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synthesis article

Financing the integration of climate change mitigation into development

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The Bali Action Plan and many other authoritative recent climate reports point to expectations that additional financing will be central to future international agreements to address climate change. Several donor governments have announced commitments to contribute significant additional amounts of funding to support climate change financing in developing countries. However, the context for financing of climate change mitigation is evolving rapidly, with significant implications for climate policy. Two key changes are the dramatic improvement in access to capital in many of the most rapidly growing, large greenhouse-gas-emitting, developing nations and the increasing shift of wealth to oil-exporting countries and Asian central banks. Energy investment is fundamental to development and is capital-intensive, and access to finance is not equally available across countries and for different types of investments. Less carbon-intensive, clean energy investments frequently remain more difficult to finance, due to their smaller scale and innovative nature. Taking climate risk into account as an element of financing is potentially consistent with the investor's need to balance risks with expected returns, but the methodologies, geographical scale, and data required are not yet commensurate with the time periods and project scope typical of financing for developing countries. The policy challenge is in making the financing available commensurate with the scale and short time available for addressing climate change. Most of the likely targeted financing programmes will not be adequate for this purpose. Rather, policy makers need to focus on creating adequate signals that climate change will be an important and continuing factor in government policies for the foreseeable future in ways that will affect investor expectations of relative risk and reward. If this is done, financing will follow.

Keywords: developing countries; development; finance; investment; Global Environment Facility; mitigation; policies and measures; sustainable development; World Bank

Le plan d'action de Bali et autres rapports notoires récents sur le climat désignent l'attente d'un financement supplémentaire qui serait central aux futurs accords internationaux sur le changement climatique. Plusieurs gouvernements bailleurs ont annoncé leur engagement à contribuer des montants importants pour le soutien au financement du changement climatique dans les pays en développement. Cependant, le contexte de financement de l'atténuation du changement climatique évolue rapidement avec des conséquences importantes pour la politique climatique. Deux changements importants incluent d'une part l'amélioration considérable d'accès au capital dans de nombreuses grandes nations où l'augmentation des émissions de gaz à effet de serre est la plus rapide et, d'autre part, le transfert croissant des richesses vers les pays exportateurs de pétrole et les banques centrales asiatiques. L'investissement énergétique est fondamental au développement et est intensi en capitaux, et l'accès au financement n'est pas accessible à même mesure selon les pays et les différents types d'investissements. L'investissement dans les énergies propres ou plus sobres en carbone reste fréquemment plus difficile à financer à cause de leur plus petite échelle et leur nature innovante. La prise en compte du risque climatique en tant qu'élément de financement est potentiellement en accord avec le besoin des investisseurs d'équilibrer les risques avec les retours attendus, mais les méthodologies, l'échelle géographique, et les données requises ne sont pas encore à la mesure de la durée et de l'échelle des projets typiquement financés pour les pays en développement. Le défi politique est de rendre accessible un financement qui soit proportionnel à l'amplitude du changement climatique et la courte durée qu'il existe pour y

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lutter. Les programmes ciblés de financement les plus usuels ne seront pas appropriés à cette fin. Les décideurs devraient plutôt se concentrer sur la création de signaux adéquats visant le changement climatique en tant que facteur important et continu dans les politiques des gouvernements dans un futur prévisible, qui affecteront les attentes des investisseurs sur les risques et gains relatifs. Dans ce cas, le financement suivra.

Mots clés: atténuation; développement; développement durable; finance; investissement; la Banque Mondiale; le Fonds pour l'Environnement Mondial; pays en développement; politiques et mesures

1. Introduction

Access to finance is frequently cited as one of the key requirements for addressing climate change. Commitments to financing were central to the Bali Action Plan adopted at COP-13. The heart of the agreement, expressed in Paragraph 1(b), conditions 'nationally appropriate mitigation actions by developing country Parties' on the provision of 'technology, financing and capacity-building'. The importance of commitments to financial assistance, investment and technology transfer to developing countries is emphasized in the following paragraphs, which identify some of the expectations to be addressed during the negotiating process to go on until COP-15 in Copenhagen. Resources should be additional, adequate, predictable and sustainable; 'positive incentives' should be created for developing-country implementation of mitigation strategies; innovative means of funding for meeting the costs of adaptation by particularly vulnerable countries; public- and private-sector funding and investment should be mobilized (Para. 1(e)).

The Bali decisions reflected numerous reports and authoritative statements on financing during the year. The IPCC Working Group III report states that 'Funding sources for greenhouse gas (GHG) mitigation in developed and developing countries is a crucial issue in the international debate on tackling climate change' (Gupta and Tirpak, 2007). A report prepared by the UN Framework Convention on Climate Change on financial flows relevant to an international response to climate change quantified the additional investment that may be required in 2030 to return GHG emissions to current levels. The authors conclude that about US$200 billion of incremental financing will be needed for mitigation and adaptation globally – seemingly a large amount in absolute terms but equivalent to only about 0.5% of expected GDP and 1.1–1.7% of global investment in 2030 (UNFCCC, 2007). Numerous experts and organizations have made proposals for clean energy financing as an essential element of any future international climate change agreement (e.g. GLCA, 2007). Recent announcements by donor governments also indicate that sizable new commitments of funds for climate change mitigation are increasingly likely (DFID, 2007; ENB, 2007; World Bank, 2007a; Planet Ark, 2008).

While pronouncements of climate change financial needs proliferate, the context for international financing has evolved enormously in recent years. In particular, the developed countries and international financial institutions no longer have the influence and primacy they once did. The largest developing countries have substantial internal financial reserves, and high oil prices are causing a massive wealth transfer to oil-exporting companies and countries. There is a financial challenge, but it has much more to do with directing resources towards more climate-friendly options and less to do with simply making financing available. Investments and, more generally, financial flows are closely associated with development choices that will determine both the growth in GHG emissions and the vulnerability of societies to the impacts of climate change.

This article reviews the issues associated with making additional financing available for financing climate change mitigation in developing countries, in several parts: a brief review of the financing

implications associated with baseline forecasts of GHG emission increases and new global financial realities, and then identifying the policy implications and opportunities for governments.

2. New financial and market realities

As the Bali Action Plan shows, financing – properly channelled – is widely seen to be a key requirement for reducing emissions. However, currently the availability of capital and its contribution to rapid economic growth are directly responsible for the rapid build-up in GHG emissions. The rise in GHG emissions and corresponding concerns about climate change reflect the rapid rate of economic growth in many developing countries. The rise in emissions has been closely associated with the rate of economic growth and, less obviously, the carbon intensity of that growth. Increasingly, much of that growth in economies and carbon emissions is coming from developing countries. In 2006, developing-country economies grew by 7%, or more than twice as fast as high-income countries, accounting for 38% of the increase in global output relative to a 22% share of global GDP (World Bank, 2007b). This trend is projected to continue, with the developing-country share of world output rising to almost one-third in 2030.

Economic growth in developing countries – particularly in China and India – has been closely associated with the increasing use of energy in general and electricity from coal in particular. According to projections by the International Energy Agency, in a business-as usual scenario, emissions from developing countries are projected to more than double between 2002 and 2030 (from 8.2 to 18.4 Gt CO_2) – much of this due to the combustion of coal and other fossil fuels for electricity (IEA, 2006, 2007). Growth in Chinese fossil fuel consumption has exceeded most forecasts, and recent analysis indicates that China may already have overtaken the USA as the largest emitter of GHG emissions, a decade ahead of some earlier predictions (Logan, 2006; Environmental News Service, 2007). The financing challenge for climate change is thus implicit within this new reality: channelling the increasing flow of investment dollars in more sustainable, climate-friendly directions without slowing or penalizing development goals.

3. The critical role of financing in energy choices

The availability of financing, whether from public or private sources, is critical for energy supply projects, due to their capital intensity. Coal mining and transportation, power plants, oil refineries, and transmission systems are among the most capital-intensive projects in any economy. Thus, expectations of continued economic growth are based on the assumed availability of very large sums for investment. The IEA estimates that, between 2005 and 2030, developing countries will need to invest $10 trillion in energy-related infrastructure ($3.7 trillion in China); more than half of total global requirements, much of this in power plants alone (IEA, 2006). On average, 1–1.5% of GDP is invested in energy worldwide, or $300–400 billion a year, with much higher levels in many developing countries (Goldemberg and Johansson, 2004). The cost and availability of capital is therefore key to making clean energy services available for development and, insofar as the climate regime can help direct more capital to such services, it can have a major positive impact (Gentry, 2000; Ogden, 2006).

From a global perspective, these percentages are consistent with historic norms and, while relatively large, are not infeasible. However, the challenge in raising these funds is changing with the increasing share of energy-related capital required by developing countries due to their higher growth rates. The total current investment in energy infrastructure in the OECD and developing

countries is about equal. However, according to the International Energy Agency (IEA), in order to support projected economic growth to 2030, investment in energy infrastructure will have to increase by more than 50% in developing countries while remaining roughly constant in the OECD (IEA, 2006).

Channelling investment towards alternative, more climate-friendly, forms of energy requires addressing multiple problems, as discussed below. Renewable energy technologies are typically equally capital-intensive – a high proportion of costs are incurred up-front but with near zero operating (fuel) costs – but are usually smaller and less mature. Efficiency technologies are highly dispersed and embodied in consumer decisions at all levels of scale, from individual home appliances to small enterprises to large manufacturers. New technologies, such as carbon capture and storage, typically require some initial public support due to their high risks and the uncertainty of rewards to any individual firm.

4. Financing development: new and more distributed sources of wealth and investment

Net private capital flows to developing countries jumped dramatically to record levels in 2005, exceeding $500 billion, with roughly the same amount expected in 2006.

> The combination of several years of low interest rates has increased global liquidity substantially. Despite the increase in short-term interest rates, the persistence of low long-term interest rates, due in part to high savings rates among oil-exporting countries, has kept global liquidity abundant (World Bank, 2006a).

Bank lending and booming stock markets in emerging markets also reflect these positive financial developments. Many developing countries have taken advantage of these trends by issuing bonds with longer maturities, buying back debt to lower interest costs, and pre-funding future financing requirements. Repayments more than offset increases in foreign aid; net official flows of grants and loans was a *negative* $71.4 billion in 2005, led primarily by net repayments to the IMF of $41.1 billion (World Bank, 2006b).

Recent higher oil prices have been another source of wealth accumulation, leading to new sources of investment managed in oil-producing nations (Mufson, 2007). In 2006, oil-exporting countries became the largest source of global capital flows – almost $500 billion, a significant source of liquidity and lower interest rates (Farrell and Lund, 2007, 2008).

The growth in financial flows to developing countries has, however, been unevenly distributed and roughly corresponds with the largest and most rapidly growing sources of carbon emissions – in 2005, China, India and South Africa received almost two-thirds of portfolio equity flows (World Bank, 2006b). The attractiveness of the investment climate is partly a function of market size and location, but government policies are also increasingly recognized as important factors.

> They influence the security of property rights, approaches to regulation and taxation, the provision of infrastructure, the functioning of financial and labor markets, and broader governance features such as corruption. Improving government policies and behaviors that shape the investment climate drives growth and reduces poverty (World Bank, 2007a).

While policy uncertainty is the constraint most often cited in business surveys, the issues are country-specific. In Bangladesh, the 'number one' issue is the lack of reliable power, in Hungary high tax rates, and in Guatemala crime, theft and disorder.

From a climate-change perspective, a key point is that the countries with the most ready access to the capital markets include those responsible for the lion's share of growth in GHG emissions. Thus the availability of capital *per se* is not a primary constraint or barrier to clean energy investments. If capital is not available, it is due primarily to other factors such as inappropriate regulatory policies, perceived technical risks, or other factors leading to an inadequate expected return on investment. Insofar as the primary source of development financing is increasingly domestic in the largest GHG-emitting nations, a further implication is that *a focus on national policies to influence investment flows is essential*. National energy policies and regulations, as well as economic policies that encourage some types of investments (e.g. energy subsidies) and discourage others (e.g. import duties), are increasingly important influences on financing related to climate investments, while external influences, including the programmes of international financial institutions, are correspondingly in decline. The evaluation and support of such national programmes is therefore an important focus (see examples from China, India and Mexico discussed below).

Another consequence of improved access to capital in many developing countries has been the emergence of technically advanced, global leaders in clean energy technologies based in developing countries. The vocabulary of 'technology transfer', still prevalent in Convention processes, which assumes a largely one-directional flow from North to South, is thus increasingly out-of-date.[1] Developing countries are increasingly among the global leaders in renewable energy investment and additions to capacity. China is expected to invest more than $10 billion in renewable energy technologies in 2007, second only to Germany; Brazil is a global leader in ethanol; and China and India are rapidly establishing themselves as leading manufacturers of wind energy (Martinot, 2006; Martinot and Junfeng, 2007; World Bank, 2007b).

A poor investment climate is a deterrent to investment in many of the poorest developing countries, which includes many of those most vulnerable to climate change. Consequently, these countries continue to be the most dependent on externally provided assistance (ODA) and debt relief. Net disbursements of ODA increased dramatically to $106.5 billion in 2005; $27 billion above the 2004 level. However, much of this increase was attributable to debt relief and special-purpose grants, including the response to the tsunami and other disaster relief. In general, more aid is going to the poorest countries, particularly those in Africa, and more is being given in the form of grants (World Bank, 2006b). The implication for climate change is that aid trends have been moving away from influencing the largest sources of GHG emission growth in favour of greater emphasis on meeting the energy needs of the poor – a trend that may be at odds with requirements for future climate change mitigation agreements.

Another consequence of the increasing accumulation of wealth in developing countries has been a corresponding growth in financial transactions among developing countries. For example, South–South foreign direct investment was $47 billion or 36% of the total FDI to developing countries in 2003, versus $14 billion (16%) in 1995 (World Bank, 2006b). Developing countries are becoming greater sources of development aid, including debt forgiveness for Africa, concessional loans, and preferential export credits. By 2010, China's export promotion programme may be lending and guaranteeing more than $70 billion annually for infrastructure and other large-scale investments in developing countries (Rich, 2007).

The availability of alternative sources of investment outside the transparency required by international financial institutions is another new factor in development finance. In contrast

with aid programmes administered by the industrialized countries, the Chinese programme is outside international agreements on environmental standards and reporting and, according to official statements, comes with 'no strings attached'. From a climate-change perspective, this represents another source of financing so far largely outside efforts to move investment in a more climate-friendly direction. The environmental and social consequences of China's external investment have been the subject of some criticism (Rich, 2007). The Chinese government has recently shown awareness of the need to make the banking sector a partner in screening its lending for environmental risk, although so far without noting the applicability of such policies to investments outside the country (IFC, 2007a).

As should already be apparent, the fact that financing is increasingly available in the largest markets for conventional investments does not mean that it is readily available to address climate-change needs. As noted earlier, financial terms are most favourable for what is known and proven, which tends to mean fossil fuels and conventional, as opposed to innovative, more energy-efficient technologies, and standard design and construction practices as opposed to those that may be more climate-safe (WBCSD, 2007). Financing programmes will also not be utilized if the costs are too high and the benefits too uncertain. There are also biases in the institutions and traditional criteria for lending that tend to relatively favour particular investment types, as discussed further below.

5. Access to capital for more climate-friendly investments

Capital flows follow expected commercial returns; unless policy intervenes, established perceptions of risk and reward will dictate investment choices. In the energy sector, this tends to mitigate against what is new and therefore less proven; investments made at a smaller scale (unless means are found to offset proportionately higher transaction costs); and fundamentally against anything that costs more.[2] The issues associated with climate-friendly and safe financing vary by country, technological opportunity and market circumstances. Numerous justifications have been offered to explain the need for dedicated climate change financing programmes, including evidence of inadequate commercial lending for energy efficiency improvements (particularly in developing countries), the high initial costs for early-stage application of promising new technologies, and the absence of demonstrated models for assessing climate risks and adopting response measures. These issues reflect some of the diversity of financing challenges.

The challenges vary for different technologies, investment scales, and different investors. As noted in a report of the World Business Council for Sustainable Development (WBCSD):

> Project based investments in emerging and lower carbon energy technologies are some of the more complex and risky forms of investment. They are normally highly capital intensive and play into a world where the average consumer is unwilling to pay a premium for their energy services (WBCSD, 2007).

A World Bank assessment similarly concludes:

> unless the policy framework changes and appropriate instruments are in place to facilitate investments in new technologies, developing countries are expected to follow a carbon-intensive development path similar to that of their developed country counterparts (World Bank ESSD, 2006).

Understanding how to channel financing more effectively to climate-friendly technologies requires a more detailed discussion of the diversity of climate solutions and the barriers they face.

5.1. Financing energy efficiency and renewable energy technologies

Investments to reduce energy demand can reduce net capital requirements but have their own challenges. They typically imply higher up-front capital costs and reduced operating costs relative to conventional equipment, but the higher initial cost can be much more than offset by the value of savings, particularly if credit is given for avoided investment in new supply. For example, an IEA alternative policy scenario for 2005–2030 reduces CO_2 emissions by 16% or 6.3 Gt, equivalent to the total current emissions of the USA and Canada. Total energy investment is lower than in the reference scenario but the allocation of investment changes significantly; spending on end-use equipment and buildings increases by $2.4 trillion, but more than $3 trillion less is spent on supply-side investment. 'On average, an additional dollar invested in more efficient electrical equipment, appliances and buildings avoids more than two dollars in investment in electrical supply' (IEA, 2006; Enkvist et al., 2007). Obvious problems arise when consumers are not well informed on the value of savings from higher initial costs or are not in a position to fully benefit from them (e.g. if the saving accrues to the utility or if the buyer is a landlord and the tenant pays energy costs).

Many less obvious economic and social benefits of energy efficiency improvements are typically not considered in evaluating investment choices, including increased energy security and labour productivity, lower pollution and maintenance costs, and indirect public and occupational safety (Goldstein, 2007). Despite these benefits, motivating cost-effective investments in energy efficiency continues to be surprisingly difficult. As a consequence, many authorities have concluded that regulatory measures, including minimum standards for buildings and appliances, may be required in order to achieve widespread adoption of cost-effective efficiency opportunities (Stern, 2006; Enkvist et al., 2007).

Renewable energy technologies have a very high proportion of capital costs, as once put into operation they require no fuel (excluding biomass systems) and minimal maintenance. (Biomass systems are a significant exception, as the identification and cost of feedstock is an important contributor to total cost.) Costs are also closely associated with changes in technology (reflected in manufacturing costs and product performance) and materials. In the long term, the former is expected to result in continuing cost declines, particularly for products such as solar cells that can be manufactured in small scales that typically result in declining costs with production experience ('learning curves'). In the short term, however, capital costs for wind and solar energy have in general been rising in recent years due to increasing material costs and growth in demand faster than can be met with existing manufacturing capacity (EIA, 2006).

Expectations of continuing high oil prices have brought substantial investment into clean energy alternatives. A study by the UN Environment Programme (UNEP) estimates that global investment in clean energy in 2006 reached $100 billion, of which about $30 billion was for corporate buyouts and the remainder for new investments (UNEP, 2007a). Most capital is still going to developed-country markets in response to subsidies and incentive policies such as mandatory purchase obligations for utilities, but developing-country investments are growing faster and now exceed $14 billion annually. The carbon market is another promising source of investment in clean energy, although it is still at an early stage.

5.2. Financing smaller-scale clean energy technologies and enterprises

Clean energy technologies come in many scales but, compared with conventional power plants, most are relatively small. A large wind machine today is typically about 3 megawatts (MW) versus about 400–600 MW for a full-sized coal burning power plant. Solar cells are typically produced in

panels in factories that may manufacture the equivalent of 250 MW per year. Panels can be sold individually for households or grouped together to provide 1 MW or more. Efficiency technologies are a feature integrated throughout the economy and thus can be found at all scales, as small as improved lighting devices costing a few dollars, and as large as new devices for making steel, costing millions of dollars.

The dispersed, smaller scale of many efficiency and renewable energy technologies is advantageous for many reasons; opportunities can be found in almost every economy, and large-volume manufacturing creates the potential for economies of scale and learning from experience. However, financing smaller-scale enterprises and applications is a barrier in developing countries. The interest rates and borrowing terms available to these groups are typically less favourable, and few developing-country banks offer loans for efficiency upgrades which lack conventional collateral. This gap is particularly important for promoting energy efficiency throughout the economy, including such household products as refrigerators and air-conditioners, which are increasingly popular consumer goods in the most rapidly growing developing countries. Consumer decisions are also important for energy use in the building sector, a rapidly growing segment of developing countries due to urbanization and population growth. Energy use in this sector in developing countries is projected to grow at almost 3% per year until 2030 (EIA, 2006).

As discussed below, the International Finance Corporation (IFC) and other international financial institutions have had some success in dealing with this problem by providing local banks with a combination of technical assistance (TA) and partial risk guarantees. The TA provides training in understanding the risks and opportunities associated with energy efficiency lending, while the risk guarantees provide banks with some confidence in taking the risks associated with new markets.

Financing of small enterprises can be critical for business development. For example, numerous donor programmes have sought to nurture small clean energy companies providing energy services to rural households without access to electricity. These firms often lack access to the capital needed to become established and grow, and furthermore may need help with business planning. While costly and labour-intensive, the effort to help small firms survive may be essential seed capital for future development. Some efforts to address this need have adopted the framework of 'patient capital', a reference to the need for investors with a tolerance for investments on longer terms with lower return requirements, compensated by greater environmental, social and development impacts (EC, 2006).

Another variant of this problem is the need for regulatory frameworks and business models compatible with distributed generation technologies, modern small-scale means of generating power well suited to the needs of power-starved developing countries. The financing costs for these smaller-scale technologies can be very high relative to those for larger power plants; a problem that might be amenable to a combination of standardized regulatory policies for power purchases; master agreements or standard contracts for end-user finance; and risk-sharing through utility purchase and eventually securitization.

5.3. Financing new climate-friendly technologies

The most established and accepted case for government intervention in support of climate-friendly investments is with respect to the development and use of new technologies, primarily for electricity generation. Attracting investment to the early stages of new technology development is particularly difficult due to the higher risk, the likelihood of longer time periods before earning a return, and the greater uncertainty with respect to which firms will eventually succeed in a competitive market. Relative to other sectors of the economy, investment in early-stage energy technology has fared poorly in recent decades. Total public spending on research and development increased by almost 50% between 1988 and 2004, but spending on energy-related research and development declined

nearly 20% over the same period. Private investment also declined. Key factors were the decline in oil prices, privatization leading to competition and increased emphasis on short-term returns, and regulatory uncertainty (Stern, 2006; WBCSD, 2007).

Recent increases in public energy expenditures have only partially offset this trend and the *Stern Report* recommends a doubling of investments to around $20 billion a year, as well as an increase in deployment incentives of two to five times from the current level of $34 billion (Stern, 2006). The need is primarily for a public subsidy to offset the risks of early-stage development as opposed to financing *per se*. In response to the recent run-up in oil prices and concerns about energy security, there has been a dramatic increase in risk capital available for some types of alternative fuels, particularly biofuels, although such funding is not as available in developing countries where land use and other conditions may actually be more suitable (Mathews, 2007).

There are few sources of dedicated financing for the commercialization of new energy technologies in developing countries. One of the few, and almost certainly the largest, is the Global Environment Facility (GEF), discussed more generally below. Over roughly a decade, the GEF has approved more than $350 million, mostly in the form of grants, in support of 25 new technology commercialization projects in developing countries (Miller, 2007). A wide range of technologies have been supported, but the largest recipients have been solar thermal power plants, fuel cell-powered buses, and several approaches to a more efficient use of biomass for power combustion. This effort has so far achieved very modest results, with many projects dropped or cancelled without completion of any operational facility. Recently the GEF has proposed that this strategy be assigned very low priority going forward.

In the context of the Montreal Protocol, there has been some noteworthy success with focused efforts to develop and transfer new technologies for replacing chemicals that threaten the ozone layer. In order to make certain that their suppliers did not use ozone-depleting chemicals regulated in the industrialized countries, large electronics companies developed alternatives and provided training and technical assistance to firms in developing countries. The result was technically and economically effective in a relatively short period of time. While some financial assistance was available through the Multilateral Ozone Fund, the key to success was, in many cases, the transfer of manufacturing knowledge in a commercial context and not the provision of financing (Andersen and Sarma, 2002; Andersen et al., 2007). The World Bank Group also recently stated that it is exploring options for accelerating the implementation of new technologies in its client countries – a significant shift from past practice and a further indication that a business-as-usual approach to climate change will not be sufficient (World Bank SDN, 2007b).

6. Financing energy services for poverty alleviation and its relationship to financing for climate-friendly investments

A further challenge to making more financing available for climate-related investments is to assure poorer countries that funds are not being redirected from the primary objective of overseas development aid (ODA), poverty alleviation. Resources provided to developing nations need to be 'new and additional' (Bali Action Plan, par. 1(e)(i)). This is a legitimate concern because the growth in GHG emissions is coming from a relatively small number of countries and is associated with power generation and manufacturing rather than the provision of basic energy services to the poor.

The two goals are distinct except insofar as climate change may make it more difficult to meet development goals; both will require substantial focusing of resources to meet international goals.[3] From the perspective of GHG emissions, what matters is how modern energy services are provided

to the poor. Socolow (2006) has calculated that if the basic human needs for the estimated 1.6 billion people without access to electricity and the 2.6 billion people without clean cooking fuel were to be met overnight, the increased energy use required would produce less than a 3% increase in global CO_2 emissions. However, emissions could be much greater if the poor are provided with electricity supplied by inefficient coal plants using poorly managed transmission systems with high loss rates, and if electricity is used for inefficient lighting and other energy-wasteful purposes. On the other hand, emissions could also be much lower if using energy-efficient technologies and low-carbon energy sources.

One example of an effort to promote climate-friendly development in a form that addresses the energy needs of the poor is a World Bank programme called Lighting Africa, which aims to promote the use of low-power lighting devices for the rural poor. By combining light emitting diodes (LEDs) with solar power, high-quality lighting can be provided to rural households at lower cost than kerosene and conventional batteries, while avoiding any increased emission of greenhouse gases (see, generally, http://lightingafrica.org).

7. Climate-friendly financing: existing mechanisms and recent experience

There have been many efforts to channel investment in clean energy technologies to developing countries. These experiences offer some valuable lessons and include some significant successes, but also highlight the difficulties that frequently arise from putting too much emphasis on financing as a means of changing energy systems.

> The [World Bank Group's] ability to work across multiple sectors and to deal at both the policy and project level; its presence in the field; its ability to innovate; the leverage which its finance provides; and its convening power – all of these advantages need to be brought to bear on what is one of the largest and most complex problems the development community has faced (World Bank SDN, 2007a).

It is also difficult to find any precedents for efforts to deal at the scale and rate of change required to address climate change.

While private financial flows now substantially exceed official development assistance (ODA), the latter is still an important resource for poor countries unable to borrow on reasonable terms, new technologies, and for advisory services such as capacity-building for policy and regulatory reforms (World Bank SDN, 2007b). ODA specifically available for clean energy and climate change purposes has been relatively limited. The primary source of public information on trends in development assistance, the OECD Development Assistance Committee (DAC), lumps all energy- and transportation-related aid within the category 'economic infrastructure'. Disbursements under this heading – which includes support for fossil-fuel-related activities as well as clean energy activities – declined from $18.4 billion in 1984/1985 to $13.3 billion in 2004/2005 (OECD, 2006). Donor-identified energy funding was about 3% of total bilateral aid in 2005, and slightly less than 4% of World Bank finance.

The World Bank (WB) reports a steady increase in energy-related commitments, about $7 billion for the 3-year period FY03–05 versus more than $10 billion expected over the subsequent 3-year period, FY06–08 (World Bank SDN, 2007a). Clean-energy-related lending by the World Bank has also been increasing in recent years, as discussed below, and was almost $1.5 billion in FY07, or 40% of total energy commitments (World Bank, 2007a).

Targeted financing programmes are not a universal panacea and must be tailored to local markets and banking. The World Bank and other international financial institutions have established numerous such programmes only to find an absence of consumer demand because of other problems related to regulatory frameworks, market awareness and affordability (Taylor et al., 2008). The barriers to a good investment climate noted above, particularly those related to inadequate government policies (such as lack of protection for property rights and lengthy delays in establishing new businesses), lack of essential infrastructure, and project sponsors with weak credit ratings will undermine or block the efficacy of otherwise attractive financing programmes.

7.1. Institutional remedies: the influence of the World Bank and other IFIs on financing for climate change

The international financial institutions (IFIs) have had a modest, albeit growing, commitment to support access to clean energy services as an essential element of poverty alleviation: the attainment of the Millennium Development Goals for health, education, clean water, etc. depend on the availability of modern energy services. The IFIs have also been increasing their commitment to support energy efficiency and renewable energy in recent years, although starting from very low baseline levels. For example, at the Bonn Renewable Energy Conference in 2004, the World Bank Group (WBG) announced a commitment to increase its lending for defined clean energy projects by an average of 20% per year for 5 years. As part of this effort, the Bank issues an annual progress report and, based on the first two years' results, has substantially exceeded its targets, increasing lending on 'new renewables' and energy efficiency from $459 million in FY2005 to $821 million in FY2007. A joint report by the WB and other IFIs found that this trend was generally true in all of them: 'All the MDBs [multilateral development banks] are giving priority to energy efficiency', bringing small-scale renewable energy technologies to client countries 'is a key priority', and all the MDBs 'have embarked on efforts to catalyse low-carbon investments through new financial instruments which can mobilize additional funding, promote innovation, and help fund the incremental costs of these projects' (ADB et al., 2007). Critics of the WBG and other IFIs argue that these institutions should eliminate all support for fossil-fuel-related investments in favour of clean energy projects (Bank Information Center, 2006). This argument has been considered and rejected as inconsistent with the Bank's primary focus on development, but most probably will be reconsidered in the context of climate change (EIR, 2003; Bank Information Center, 2007).

The ability and influence of the Bank to act effectively as a promoter of clean energy has also been a continuing question. The Bank has historically had mixed results with projects that provide substantial subsidies for higher-cost technologies, and arguably also has limited experience and comparative advantage with respect to commercializing new technologies (IFC, 2007b; Miller, 2007). Insofar as the Bank and other IFIs are primarily lending institutions, their influence is contingent on the willingness of borrowers to take on debt for specific purposes. As other sources of capital have become more available, the Bank's ability to impose conditions and dictate priorities has also been in decline. Where clean energy projects make economic sense and policy environments are favourable, alternative sources of financing are often available on equivalent or even better terms. As discussed above, the rise in oil prices and increasing availability of capital globally mean that the IFIs are in a less dominant position as financiers, except when policy advice and concessional resources are required.

Targeted clean energy financing programmes have had some notable success within the WBG with the application of targeted technical assistance and partial risk guarantees to engage local

banks in lending for clean energy investments (primarily efficiency upgrades). These projects require some concessional resources but have very high leverage; once banks become comfortable with the different lending criteria needed to evaluate investments justified by energy saving, the projects become self sustaining and even self-replicating as other banks duplicate product offerings. In the case of the International Finance Corporation (IFC), projects are now in effect in eight countries including two of the largest and least energy-efficient, Russia and China. With $54 million in support from the GEF and other donors supporting clean energy investments by more than 20 financial institutions, banks have lent more than $120 million for projects with a much greater value (World Bank, IFC and MIGA, 2007). The IFC is now proposing to scale-up such activities to support $500 million worth of lending annually, without the need for donor funds. Such projects can only be implemented where financial markets are adequately developed and receptive; conditions which, fortunately, are being met in a growing number of countries.

Another role for the European Bank for Reconstruction and Development (EBRD) and IFC, the two most private-sector-oriented of the IFIs, is to demonstrate more aggressive means of identifying opportunities for clean energy upgrades associated with their mainstream investments (EBRD, 2007; World Bank, IFC and MIGA, 2007). Both institutions describe ongoing efforts to 'push the envelope' through review of their portfolios, financing audits (EBRD), requiring clients to evaluate GHG emissions (IFC), and establishing benchmarks for different types of investments (EBRD). These measures benefit from donor support but may be replicable by interested private banks through cooperative information-sharing efforts (e.g. the Equator Principles).

An important need arguably inadequately addressed by existing international arrangements is to share lessons and experience across countries and institutions. The IEA remains linked to the OECD but is gradually expanding its efforts with respect to clean energy technologies, and is also seeking to engage more effectively with large developing countries. The Bonn Renewable Energy Conference in 2004 resulted in REN21, an ongoing secretariat for information exchange on trends in the global renewable energy market. Some energy experts propose the creation of an international clean energy agency to assume responsibility for information exchange and technology promotion in this field, although this idea has yet to receive much governmental support (Geller, 2003).

Most probably there is little government appetite for the creation of new international institutions. However, as already hinted above, there is some indication of a willingness among the IFIs to take on expanded mandates in the funding of low-carbon energy programmes in partnership with their largest clients. An exploration of this approach became possible with the agreement of the G8 on a climate action plan at Gleneagles in July 2005 (G8, 2005). In response, the World Bank Group, in cooperation with other leading IFIs (particularly EBRD and ADB), have spent the past year preparing approaches for significantly expanding the scale of their support for clean energy finance in large developing countries – particularly the 'Plus 5' countries: China, India, Brazil, Mexico and South Africa. The World Bank released two reports on a Clean Energy Investment Framework in 2006, a short 'Action Plan' in March 2007, and a progress report in September 2007 (World Bank ESSD, 2006; World Bank SD, 2006; World Bank SDN, 2007a, 2007b).

7.2. Financing via the Global Environment Facility (GEF)

The Global Environment Facility (GEF), a financial mechanism of the UNFCCC governed by an independent Council of 32 donor and recipient countries, has been the most important source of dedicated financing for climate change mitigation projects. As of 2004, the GEF had committed more than $1.6 billion for over 500 projects and activities in more than 80 countries, with a total investment value now four to six times greater than at its founding as a pilot programme in 1991

and subsequent restructuring as an independent entity in 1994 (Hennicke et al., 2007). Projects have included financing for the removal of barriers to cost-effective energy efficiency and renewable energy investments, substantial subsidies for several promising climate-friendly technologies (e.g. solar thermal power plants, mobile and stationary fuel cell applications, grid-connected PV, advanced biomass combustion), and measures to promote low-carbon transportation alternatives (e.g. bikeways and bus rapid transit).

7.3. Financing via the carbon market

The GEF was initially a unique source of financing for climate change mitigation projects but, in recent years, carbon trading has become a much larger resource. With the onset of the first commitment period rapidly approaching in 2008, the volume and (inconsistently) the prices paid for carbon offsets have been steadily rising. In 2005, the aggregated value of global carbon markets exceeded $10 billion, with much greater than expected values in the first half of 2006. About half of traded volumes, or about $5 billion, was in developing countries (World Bank and IETA, 2006). Carbon trading cannot be directly compared with the GEF, as the two have very different roles and reach very different types of investments. In contrast with the GEF, which is publicly administered and adopts its programme priorities based primarily on the expected long-term market on GHG emissions, carbon trading is primarily intended to engage the power of the market to find the lowest possible costs of carbon abatement (although numerous specialized funds and 'premium' buyers provide some demand for blended products that achieve a wider range of developmental characteristics).

In the short run, the greatest carbon offset value has been for investments in reducing methane and other GHGs with very high warming effects relative to CO_2. More than half the traded volumes in 2005 were for the destruction of hydrofluorocarbons (HFCs); because of their very high GHG value and low destruction cost, reductions can be had for a cost equivalent to $\$1/tCO_2$ or less, and accomplished relatively quickly. Once such projects are included in the CDM pipeline, the likelihood of success is very high – more than 90%, compared with 64% for wind projects according to UNEP analysis (UNEP, 2007a). Going forward, the availability of reductions from HFCs is finite and, in the most recently available pipeline data (1 April 2007), account for about a quarter of projected 2012 CERs (Certified Emission Reductions).

In contrast, energy efficiency and renewable energy projects are typically relatively small and consequently have correspondingly high transaction costs. Renewable energy projects also tend to have much higher abatement costs. Together, these clean energy projects amounted to only about 10% of volumes in 2005, although this share appears to be rising based on the status of the CDM/JI pipeline as of 1 April 2007 (UNEP, 2007a). In the short term, the concern is the marginal development benefit associated with HFC destruction. In one major project managed by the World Bank in China, the government has agreed to put a substantial share of the proceeds into a trust fund for projects with defined sustainable development benefits.

The HFC projects illustrate the tension inherent in balancing the desire for low-cost carbon abatement in the interests of achieving the overriding objectives of the climate convention, with requirements for a wider range of local development benefits. Both objectives are of obvious importance, although if the imposition of developmental benefits is imposed in an overly restrictive way, the decline in trading could mean few benefits of any kind. This challenge has attracted growing interest from 'think tanks' and individual experts including the World Resources Institute and IISD, resulting in some interesting proposals (e.g. the WRI proposal for Sustainable Development Policies and Measures and the Development Dividend project of the IISD).

7.4. Channelling resources via national policies

The rapid rise in financial resources within the largest and most rapidly growing developing countries suggests that an important priority for influencing financial flows is to identify policies to channel local resources in a more climate-friendly and safe direction. The potential for such strategies has been promoted in numerous recent studies such as the *World Energy Assessment,* beginning with reducing market-distorting subsidies for fossil fuels, which approach $100 billion per year in non-OECD countries (Goldemberg and Johansson, 2004). Bilateral aid agencies and international financial institutions have increasingly focused on such measures to create sustainable frameworks for clean energy development.

In China, a Renewable Energy Promotion law, developed and implemented with the benefit of more than $200 million from the World Bank and Global Environment Facility, took effect on 1 January 2006. The Chinese government adopted the law after an assessment of international models and experience, based on a feed-in tariff approach used in Germany and Spain, in which the purchase of specifically identified renewable energy technologies is mandated at a fixed price. The implementation experience to date has produced mixed results, as the regulations provided a fixed price for biomass but relied on competitive bidding for wind farm development. The winning prices proved to be so low that the developers selected had difficulty in obtaining financing and construction was delayed (Cherni and Kentish, 2007; Wang, 2007).

Another World Bank clean energy programme with GEF support is under development for India, in this case focused on coal-fired power plant rehabilitation. Fossil-fired power plants in India are among the least efficient in the world, about 13% below the world average. If power plants in India, China, and other inefficient countries could be brought up to the standards of those in the Nordic countries and Japan, this would reduce CO_2 emissions by over 800 Mt (Graus et al., 2007). The government of India has initiated a programme to rehabilitate its existing coal-fired stations. The World Bank is supporting this effort with a project to demonstrate energy-efficient rehabilitation as a model for operational practices nationwide (GEF, 2006).

In Mexico, several GEF projects support various elements for the successful development of a wind industry. A UNDP project has been established to enable the creation of a wind turbine research facility, train technicians, and promote joint ventures with wind turbine manufacturers. UNEP is assessing solar and wind resources to provide the basic information essential for siting wind projects. Finally, the World Bank is working with the government to develop and implement electricity regulatory policies favourable to the purchase of wind-generated power, including a competitive purchase system and performance-based incentive payments through a 'green fund', with GEF support (Mata, 2006; REN21, 2006).

These policies are indicative of a growing trend for adoption of renewable energy policies in developing countries. Martinot (2006) identifies such policies, reflecting diverse degrees of commitment and diverse approaches, in Brazil, Chile, Columbia, Egypt, India, Madagascar, Malaysia, Mexico, Morocco, Pakistan, the Philippines, South Africa, Thailand, Tunisia, Turkey and Uganda. From a financial perspective, these policies sometimes provide a critical source of revenue (e.g. via feed-in tariffs and mandatory purchase requirements), but more generally provide project developers with legitimacy and a higher level of public recognition helpful in capital markets. The fact that such policies are designed and implemented by national and local authorities also improves the likelihood that climate change, energy security, and general environmental concerns will be considered alongside other development goals.

8. Implications for policy makers

References to the need for new and additional financing in the Bali Action Plan and recent promises by several donor governments need to be understood in the context of radical changes

in the realities of international finance. Financial power is dispersing as oil-rich countries and Asian central banks are becoming increasingly important players, and potential sources of investment are becoming more diffuse and, in some cases, less transparent. However, these resources are much more volatile, are unevenly distributed, and from a climate-change perspective tend to be more accessible for larger, more established, and more conventional energy sources as opposed to energy efficiency, renewable energy, and other more climate-friendly alternatives. The basic ground rules for commercial investment have not changed; money is drawn to the highest potential return adjusted for risk. Climate-friendly investments are disadvantaged by higher risk, smaller transaction size, and regulatory uncertainty; all of which makes them less attractive relative to more conventional alternatives. Higher oil prices have begun to change this picture and, if maintained over time, will be a powerful inducement to continue the rise in private investment in clean energy.

Financing issues also vary by market and technology. Support for research on early-stage carbon capture and storage is a very different challenge than financing a wind energy project, or a household solar water heater. Local market conditions and the policy environment also always matter; the willingness to invest in a wind project depends not only on the wind regime, but also on regulatory policies that establish the value and certainty of the price to be paid for the electricity generated. A generally good investment climate such as in the USA has only a mixed record in supporting wind energy because the primary form of federal support has been insufficiently predictable – a tax credit approved for relatively short periods that requires regular reauthorization.

The carbon market and GEF-funded projects are two significant, but inadequate, sources of funding for the incremental costs of climate-friendly and safe investments. Policies to channel locally based resources to these goals are beginning to be significant and may have to bear the largest share of the burden in developing countries. As national and local authorities are in the best position to integrate climate change with development goals, this trend may prove to be a highly positive consequence of the new financial realities.

Recent trends with respect to investment in climate-friendly technologies have been promising. However, the challenge for climate policy is the need to move quickly to promote changes on a much larger scale than ever before. This can be done most effectively if policy makers engage with the financial sector to identify the necessary assurances that investments in climate-friendly technologies will – on a competitive basis – be rewarded in the market place. Once the risk of climate change is properly reflected in the investment calculus, financing will follow.

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Notes

1. Discussions at Bali revealed many examples of both the old rhetoric of technology as something owned by the North to be 'transferred' to the South and some insightful discussions of the importance of national policies in creating conditions for investment in technology, as well as examples of technology leadership in developing countries. See, in particular, the High-Level Roundtable Discussion on International Technology Cooperation, a plenary event at COP-13 and part of the Convention video archive (available at www.un.org/webcast/unfccc/2007/index.asp?go=071213).
2. Comparative evaluation of costs of technologies with different characteristics is not a simple matter. For example, investments in gas turbines require assumptions about future gas prices, while investments in wind energy require

localized wind data and an analysis of the system value of an intermittent resource. Moreover, companies and financiers use different decision criteria when making investments, depending on local circumstances and priorities, e.g. net present value, internal rate of return, and payback period. The investment perspective of an individual consumer weighing an additional up-front cost for a more efficient refrigerator will be substantially different from the decision approach employed by a utility seeking to improve its system reliability and expand capacity (WBCSD, 2007).

3. The United Nations Millennium Development Goals (MDGs), adopted by international agreement in 2000, define development targets for reducing world poverty by 2015, including halving the share of the global population living on less than $1 a day (see, generally, www.un.org/millenniumgoals). While there is no energy-focused MDG, numerous studies and reports have focused on the importance of providing modern energy services as a precondition to achieving goals for water, health, sanitation and hunger reduction (Flavin and Aeck, 2005).

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