Journal of International Law and Politics* 39 (4): 873–928.

Michaelowa, A., and P. Pallav. 2007. *Additionality Determination of Indian CDM Projects. Can Indian CDM Project Developers Outwit the CDM Executive Board?* Zurich: University of Zurich.

Michaelowa, A., and K. Umamaheswaran. 2006. "Additionality and Sustainable Development Issues Regarding CDM Projects in Energy Efficiency Sector." HWWA Discussion Paper 346, Hamburg.

Ministry of Finance (Indonesia). 2008. *Climate Change and Fiscal Policy Issues: 2008 Initiatives*. Jakarta: Working Group on Fiscal Policy for Climate Change.

Müller, B. 2008. "International Adaptation Finance: The Need for an Innovative and Strategic Approach." Economic Working Paper 42, Oxford Institute for Energy Studies, Oxford, UK.

Newell, R. G., and W. A. Pizer. 2000. "Regulating Stock Externalities Under Uncertainty." Working Paper 99-10, Resources for the Future, Washington, DC.

Nussbaumer, P. 2009. "On the Contribution of Labelled Certified Emission Reductions to Sustainable Development: A Multi-criteria Evaluation of CDM Projects." *Energy Policy* 37 (1): 91–101.

Olsen, K. H. 2007. "The Clean Development Mechanism's Contribution to Sustainable Development: A Review of the Literature." *Climatic Change* 84 (1): 59–73.

Olsen, K. H., and J. Fenhann. 2008. "Sustainable Development Benefits of Clean Development Mechanism Projects. A New Methodology for Sustainability Assessment Based on Text Analysis of the Project Design Documents Submitted for Validation." *Energy Policy* 36 (8): 2819–30.

Parry, M., C. Rosenzweig, A. Iglesias, G. Fischer, and M. Livermore. 1999. "Climate Change and World Food Security: A New Assessment." *Global Environmental Change* 9 (S1): S51-S67.

Parry, M., C. Rosenzweig, A. Iglesias, M. Livermore, and G. Fischer. 2004. "Effects of Climate Change on Global Food Production Under SRES Emissions and Socio-Economic Scenarios." *Global Environmental Change* 14 (1): 53–67.

Parry, M., N. Arnell, P. Berry, D. Dodman, S. Fankhauser, C. Hope, S. Kovats, R. Nicholls, D. Satterthwaite, R. Tiffin, and T. Wheeler. 2009. *Assessing the Costs of Adaptation to Climate Change: A Review of the UNFCCC and Other Recent Estimates.* London: International Institute for Environment and Development and Grantham Institute for Climate Change.

Pollitt, M. 2008. "The Arguments For and Against Ownership Unbundling of Energy Transmission Networks." *Energy Policy* 36 (2): 704–13.

Project Catalyst. 2009. *Adaptation to Climate Change: Potential Costs and Choices for a Global Agreement*. London: Climate Works and European Climate Foundation.

Robins, N., R. Clover, and J. Magness. 2009. *The Green Rebound: Clean Energy to Become*

an Important Component of Global Recovery Plans. London: HSBC.

Schaeffer, M., T. Kram, M. Meinshausen, D. P. van Vuuren, and W. L. Hare. 2008. "Near-linear Cost Increase to Reduce Climate Change Risk." *Proceedings of the National Academy of Sciences* 105 (52): 20621–26.

Schneider, L. 2007. *Is the CDM Fulfilling Its Environmental and Sustainable Development Objective? An Evaluation of the CDM and Options for Improvement*. Berlin: Institute for Applied Ecology.

Sperling, D., and D. Salon. 2002. *Transportation in Developing Countries: An Overview of Greenhouse Gas Reduction Strategies*. Arlington, VA: Pew Center on Global Climate Change.

Stehr, H. J. 2008. "Does the CDM Need and Institutional Reform?" In *A Reformed CDM: Including New Mechanisms for Sustainable Development,* ed. K. H. Olsen and J. Fenhann. Roskilde, Denmark: United Nations Environment Programme, Risoe Centre Perspective Series 2008.

Sterk, W. 2008. "From Clean Development Mechanism to Sectoral Crediting Approaches: Way Forward or Wrong Turn?" JIKO Policy Paper 1/2008, Wuppertal Institute for Climate, Environment and Energy, Wuppertal, Germany.

Streck, C., and T. B. Chagas. 2007. "The Future of the CDM in a Post-Kyoto World." *Carbon & Climate Law Review* 1 (1): 53–63.

Streck, C., and J. Lin. 2008. "Making Markets Work: A Review of CDM Performance and the Need for Reform." *European Journal of International Law* 19 (2): 409–42.

Sutter, C., and J. C. Parreno. 2007. "Does the Current Clean Development Mechanism (CDM) Deliver Its Sustainable Development Claim? An Analysis of Officially Registered CDM Projects." *Climatic Change* 84 (1): 75–90.

Tol, R. S. J., K. L. Ebi, and G. W. Yohe. 2006. "Infectious Disease, Development, and Climate Change: A Scenario Analysis." *Environment and Development Economics* 12: 687–706.

UNEP (United Nations Environment Programme). 2008. "UNEP Risoe CDM/JI Pipeline Analysis and Database." Roskilde, Denmark.

———-. 2009. *Global Trends in Sustainable Energy Investment 2009: Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency*. Paris: UNEP and New Energy Finance.

UNFCCC (United Nations Framework Convention on Climate Change). 2007. *Call for Input on Non-Binding Best-Practice Examples on the Demonstration of Additionality to Assist the Development of PDDs, Particularly for SSC Project Activities*. Bonn: UNFCCC.

———-. 2008a. *Investment and Financial Flows to Address Climate Change: An Update*. Bonn: UNFCCC.

———-. 2008b. *Mechanisms to Manage Financial Risk from Direct Impacts of Climate Change*. Bonn: UNFCCC.

Vagliasindi, M. 2008. "Climate Change Uncertainty, Regulation and Private Participation in Infrastructure." Background note for the WDR 2010.

Wara, M. 2007. "Is the Global Carbon Market Working?" *Nature* 445: 595–96.

Wara, M., and D. Victor. 2008. "A Realistic Policy on International Carbon Markets." Working Paper 74, Program on Energy and Sustainable Development, Stanford University, Stanford, CA.

Watson, C., and S. Fankhauser. 2009. "The Clean Development Mechanism: Too Flexible to Produce Sustainable Development Benefits?" Background paper for the WDR 2010.

Weitzman, M. L. 1974. "Prices vs. Quantities." *Review of Economic Studies* 41 (4): 477–491.

World Bank. 2007a. "Annual Report On Portfolio Performance, Fiscal Year 2006." Quality Assurance Group, World Bank, Washington, DC.

———. 2007b. "Country Policy And Institutional Assessments 2007: Assessment Questionnaire." Operations Policy And Country Services, World Bank, Washington, DC.

———. 2007c. *World Development Indicators 2007*. Washington, DC: World Bank.

———. 2009. *The Economics of Adaptation to Climate Change.* Washington, DC: World Bank.

WRI (World Resources Institute). 2008. "Climate Analysis Indicators tool (CAIT)." Washington, DC.