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How Much Sustainable Development Can We Expect From The Clean Development Mechanism?

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Advancing Sustainable Development Goals Through the CDM

The Clean Development Mechanism (CDM) has two goals. It is designed to lower the overall cost of reducing greenhouse gas (GHG) emissions released to the atmosphere, while also supporting sustainable development initiatives within developing countries. These twin objectives reflect the need to coordinate action between differently positioned developed and developing countries, which nevertheless share a common aim of reducing the buildup of GHGs.

The basic principle of the CDM is simple. It allows developed countries to invest in low-cost abatement opportunities in developing countries and receive credit for the resulting emissions reductions. Developed countries can then apply this credit against their 2008–2012 targets, reducing the cutbacks that would have to be made within their borders. Because many abatement opportunities are less expensive in developing countries, this increases the economic efficiency of achieving initial GHG emissions reductions. Because GHG emissions contribute equally to climate change irrespective of where they occur, the impact on the global environment is the same.

While this abatement mechanism is cheaper for developed countries, developing countries benefit too, not just from the increased investment flows, but also from the requirement that investments both offset GHG emissions and advance sustainable development goals. Thus, the CDM allows developing countries to participate at a time when other development priorities limit funding for GHG reduction activities and encourages them to do so by promising that these development priorities are addressed as part of the solution. More generally, the CDM's objective of advancing development initiatives in developing countries recognizes that only through long-term development will all countries be able to play a role in climate protection.

KEY FINDINGS

While many assessments of the Clean Development Mechanism (CDM) have asked how much the mechanism can reduce greenhouse gas emissions, less attention has been given to the question of how far the CDM will advance sustainable development goals.

A new collaborative report (WRI, in press) reviews candidate CDM projects for Brazil, China, and India to see how they might advance both carbon *and* sustainable development objectives, as the Kyoto Protocol requires. The present *Climate Note* summarizes the main findings of the case studies from the report including the following:

- Potential CDM projects in all three countries offer a wide range of sustainable development benefits. These include environmental benefits such as cleaner air and water, reduced deforestation, soil conservation, and biodiversity protection; and social benefits such as rural development, employment, and poverty alleviation.

  In many cases, these benefits overlap markedly with goals that developing countries have formally or informally identified as development priorities. Far from skewing investment priorities in developing countries, the CDM offers an opportunity to make progress simultaneously on climate, development, and local environmental issues.

- Explicit assessment of the noncarbon, or sustainable development, attributes of a project are important if developing countries are to design and prioritize projects so that they are most consistent with their own development goals.

- In some cases, lowest cost carbon-abatement projects are *not* the most preferable from a sustainable development perspective. In these cases, deciding between projects will require some trade-off between the CDM's two objectives.

The full report, including individual case studies for Brazil, China, and India, is also available online at: www.wri.org/wri/cdm.

How Much Sustainable Development?

While there has been much speculation about how much GHG abatement the CDM might deliver, less attention has been given to the question of how far the CDM will advance sustainable development goals. Part of the answer lies in estimating how the CDM will increase investment flows to developing countries. With continued uncertainty regarding the rules of the CDM and countries' likely responses to it, estimating the size of new investment flows is very difficult. *(See Box 1.)*

The other part of the answer lies in assessing how much sustainable development might result from the CDM projects that have been proposed. The Kyoto Protocol embodies something of an unwritten assumption, namely that projects that are good for carbon abatement must also be good for sustainable development in developing countries. On the face of it, this will surely be true for a great many projects, but it is not clear that it must be true nor that a project deemed most preferable from a carbon perspective will be as attractive from a sustainable development perspective.

If the CDM is to achieve its dual objectives, the sustainable development attributes of projects will need to be examined. First, do low-cost carbon abatement projects in fact promise sustainable development gains in developing countries? Moreover, recognizing that sustainable development benefits encompass a wide range of attributes, are the actual benefits that arise consistent with the priorities of the developing country hosting the project? Finally, where the two goals are not mutually consistent, how does one balance the two objectives in designing, selecting, and prioritizing projects?

Without careful assessment of the noncarbon attributes, there is a danger that the CDM will become little more than a cost-reduction tool for developed countries legitimized by incidental secondary benefits that may or may not be consistent with developing country

Box 1 How Large Will The CDM Be?

Not surprisingly, the creation of a new international funding mechanism has led to speculation about its potential magnitude, both in terms of the share of emissions reductions that could be achieved and the accompanying financial flows. Generally speaking, the larger the CDM, the greater the sustainable development benefits to developing countries—and the lower the overall cost to developed countries of meeting their targets. At the same time, a larger CDM implies fewer reductions in developed countries, which may be undesirable politically and may dampen incentives for technological innovation, which is crucial to long-term reduction efforts.

Although the Kyoto Protocol sets up the CDM's framework with implementation due in 2000, important details regarding its precise functioning are still unresolved. For example, it is not clear whether activities involving carbon sequestration in forests or emissions reductions from changes in land-use patterns will count as official GHG reductions despite the fact that land-use change and deforestation releases account for about 22 percent of annual carbon dioxide (CO_2) emissions (IPCC, 1996). Similarly, the procedures by which emissions reduction activities will be measured, verified, and then certified have not been settled even though it is the "certified emissions reduction" (CER) that developed countries will need to count against their own targets. Nor is it clear how funds will be raised to pay for CDM administration and to fund adaptation activities in developing countries, as the Kyoto Protocol requires.

Given these uncertainties, it is difficult to know just how large a mechanism the CDM will turn out to be. A rough idea can be gleaned from economic assessments of the relative costs of offset projects in developed and developing countries (e.g., Edmonds et al., 1998; McKibbin et al., 1998; van der Mensbrugghe, 1998; and Ellerman et al., 1998). These suggest that offset options in developing countries could make up between one third and one half of total reductions during the first budget period, in the absence of any constraint on CDM activity. If so, the value of CER credits to Annex I (developed) countries could be US$5 billion to US$17 billion per year by 2010, or US$25 billion to US$85 billion for the whole budget period (WRI, in press). Of course, with the CDM starting as early as 2000, these figures could conceivably be higher.

The more important question for developing countries is what the CDM will imply for the magnitude and direction of investment flows to developing countries. The CDM will have two distinct effects. First, and most obvious, it should generate more net investment from developed countries. Unfortunately, determining the exact extent of additional investment is impossible without knowing what activities CDM investment will displace. In some cases, CDM investment will represent funds that would otherwise have been used in developed countries and so constitute an unambiguous addition to developing country inflows. In other cases, CDM investment may displace existing FDI flows, implying no change in overall inflows but changing the type of activity that takes place in developing countries.

Irrespective of where flows come from, the CDM's second effect will be to leverage much larger sums of money than the mere value of CERs would indicate toward sustainable development activities. While some offset projects will be solely motivated by the desire to earn CER credits, many other projects will be motivated by other sources of return. For example, investing in a gas-fired generation facility may earn CER credits if it replaces a planned coal-fired power station whose carbon emissions would have been significantly higher.

However, any returns from CER credits are likely to be secondary to the return from electricity sales. In this case, the potential return from CERs justifies the additional expense of a gas-fired plant over the coal-fired plant, but in so doing transforms the total expenditure involved in the project away from a conventional development project toward a more sustainable alternative. Assessing the CDM only in terms of the potential value of the CER stream to developed countries underestimates the impact that the CDM will have on altering the development path in developing countries. In fact, a small amount of financing directed explicitly toward sustainable development may be sufficient to revolutionize the development path.

priorities. Yet, it is questionable whether the CDM would succeed were such a carbon-centric attitude to prevail. For one, projects that do not expressly meet the twin aims of the CDM would fail to qualify for credit under the Kyoto Protocol's definition. More to the point, projects that fail to address both participants' needs are unlikely to get off the ground. It is only as a mutually beneficial instrument that the CDM has any chance of success.

Regardless of how CDM details are resolved in international negotiations, the case studies suggest that Brazil, China, and India could benefit substantially from many viable GHG abatement projects.

Study Overview

To explore the CDM's ability to fund sustainable development in developing countries, we conducted case studies focusing on potential projects in Brazil, China, and India (WRI, in press). Based on their GHG emissions, population size, and prominence in ongoing political discussions, Brazil, China, and India will be pivotal to the success of the CDM. China and India are the two biggest emitters in the developing world. Brazil is a smaller emitter, but takes credit for proposing the CDM and remains important in shaping the mechanism. In addition, with its vast forest reserves, Brazil has a major stake in one of the outstanding questions regarding CDM design—namely whether forest and land-use activities will be eligible to earn reduction credits.

Case studies were authored by in-country experts familiar with development needs and CDM possibilities. Each study was conducted in three phases. First, the case study authors examined the development issues and priorities within their countries, as they have been articulated in formal plans or policies and on the basis of their own insights and experience. Next, they reviewed the literature on potential carbon abatement projects within their own countries and assessed the noncarbon, or sustainable development benefits, that might arise. Finally, authors examined the degree to which these noncarbon benefits aligned with domestic development priorities.

Although each case study follows the same conceptual approach, there are inevitable differences stemming from data availability, adoption of different sustainable development criteria, and different methods of evaluating and comparing projects. This was in addition to different types of abatement projects reflecting each country's own priorities and opportunities.

Regardless of how CDM details are resolved in international negotiations, the case studies suggest that Brazil, China, and India could benefit substantially from many viable GHG abatement projects. Far from skewing development paths, the noncarbon benefits (or "cobenefits") associated with likely CDM projects often overlap markedly with development objectives that countries have themselves identified as important. Such cobenefits include improved air and water quality, enhanced soil preservation, flood protection, electrification of rural and remote areas, and increased employment. Although the study looks at only three countries, the approach and findings are likely to have broad applicability.

Moreover, through careful project selection and prioritization, the level of cobenefits could be deliberately enhanced rather than incidentally generated. If developing countries are to reap the full benefit of CDM flows, they will need to be actively engaged in project selection within their own countries, steering offset activities toward those projects that offer the greatest overlap with sustainable development goals.

Financing Sustainable Development In Brazil, China, and India

Development Pressures and Priorities

Together, Brazil, China, and India presently account for 40 percent of the world's population and 18 percent of industrial carbon dioxide (CO_2) emissions (WRI, 1998). Each is also growing rapidly. By 2010, their economies could be 50 to 100 percent larger than today while their combined populations are projected to increase by more than 250 million people. At the same time, these countries could collectively be emitting an additional 900 million metric tons of CO_2 per year if they follow conventional development paths (van der Mensbrugghe, 1998; DOE, 1998).[1]

Brazil, China, and India have a range of development goals—some common, some unique—reflecting their current stage of development and their particular circumstances. Economic growth is a core objective in all three countries, most overtly in China where an official goal is to double GNP by 2010. Economic aspirations will create strong incentives for the development of commercial energy sources—the bulk of which would come from coal or other fossil fuels if current trends continue. China and India both have abundant supplies of coal, which already constitutes the primary fuel for power generation in these countries (65 to 75 percent), and which will continue to dominate energy supplies in the coming decades (Zha, 1996; TERI, 1998a). Even Brazil, where a large fraction of existing power is provided by hydroelectricity, will increasingly rely on fossil fuels (particularly fuel oil and natural gas) as potential hydroelectric sites become fully utilized.

The reliance on fossil fuels, and coal in particular, will exacerbate regional and local environmental problems. Particulates, smoke fumes, and sulfur dioxide (SO_2) have already created intolerable conditions in many developing country cities. Average levels of particulates in major cities in India and China are more than three times above those recommended by the World Health Organization (WRI, 1998). In addition, SO_2 emissions from coal are responsible for acid rain in southern and eastern China and in neighboring Japan (World Bank, 1997). Thermal power plants are also implicated in water pollution and solid waste issues. In India, fly ash from thermal power plants constitutes a major share of total industrial waste (TERI, 1998a).

The industrial development accompanying economic growth will add to air and water quality problems. Water quality is a growing problem in China particularly for the water-scarce northern regions. Fifty percent of the rivers running through urban areas do not meet minimum water quality standards and more than 80 percent of wastewater is discharged without treatment (SEPA, 1999; EBCEY, 1996).

Conventional development also brings with it other environmental problems. In Brazil, persistent deforestation is regarded as a major environmental issue leading to soil degradation, deterioration in water quality and availability, enhanced risk of natural disasters such as floods and landslides, biodiversity loss, and conflict with traditional forest-dependent communities. China, too, has suffered the consequences of widespread tree loss—the principal cause of the flooding in the Yangtze and Songhua river basins in 1998.

Far from skewing development paths, the noncarbon benefits associated with likely CDM projects often overlap markedly with development objectives that countries have themselves identified as important.

Some immediate development priorities for the three countries can be inferred from a mix of programs, policy positions, and formal plans.[2] Other priorities are clear from an assessment of current environmental and social conditions. While environmental quality is recognized as an integral part of the development process in all three countries, in practice, there is often tension between economic and environmental objectives.

As part of the 2010 Long-Term Goals for Environmental Protection, China has set air quality standards to be met by some cities as soon as 2000. Another priority for China is to curb SO_2 emissions by reducing the use of high-sulfur coal and introducing coal-washing facilities and costly desulfurization processes before 2010. China also has a nationwide afforestation program that aims to increase forest area by 10 million hectares before 2000.

In Brazil, “Brasil em Ação” (Brazil in Action)—one of many development programs—directs investments towards social, regional, and development aims, including improvements to health, sanitation, irrigation, transport links, and energy distribution. In some cases, projects have had to avoid potential environmental problems. A waterway project (the Paraná Waterway) that had been intended to cross 3 million hectares of wetlands in central Brazil was cancelled for ecological reasons.

Country priorities also extend beyond environmental objectives. India’s present Five-Year Plan enumerates goals that include agricultural and rural development, empowerment of women and socially disadvantaged groups, developing participatory institutions, and encouraging self-reliance. Reducing poverty and social disparities are common themes in other countries, too.

However, it would be misleading to suppose that environmental and social objectives always carry the same weight as economic priorities. Polling in Brazil reaffirms that the provision of energy is the most pressing issue, with people—especially at low income levels—prepared to sacrifice environmental quality for economic growth (MMA, 1997).

Table 1 **Selected Abatement Opportunities in Brazil, China, and India**

Conventional power generation
- Combined-cycle gas turbines
- Improved coal technologies

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

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

Use of renewables
- Extending biomass fuel sources
- Wind energy
- Solar thermal and solar photovoltaic applications
- Small-scale hydropower
- Wind pumps for irrigation

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

Source: WRI, in press.

Often environmental rules are relaxed, particularly for political reasons and actual policy decisions often bear testimony to the precedence of economic goals over environmental protection.

The drive for economic growth presents both threats and opportunities for sustainable development. Were development to follow conventional paths, increased access to energy and provision of basic economic services could spell trouble for the environment—both local and global. With the foresight to chart a different course and the technological and financial assistance to realize it, many possible problems could be avoided.

Potential CDM Projects

During the study, more than 40 potential abatement opportunities were reviewed in a variety of sectors within the three case study countries. *(See Table 1 for examples.)* Not surprisingly, the most significant opportunities for all nations were those of transforming power generation in both the utility and industrial sectors. Although the long-term goal of stabilizing GHG concentrations at safe levels will ultimately require substantial dependence on renewable energy sources, the reality is that much of the near-term increase in power generation will be based on fossil fuel use—coal use in particular. Projections for India show that demand for coal will increase by 60 percent by 2007 in the absence of new policies (TERI, 1998b). In China, coal-fired power plants will account for 60 to 70 percent of electric generating capacity even as total capacity triples by 2020 (Li et al., 1997).

Simple options center on improving the efficiency of conventional fuel use essentially by introducing state-of-the-art technology and techniques from developed countries. There is much room for improvement in these areas. Power generation in India and China is presently very inefficient compared to that in developed countries. Possible improvements could be made to both industrial boilers and power generators used to provide commercial electricity.

With an eye to the longer term, CDM flows could also increase the role of alternative fuels and power sources and precipitate greater use of natural gas, which has about half the carbon content of coal per unit of energy delivered (DOE, 1999). Their development will be key to a sustainable future. Unfortunately, investment in alternative energy sources often requires high up-front costs and is frequently hampered by financing difficulties. Capital flows under the CDM directly address this obstacle.

Many alternative energy sources could become, or already are, viable. Recovering methane in coalbeds in China, for example, both limits direct GHG releases and provides fuel for power generation that might otherwise come from coal. This is already occurring, but on a relatively small scale. In all three countries, there is potential for greater reliance on biomass as a commercial fuel source through gasification of wood and pulp residues.

A particularly promising alternative is the use of nonconventional fuel sources in cogeneration roles. In India, bagasse cogeneration allows sugar mills to function as energy providers in their off-season. This is ultimately profitable even without credit for the carbon offset, but would require substantial capital investment including retrofitting existing boilers and installing cogeneration equipment.[3] In practice, capital constraints presently limit bagasse cogeneration investment. Similarly profitable opportunities exist for cogeneration involving the chemical, paper, and metallurgy industries in Brazil.

Renewable options, such as photovoltaics and wind power, are obvious possibilities. However, they tend to be more expensive, reflecting relatively high costs at this early stage of their development. Again, financing provided by the CDM could reduce these obstacles and make renewables more competitive. In India, wind and photovoltaic power could also be harnessed directly to pump water for agricultural uses.

Our analysis also highlights a potentially important role for mitigation options within the forestry sector were they to be allowed under the CDM. This is particularly true for Brazil, where silvicultural plantations and sustainable logging practices could provide low-cost carbon abatement. Moreover, the scale of Brazil's forest reserves that are under threat is reflected in an estimate that up to 1 billion tons of carbon could be abated by enabling reduced-impact logging in the Amazon to displace the current illegal frontier logging.[4]

We also identified opportunities in India and China to reduce CO_2 emissions from heavily polluting sectors (e.g., metallurgy and the manufacture of cement, iron, and steel) by introducing sector-specific modern technologies.

Many other potential projects exist beyond those evaluated here. For example, substantial carbon reductions seem possible from improving the efficiency of transmission and distribution of electricity while also improving the efficiency of the transport sector.

It is clear that many abatement projects will entail not only carbon benefits, but may also result in a range of environmental and social benefits, as the Kyoto Protocol requires of CDM projects.

Evaluating the Sustainable Development Benefits of CDM Projects

In comparing potential abatement projects with what might otherwise take place, it is clear that many will entail not only carbon benefits, but may also result in a range of environmental and social benefits, as the Kyoto Protocol requires of CDM projects. Table 2 shows a number of projects that abate carbon and advance domestic goals within developing countries. Most prominently, sustainable development benefits include reductions in air and water pollution through reduced fossil fuel use, especially coal, but extend to improving water availability, reducing soil erosion, and protecting biodiversity. Regarding social benefits, many projects would create employment opportunities in target regions or income groups and promote local energy self-sufficiency. The evidence strongly suggests that carbon abatement and sustainable development goals can be simultaneously pursued.

However, some caution is needed—noncarbon effects may not always be positive. For example, in India, replacement of conventional energy technology with some alternative technologies actually increases residual solid waste. In Brazil, the use of chemicals in plantations may diminish soil and water quality. More frequently, noncarbon effects may consist of a mix of costs and benefits. Cogeneration using chemical byproducts in Brazil improves urban air quality in some areas, while making it worse in others.

Assessing whether the noncarbon effects are, on the whole, beneficial requires weighing different types of impact in different regions affecting different groups. Comparing improvements in water quality in one area with increases in solid waste in another area is a difficult calculus, and inevitably evaluation is something of a subjective exercise. Nonetheless, the Brazilian and Indian studies have attempted to create a framework in which such assessments can be made. This allows decisionmakers not only to avoid projects that exacerbate local conditions, but also to identify those projects that offer the greatest possible cobenefits.

Case Study Findings

Brazil

Potential CDM projects in Brazil arise in both the forestry and energy sectors. If allowed under the CDM, forestry opportunities offer enormous potential for carbon sequestration through plantation growth and protection of natural carbon sinks. Brazil's climate is ideal for silvicultural plantations. Although already profitable, development of silvicultural plantations has been limited by capital constraints and a lack of long-term financing mechanisms. Preventing deforestation, through protection of native forests, could have an even greater impact by avoiding the release of more carbon to the atmosphere than could be easily sequestered by new tree growth. However, curbing deforestation is no easy task. It would require addressing pervasive economic structural problems and a program broad enough to

Table 2 Sustainable Development Benefits Associated with Potential CDM Projects

Environmental Benefits	Potential CDM Projects
Air quality	Many alternative power generation and cogeneration options lead to substantial reductions in SO_2, CO, particulates, smoke dust, and NO_x. Renewable technologies, such as wind and solar, completely eliminate such pollutants.
Water quality	Solar and wind energy offer unambiguous gains over conventional alternatives. Use of anaerobic digestor technologies at industrial sites could simultaneously treat wastewater and provide natural gas.
Water availability	Sustainable forest management could protect against water depletion and runoff problems, especially if practiced over a wide area.
Soil conservation	Sustainable forest management could have a significant positive impact on soil conservation, especially if practiced over a wide area. New silvicultural plantations may lead to reduced soil erosion, depending on existing land use. In China, planting of 'tree webs' on plains can reduce wind erosion. Afforestation projects in key water basins can prevent runoff.
Solid waste	Alternative combustion technologies reduce or remove solid waste, in some cases creating marketable byproducts.
Noise	Replacing diesel pumps with wind pumps leads to substantial reductions in noise.
Flood prevention/protection	Afforestation in river basins could prevent or control flooding risks.
Biodiversity protection	Sustainable forest management offers substantial benefits over present logging practices. Cogeneration and renewable technologies reduce some mining pressures.
Social and Development Benefits	
Employment	Many options offer enhanced employment opportunities in key, underdeveloped regions or among key social groups.
Rural development	Renewable energy sources promise electrification of rural and/or remote areas not otherwise possible given high transmission costs.
Poverty alleviation and equity	Positive equity impacts with many projects because of increased demand for unskilled labor, often in areas of high unemployment.

Source: WRI, in press.

eradicate, not merely relocate, illegal logging. Government-supported concession schemes could be instrumental in providing large-scale reduced-impact logging opportunities.

In the energy sector, electricity supply is presently dominated by hydroelectricity, although business-as-usual trends indicate a greater role for fossil fuels, particularly natural gas and fuel oil. This would markedly increase Brazil's CO_2 emissions. The abatement options considered for the energy sector focus on the use of residues and byproducts that can be employed in cogeneration activities. Wind power is also a promising option; however, the abatement cost is relatively high.

To assess the degree to which the noncarbon attributes of projects overlap with Brazil's domestic objectives, each project was evaluated against 12 different environmental, development, and social criteria that reflect current policy areas. These included impacts on water quality and availability, biodiversity, trade balance, and employment and consumption effects by income group. For each of the criteria, projects were assessed to have a positive, negative, or neutral impact and, in the first two cases, how strong the impact would be (high, medium, or low). For forestry sector options, the major positive impacts include soil preservation, improvements in water quality and availability, and protection of biodiversity. For energy projects, the main benefits include improved urban air quality, some degree of avoided fossil fuel imports and protection or enhancement of employment opportunities in low-income groups.

For each project, the scores against the 12 individual criteria were then crudely aggregated to determine whether noncarbon impacts of a project were beneficial or detrimental overall. Table 3 presents the results for several of the more promising projects in Brazil.

A pure offset market would gravitate toward those options that are cheapest in terms of carbon prices. For Brazil, this implies plantations and industrial cogeneration in particular. While the former generates overall positive secondary impacts, some plantations may have a negative impact on the local environment because of the use of chemicals and the impact on soils. As the table shows, those projects that are the cheapest do not necessarily entail the greatest cobenefits. Though slightly more expensive, sustainable forest management and wind energy options promise a higher level of environmental and development benefits for Brazil.

India

More than 20 potential CDM projects in 5 different sectors were reviewed for India. They include new technologies and fuel switching options for conventional power generation, applications of renewable technologies for power generation and agricultural activities, and efficiency improvements in two industrial sectors: cement, and iron and steel. All projects broadly advance sustainable development in some form or other. Noncarbon environmental benefits include improved air and water quality, reduced solid waste, and soil protection. Development benefits range from rural electrification and employment opportunities for particular social groups, to improvements in industrial efficiency. Each project was evaluated against nine different criteria that seek to capture India's development priorities. These included, among others, resource conservation, impact on human health, consistency with government policy, and employment generation. To compare projects that offered different mixes of domestic development benefits, an analytical tool—the Analytical Hierarchical Process—was used. This tool creates a hierarchy among the benefits by giving, for example, more importance to human health gains than to employment generation. In this exercise, the base-case weights for different sustainable development benefits were determined through polling of researchers and government officials. Scoring each project against these weighted criteria created an approximate assessment of the overall development potential. Table 4 shows the resulting ranking of projects within each sector.

Of the abatement opportunities reviewed, there appears to be a considerable overlap between projects that offer low-cost GHG reductions and projects that are consistent with India's development priorities. In three of the four sectors for which comparisons can be made, the two highest ranked options based on cost of carbon offset are also the two highest ranked options based on their cobenefits. Unfortunately, this process could only be used to compare options within the same sector, and not across different sectors. An obvious next extension of the analysis would be to conduct cross-sector comparisons.

One of the advantages of the framework adopted in the Indian case study is that it allows for sensitivity analysis, showing how project rankings may change as

Table 3 Evaluating Potential CDM Projects in Brazil

Project	Predicted Abatement Cost (US Dollars per Ton of Carbon Removed)	Impact: Environmental	Impact: Development	Impact: Social
Chemical cogeneration of electricity	< 0	++	+	+
Plantations	< 0 to 2	−	+	+
Biomass electricity	2–3	−	++	+
Sustainable forest management	5	+++	++	++
Wind energy	15	+++	+	+
Ethanol with electricity cogeneration	20	−	+++	+

Negative impact: − Low

Positive impact: + Low; ++ Medium; +++ High

Source: WRI, in press.

different issues are weighted differently. For example, although bagasse-based cogeneration is regarded as the best option for the power sector under base-case weightings, if more weight were to be given, say, to local environmental concerns, and less to rural development and employment goals, investing in combined cycle natural gas technologies might be deemed preferable.

Developing and refining flexible tools that are capable of gauging the extent of noncarbon benefits will be invaluable as part of the ongoing decisionmaking process around CDM projects.

China

China differs from Brazil and India in that one issue—the extent of China's coal use—dominates any assessment of likely CDM activities and potential sustainable development benefits. Largely dependent on coal for its present and future energy needs, coal is the main driver of China's severe air quality problems and is also responsible for high levels of acid rain. One study conservatively estimates the total cost of indoor and outdoor pollution—to which coal-derived pollutants are the major contributor—at US$43 billion per year, equal to 6 percent of China's gross domestic product (World Bank, 1997). Acid rain, caused by coal-derived SO_2, is a problem for 40 percent of China's land mass (EBCEY, 1997). Any climate-motivated reduction in coal use will yield substantial cobenefits in terms of air quality improvements and reduced acid rain.

One part of the case study analysis shows the strong link between coal use and SO_2 and particulate emissions. Reducing coal consumption by 1 percent would lower SO_2 emissions by 0.88 to 0.97 percent and particulate emissions by 0.91 to 0.93 percent.[5] With reductions in carbon-intensive coal leading to proportionate reductions in conventional air pollutants, there is a natural overlap between projects ranked first in terms of carbon abatement costs and projects that will do the most to address two of China's most pressing environmental problems.

Although the location of reductions is not important from a carbon perspective, the local and regional benefits of reduced coal use could be maximized by tailoring reductions to achieve the greatest benefit for densely populated or badly afflicted areas. From this per-

Table 4 Evaluating Potential CDM Projects in India

Project	Predicted Abatement Cost (US dollars per Ton of Carbon Removed)	Ranking by Abatement Cost	Ranking by Overall Development Benefits (Base-Case Weights)
Conventional Power Generation			
Bagasse-based cogeneration	–244	1	1
Combined cycle generation (natural gas)	–133	2	2
Atmospheric fluidized bed combustion	7	3	5
Pressurized fluidized bed combustion	47	4	4
Pulverized coal super-critical boilers	96	5	6
Integrated gasification combined cycle	96	5	3
Renewables for Power Generation			
Small hydro	29	1	2
Biomass power	134	2	1
Wind farm	216	3	3
Photovoltaic	1,306	4	4
Renewables for Agriculture			
Wood-waste gasifier	169	1	1
Agro-waste gasifier	177	2	2
Wind well (shallow)	298	3	5
Wind well (deep)	329	4	4
Photovoltaic pump	6,333	5	3
Cement, Iron, and Steel Manufacture			
Dry suspension preheater kiln	7	1	1
Dry precalciner kiln	214	2	2

Source: WRI, in press.

spective, projects will need to be evaluated within China on the basis of how they can enhance local environmental quality.

Moreover, given the scale of coal consumption and its relatively inefficient use, the potential scale for low-cost abatement projects targeting coal reduction is huge. In economic studies that estimate how CDM flows might be distributed, China invariably snares more than half of the overall funds (e.g., Edmonds et al., 1998; McKibbin et al., 1998).[6]

Possible options for reducing coal use include the introduction of advanced coal generation techniques, fuel switching, efficiency improvements in the power and industrial sectors, and the wider application of renewable energy sources.

Aside from immediate energy benefits, these and other projects offer benefits ranging from improved industrial competitiveness, rural and off-grid electrification, wastewater treatment, mining safety, soil retention, and flood prevention. Anaerobic digestor technologies that could be applied to treat industrial wastewater discharges and in so doing produce a source of (coal-replacing) biogas are a perfect example of how CDM projects could meet diverse environmental goals.[7]

Afforestation projects could also offer a significant mix of carbon, soil protection, and flood prevention opportunities as well as providing employment in low-income areas. In the wake of recent flooding disasters, the cobenefits in this area could be significant.

Conclusion

Just how much sustainable development can be expected from the CDM is difficult to forecast, in view of continued uncertainties and the lack of precedent. However, from examining potential CDM projects in Brazil, China, and India, it is clear that many options will create desirable cobenefits in developing countries, addressing local and regional environmental problems and advancing social goals. Moreover, in some cases, the projects that do most for developing countries are also the ones that do most for carbon. The ranking of projects in India and coal's contribution to chronic air pollution in China point to a good correlation in these countries between those projects deemed best from a carbon perspective and those deemed best from a development perspective. Even in Brazil, the first-choice option based on cost offers positive benefits in all three evaluative categories; other projects promise more, however. For developing countries that might otherwise be preoccupied with immediate economic and environmental needs, the prospect of significant cobenefits should provide a strong inducement to participate in the CDM. Moreover, the extent to which there is a natural overlap between the two objectives should quell fears that the CDM will do much for developed nations and little for developing countries.

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The experience of conducting these case studies also points to the value of conducting and extending such analyses. For example, in Brazil, although chemical cogeneration offers abatement at the lowest cost, the more expensive sustainable forest management project may offer greater local benefits with wind power close behind. This raises questions about how far developing countries can promote projects that would be optimal in the sense of promoting both climate and sustainable development goals.

A pure carbon offset market (i.e., one that made no stipulations regarding sustainable development benefits) might not be able to tolerate the price increments—small as they are—associated with the more expensive options. However, if investments are to meet the twin aims of the CDM, there will need to be some recognition of, and response to, the noncarbon benefits. This raises a bigger question about how countries, and indeed the CDM itself, will need to balance the twin objectives, and to what extent rules and modalities will ensure that both aims are met.

Next Steps

In conducting the case studies, we also identified actions for both developed and developing countries that would facilitate the emergence of a mutually beneficial CDM. These include the following:

1. Extend the Analysis

For developing countries, an obvious step is to extend this analysis. Among other things, developing countries may wish to consider a greater range of projects and criteria, to weigh differently the mix of environmental and development benefits, to explore sensitivities to different weightings, and to compare projects across sectors. Policymakers within countries may have access to more accurate and timely data that would improve comparisons. In addition, countries will need to examine how the location of investment affects local and regional benefits. Although carbon gains are insensitive to location, reductions in air pollution or the creation of employment opportunities will depend on exactly where abatement activities take place. Systematic evaluation of projects against national priorities is necessary if developing countries are to promote favorable projects.

2. Filter Projects

On the basis of such analysis, developing countries may wish to "filter" or screen projects. In some cases, this may involve a trade-off with evaluation processes. At one extreme, a government could require not only a thorough evaluation of individual projects, but also act as the main supplier of projects. While ostensibly raising the likelihood that projects will be in the national interest, government control to this degree could generate high transaction costs, increase the risk of policy failure, and probably stifle competitive proposals for projects. A more *ad hoc* approach might be to set broad rules for acceptable project options to promote those that generate high social return on desirable benefits—perhaps meeting or surpassing a target level of noncarbon benefits. This would be considerably simpler than a systematic evaluation of all projects, even if it raises the possibility of first-best projects being missed or not exhausted.

3. Build Analytical Capacity in Developing Countries

The ability to rank and select projects presupposes a certain institutional capacity available in developing countries. In the major developing countries examined here, such capacity exists even if it has not been tapped formally or brought together in a CDM-focused organization. In smaller and poorer countries, such expertise may be considerably scarcer and harder to organize. If countries are eager to attract CDM flows, but lack the capacity to evaluate the local and regional implications, the result may be a less than optimal set of projects, or worse still, projects that actually exacerbate existing issues. More likely, it could manifest itself as an inability to compete with larger, or more organized, countries in attracting funds at all, leading in turn to a CDM market that benefits relatively few developing countries. The lack of institutional capacity clearly constitutes a constraint on some countries' ability to participate in the CDM.

One solution to this might be to have organizing entities playing a filtering role for more than one country under a multilateral approach to the CDM. This would extend expertise to countries that might otherwise be unable to participate effectively or to their own best advantage. Similarly, expertise might be forthcoming from reputable broker organizations that can be relied on to ensure that sustainable development benefits are part of the project outcome. Already, some developed country environmental groups have been engaged in the selection of such projects.

4. Identify Supporting Policies to Make Favored CDM Projects More Viable

Developing countries should dismantle institutional and other barriers that would impede financing of favored projects. For example, strengthening the capacity to enforce logging laws or to monitor forest areas in Brazil would reduce the 'leakage' problem—whereby carbon sequestration in one area merely leads to higher deforestation in other areas—and thus lower the risk and cost required to attract investors into reduced-impact logging projects. Such a policy would also allow reduced-impact forestry projects to garner a large share of overall investment funds. This policy would overlap with current domestic objectives and future CDM ones.

5. Urge Investors to Pay Attention to Sustainable Development Impacts

Although developed country investors will be primarily concerned with the quantity of CERs earned in a project, they also need to be sensitive to a project's sustainable development impacts given their bearing on a project's ability to earn credit at all. Hence, in a bilateral approach, it will behoove developed and developing country partners to work closely in deciding which sustainable development objectives are relevant for a particular project and to what degree they will be advanced.

Alternatively, in a multilateral approach, evaluation of these noncarbon factors could be undertaken by the body or organization that "bundles" the offset projects, with input from the developing countries hosting the projects. Interest in the World Bank's Prototype Carbon Fund (PCF)—an example of the multilateral approach—is evidence of enthusiasm for hands-off investing in projects that can be relied on to meet sustainable development criteria. An organizing entity like one modeled after the PCF could not only lessen the burden for individual developed country investors but could also provide expertise on sustainable development aspects for developing countries.

Whether investing directly or via a portfolio such as the World Bank's, investors will need to ensure that their CDM investments are consistent with regional and local development aims. Consideration of the sustainable development benefits should become an integral part of project selection.

6. Press Developed Countries to Consider Their Own Criteria

Just as developing countries may want to rank projects against certain criteria, so might developed countries evaluate projects against their own criteria. An important next step in selecting candidate CDM projects will be to overlay criteria deemed important by investors. Investors will be primarily concerned with the rewards and risks of a project. Some investors may feel more comfortable investing in projects in which they have some expertise or understanding and in which the CDM benefits are merely an add-on. Energy companies, for example, may be more likely to upgrade existing or planned energy investment installations. Other investors will prefer a hands-off approach and might feel happier investing either in a straightforward sequestration project, or in a "pooled" set of projects managed by an intermediary organization. In either case, developed and developing countries will need to work together in identifying and selecting projects that meet their shared and individual goals.

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NOTES

1. Projections predate the recent financial crisis, which makes high-end estimates less likely. In addition, there is evidence that all three countries are moving away from conventional development paths—movement that may not be fully reflected in these figures (Reid and Goldemberg, 1997; UNDP, 1999).

2. China and India are presently both under their ninth 5-year plan (1996–2001 in China; 1997–2002 in India). There is no equivalent in Brazil.

3. The project's profitability without carbon credits raises questions as to whether it would be considered "additional." For the CDM and the Kyoto Protocol to be successful in environmental terms, one cannot merely credit projects that would have occurred anyway. To do so would be to reduce developed countries' effective emissions requirements with no net improvement in global emissions. Some have argued that any project that is profitable will be implemented and so ought not to be credited. However, this perspective overlooks several tangible barriers that may impede even profitable projects. Most simply, a shortage of available capital—a common enough situation for developing countries—means that not all profitable projects can be undertaken. Other barriers include a lack of supporting technological or physical infrastructure. Defining additionality in terms of profitability alone, may prevent precisely those projects that should be funding priorities under any notion of sustainable development—those that mitigate carbon and make money.

4. Estimate based on calculations in the Brazil case study (WRI, in press).

5. See the China case study for details (WRI, in press).

6. Of course, whether it would be desirable for a single country to take such a large share of the total investment under the CDM is another matter. From an economic perspective, it raises questions about the possible efficiency of the overall CDM market. More importantly, a pure market-based CDM that benefited a few large countries and excluded many smaller countries might not be politically desirable.

7. Anaerobic digestor technologies convert about 70 to 90 percent of organic materials in industrial wastewater to biogas, a mixture of methane and carbon dioxide. Hence, these technologies simultaneously reduce pollution, curtail methane releases, and provide an alternative energy supply (CRED, 1996).

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