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Background papers

Background paper I
Global Policy Challenges: climate change and sustainable development

Introduction

As indicated by the Fourth Assessment Report of the IPCC (Intergovernmental Panel on Climate Change), several of the impacts of climate change are gradual, cumulative, and irreversible. With its far-reaching impact on the world's ecosystems as well as human security and development, climate change has emerged as a significant component of the matrix of issues that need policy-makers' attention. Further, that climate change mitigation is a global public good requiring concerted international response adds to the complexity of the problem at hand. As the world economy faces a downturn being seen as one of the worst since the Great Depression, and developing countries grapple with meeting the basic needs of their populations, climate change exposes the human population to exacerbated life and livelihood risks. It is crucial, and even beneficial in the long term, to incorporate measures to address climate change as a core concern in development policy and recovery plans.

This paper discusses the policy challenges that climate change presents at different spatial levels of governance – from the global to the local – and possible ways of addressing potentially conflicting national and international policy agendas. It argues for a close integration of mitigation and adaptation plans into development thinking and planning. It also puts forth a possible structure for a post-2012 climate regime that would account for historic and current responsibilities for GHG emissions. Some key questions that the paper raises and addresses are as follows.

- Why is climate change a critical issue for sustainable development? What are some of the projected impacts of climate change for the Asia and Pacific region?
- What are some possibilities to integrate climate change adaptation and mitigation into mainstream development policy? How can these be affected at different levels of governance?
- What would be some of the characteristics of an equitable and effective post-2012 climate regime?
- What are the implications of the global financial crisis on policy decisions regarding climate change adaptation and mitigation?

That climate change mitigation and adaptation needs to be seen as an integral component of sustainable development action is beyond doubt. What requires attention is how countries can rally their resources towards policies that produce co-benefits for economic growth and mitigation; how they can collaborate to further sustainable development; and what are the institutional structures that need to be in place to implement programs and verify action. The Asia and Pacific region, home to a large number of developing economies and SIDS (small island developing states), is in a particularly precarious situation. Governments in the region, therefore, need to be keenly aware of the risks and vulnerabilities that the region is expected to deal with, and in some cases is already facing.

Projected impacts of climate change, and the inertia of climate and energy systems

Over the past 100 years, the world has experienced warming of about 0.74°, and the IPCC projects further warming of between 1.1 °C and 6.4 °C over the 21st century.

This would induce changes, larger and more intense than those observed during the 20th century. The impacts are projected to vary according to the timing and magnitude of change, as well as adaptive capacity. According to the IPCC, the resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances (for example, floods, droughts, wildfires, insects, and ocean acidification), and other global change drivers.

It is notable that the impacts of climate change will fall disproportionately upon developing countries and poor persons within all countries. The causes for these are numerous, ranging from the heavy dependence of developing economies on agriculture, to the lack of available resources for adaptation and mitigation. Projected reductions in agricultural yield in some countries are as much as 50% by 2020, with small-scale farmers being the most affected.[1] In Africa by 2020, between 75 and 250 million people are expected to be exposed to increased water stress due to climate change.

In addition, model experiments show that even if all radiative forcing agents were held constant at year 2000 levels, a further warming trend would occur in the next two decades at a rate of about 0.1 °C per decade, due mainly to the slow response of the oceans.[2] Thus, the projected impacts of climate change, when considered in conjunction with the inertia of the climate system, make a strong case for immediate action. The inertia of global energy systems provides another dimension to the time scales required for climate policies to be effective. It has taken at least 50 years for each major energy source to move from 1% penetration to a major position in global supplies, which underscores the long-term impacts of present energy infrastructure. Future energy infrastructure investment decisions, expected to total over US $20 trillion between now and 2030, will have long-term impacts on GHG (greenhouse gas) emissions, because of the long lifetimes of energy plants and other infrastructure capital stock. Initial estimates show that returning global energy-related CO_2 (carbon dioxide) emissions to 2005 levels by 2030 would require a large shift in the pattern of investment, although the net additional investment required ranges from negligible to 5%–10% GW3 [4.1, 4.4, 11.6] (SPM p.18).

Climate and development: the inter-linkages

Climate variability and development parameters of growth, welfare, and sustainability are intrinsically linked. Intense climate change impacts can come to offset the gains that have been made by development programs in the last few decades. Also, mitigation and adaptation needs imply a re-direction of funds, time and effort, from poverty alleviation/welfare programmes to management of climate-related challenges. Increasingly, it is also being noted that policy measures being implemented to counter climate change are exacerbating socio-economic risks, for instance the impact of aggressive biofuels production on food security. This calls for cautious and informed policy-making for it is amply clear that neither development, nor climate mitigation and adaptation, can be sacrificed at the altar of the other.

Climate and the MDGs

The UN's MDGs (Millennium Development Goals) Report 2008, an assessment of progress towards achieving the MDGs,[3] identifies the disproportionate, adverse impact of climate change on the world's poor as a significant challenge to development. The

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1 WG2 Chapter 9 p.435

2 {9.4, 10.3, 10.5, 11.2} (SPM p.12)

3 The MDGs (Millennium Development Goals) were adopted as part of the United Nations Millennium Declaration in September 2000. These 'form a blueprint [for development] agreed to by all the world's countries and all the world's leading development institutions'.

maintenance of a healthy, stable ecology is central to the achievement of all MDGs, and the degradation of ecosystems and the natural resource base brought about by climate change directly impinges on development aims (Table 1).

Table 1 Implications of Climate Change for Certain Key Millennium Development Goals

Millennium Development Goals	*Linkages with climate*
MDG 1 Eradicate extreme poverty and hunger	The Millennium Development Goal of eradicating extreme poverty and hunger involves reducing, by 50%, the number of people living on $1 per day and the people affected by hunger (with 1990 as baseline). It also encompasses the provision of productive employment for all. Destruction of livelihood assets due to climate disasters, and the financial requirements of adaptation and mitigation, hit at the core of development – poverty alleviation. Climate variability, prevalence of floods and droughts, and the resultant water stress, have a pronounced influence on farm productivity and consequently world food security. Rising food prices make basic nutrition inaccessible while also reducing the finances available with the poor for education and health services.
MDG 2 Achieve universal primary education	Destruction of educational infrastructure and deterioration in standards of living due to adverse climate conditions will impede achievement of universal primary education. Displacement due to climate-related catastrophes can further exacerbate the situation.
MDG 3 Promote gender equality and empower women	Women, given their roles in the household (which involve significant interaction with the environment), will face the brunt of climate change. Agriculture, an important source of livelihood for women in rural areas, is one sector that is expected to be amongst the worst hit.
MDG 4 Reduce child mortality	Programmes targeted at achieving health-related MDGs will need to contend with rise in the incidence of vector-borne and water-borne diseases, and growing malnutrition. (The endemicity and epidemicity of vector-borne diseases like malaria are influenced by climate changes [Hellmuth and Bhojwani 2007]).
MDG 7 Ensure environmental sustainability	Climate change is closely tied with resource loss and non-availability of adequate and quality water services, even while GHG emissions contributing to climate change are amongst the biggest threat to the environment.
MDG 8 Develop a global partnership for development	Developing a global partnership for development is not only a stand- alone MDG but is key to meeting the other goals as well. Climate change provides both a challenge and opportunity for building a global partnership that is equitable and effective. Environment as a 'global common' needs to be governed in a framework of transnational governance that takes on board the interests of all countries and communities.

Integration of climate and development action

Clearly, the two categories of climate risk management, and development, are not mutually exclusive. Development is not about economic growth and creation of wealth alone, but encompasses protection of natural ecosystems, and effective governance of resources. A holistic conception of development needs to take into account environmental sustainability, and international and inter-generational equity.

The grave threat that climate change poses to human development calls for innovative thinking that ties up multiple objectives, integrating economic growth, human security, social empowerment, and sustainability. Development policies that have co-benefits for climate mitigation and adaptation, therefore, need to be foregrounded in both developed and developing countries. A recent major policy initiative that seeks to mainstream climate change mitigation into development policy has been the Republic of Korea's 'green growth' strategy unveiled in 2008, in which the government aims to invest 3 trillion Won (US $2.7 billion) in the next five years to foster green energy sector, and to capture 13% of the global market share by 2030 in the green energy sector.[4] According to some estimates, the green energy industry in the Republic of Korea will create about 950 000 new jobs by 2030.[5] Similarly, the World Resources Report highlights how resource-based enterprise, coupled with tenure rights and supportive government policies, can help rural communities boost income and increase agricultural yield, while reducing their vulnerability to climate change (Schwin 2008).

Energy sector transformations that meet development objectives such as ensuring access to lifeline energy to the poor while prioritizing low-carbon, renewable energy sources is another example. Developing countries have more than 40% of existing renewable energy capacity. This includes 70% of solar hot water capacity and 45% of biofuel production (Lloyd and Subbarao 2009). Developing this potential should be a significant component of a low-carbon growth strategy that taps on climate change mitigation and economic development synergies. In developing countries, where a large proportion of the population still does not enjoy access to modern forms of energy, increased access to modern energy is integral to poverty alleviation. Further, efforts geared towards reduction in energy intensity and improvements in energy efficiency need to be promoted and accelerated. Technology choices that can help reduce energy consumption and have short payback periods are now available both for retrofitting and for new ventures. As countries invest in infrastructure, optimal use of these available choices can help chart a sustainable development pathway.

Governance challenges: from the global to the local

The challenge of addressing the twin concerns of climate and development confronts policy-makers at all levels today. The specific policy challenges encountered at the different levels of governance are discussed here. Several of these issues present some degree of overlap as well as trade-offs, which underscores the need to ensure adequate communication and coordination between levels of governance, as well as harmonization of policies to ensure that the overarching goals of reducing climate vulnerabilities and pursuing appropriate mitigative action are met.

The global level

At the global level, optimal allocation of the carbon budget that recognizes the development imperatives of emerging and under-developed countries is key. Countries need to arrive at a collectively agreed climate stabilization target, and equitably and

[4] Details available at, http://www.redorbit.com/news/science/1552999/s_korea_to_focus_on_green_growth/index.html

[5] Details available at, http://www.iea.org/Textbase/Papers/Roundtable_SLT/korea_oct08.pdf

pragmatically allocate both the right to emit and the responsibility to tackle climate change. That the developed countries have reached the current level of development following a high carbon growth path needs to be recognized in determining the responsibilities of developing countries today. A primary international climate policy challenge is with regard to allocating responsibility for emission reduction. Consensus regarding who should mitigate, and by how much, is clearly a crucial first step for a successful international climate agreement. Yet the very nature of the climate change problem, combined with the costs of mitigation and international economic competition, means that the effects of mitigative action by one or few countries are likely to be insignificant, even if those countries agree to reduce emissions. This presents an international coordination challenge that requires countries at all levels of development to be committed and actively involved. Past successful international environmental interventions such as the Montreal Protocol in Substances that Deplete the Ozone Layer provide encouraging evidence that concerted international action is a viable means to tackle a global environmental issue.

Technology is a key component of the strategy to decouple energy intensity and development, and can help enable a future where energy needs and climate concerns are addressed simultaneously (Mathur, et al. 2009). Many technologies that have the potential to provide solutions for low-carbon development are already available, though several are not yet economically competitive. The IPCC Fourth Assessment Report stresses, however, that 'without substantial investment flows and effective technology transfer, it may be difficult to achieve emission reduction at a significant scale. Mobilizing financing of incremental costs of low-carbon technologies is important {5.5}'.

While it is widely recognized that developing countries cannot introduce systemic changes in their energy systems without technology transfer and/or assistance from the developed countries, technology transfer has failed to kick-start. Some of the barriers here include intellectual property rights around technology innovation and access, limited institutional support, lack of technical standards, non-transparent markets, lack of access to capital, and unclear arbitration procedures (UNFCCC 1998, Srinivasan 2006 [cited in du Pont, et al. 2007]). The process involves multiple stakeholders that straddle across the public and private sector divide, bringing in crucial discussions on ownership, profit, and monopolization of knowledge.

Given the constraints encountered in transfer of technologies, collaborative technology development and knowledge sharing on technology acquire great significance. While both public and private players may engage in such ventures, the government will need to play the role of the initiator and the catalyst. The policy-making apparatus can work towards ensuring that both the corporate sector and the government earmark funds for technology R&D. This is of particular relevance for clean coal technologies, and solar thermal and photovoltaics. The latter's deployment in the developing world is often constrained by large costs, but recent technological developments allow for scope in reduction of per unit cost of solar power. Establishing effective institutional mechanisms and a conducive policy environment, both at the national and international levels, is vital for the development of low-carbon technologies and their diffusion into mainstream use. For instance, through targeted policy initiatives and enabling favorable conditions for research and development of low-carbon technologies, the output in Japan's industrial sector nearly tripled between 1973 to the present, but kept its energy consumption roughly flat.

The operationalization of CDM is targeted at facilitating developed countries' assistance to the developing world 'for implementing environmentally benign projects through technology transfer or financial investments for a return of emission reduction units or CERs (certified emission reductions)' (Lloyd and Subbarao 2009). The CDM, however, has failed to meet the dual objectives of emission reduction and furtherance

of sustainable development in developing host countries. It is being suggested that CDM procedures need to be reframed such that appropriate sustainability development standards are adopted, and the poor in developing countries see themselves accruing tangible benefits from projects (Lloyd and Subbarao 2009).

Channellization of funds for mitigation remains an important challenge. In 2030, macro-economic costs for multi-gas mitigation, consistent with emissions trajectories towards stabilization between 445 PPM (parts per million) and 710 PPM CO_2-eq, are estimated at between a 3% decrease of global GDP and a small increase, compared to the baseline. However, regional costs may differ significantly from global averages.[6] With regard to long-term mitigation, in 2050, the estimated global average macro-economic costs for multi-gas mitigation towards stabilization between 710 PPM and 445 PPM CO_2-eq, are between a 1% gain to a 5.5% decrease in global GDP (gross domestic product). For specific countries and sectors, costs vary considerably from the global average.

Adequate allocation of money for adaptation, and transparent management of these funds, is another area that needs immediate attention. The GEF (Global Environmental Fund) finances adaptation through the GEF Trust Fund (under the Strategic Pilot on Adaptation) and two new climate change funds: the Least Developed Countries Fund and the Special Climate Change Fund. Total funds currently available for adaptation total $320 million[7] (total pledges), in four complementary Adaptation Funds

- SPA (Strategic Priority on Adaptation) (GEF Trust Fund): $50 million
- LDCF (Least Developed Countries' Fund) (UNFCCC): $180 million
- SCCF (Special Climate Change Fund) (UNFCCC): $90 million
- Adaptation Fund under discussion (Kyoto Protocol) (to be financed with 2% of the CERs [certified emission reductions] issued for projects of the CDM [Clean Development Mechanism] and funds from other sources): estimated $80–$300 million/year between 2008 and 2012

However, an Oxfam International study estimates that at least US $50 billion will be required per year to support adaptation measures in the developing world if current emission rates are stabilized. The clauses in the recently announced World Bank Climate Adaptation Funds also reveal gaps in the adaptation funding mechanisms for developing nations. Concerns have been with regard to the Bank's Adaptation/Climate Resilience Pilot Fund, mostly expressing that 'it is inappropriate to use loans given that the problems that developing countries must tackle were largely created by rich countries in the first place'.[8]

The regional level

The growing 'functional globality' of regional organizations has brought into focus the role that regional alliances can play in addressing new emerging global threats (Suominen 2005). Ray Hudson makes a strong statement for a return to the region on three counts: as a sustainable economic space, as a space for sustainable mobility and movement, and as a space for waste disposal and recycling. Hudson argues that the

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6 IPCC WG3 SPM p.16

7 Details available at, www.povertyenvironment.net/?q=filestore2/download/1817/PEP13-GEFfunding-Hale.ppt

8 In a letter sent to UK Secretary of State for International Development, Douglas Alexander, on Tuesday 11 March 2008, representatives from over 20 UK-based and international NGOs said that the current rush to finalize the proposals for the funds could lead to the establishment of 'top-down funds, without adequate participation of developing countries, without much needed accountability mechanisms, and without promoting the wider environmental and development benefits and sustainable transformations'.

region in the context of sustainable development forces us to think 'seriously about returning to more localized and regionalized ways of living, predicated on a different conception of what constitutes development' (Hudson 2007, p. 829).

Regional organizations stand in a position to provide finance and knowledge support to state policy apparatuses, and reinforce state efforts for securing energy supplies, developing alternate sources of energy, and undertaking mitigation and adaptation initiatives. The institution of regional mitigation and adaptation funds for the region is one possible support mechanism that regional initiatives can work towards for facilitating the move towards a low-carbon economy. Knowledge sharing on technology and capacity building are other areas where regional organizations can contribute, to feed into both national and international programmes. The region provides an optimal policy space for inter-state cooperation in technology innovation. If a region comprises mainly of developing countries, a coming together of their resources and strengths can help the region leapfrog stages of technology development.

In Asia and the Pacific, one of the key concerns is meeting the growing demand for energy in a climate-constrained policy environment. Several governmental and inter-governmental initiatives have been taken to establish mechanisms to cap emissions through a movement towards renewable energy and energy efficiency, and institute information and monitoring systems for risk assessment and disaster forewarning. Given the Asia and Pacific region's growing development and energy needs, its contribution to global CO_2 emissions, as well as its vulnerability to climate change, integrating climate change adaptation into mainstream development policy is a crucial component of sustainable development path. This would also facilitate decelerating the unsustainable growth patterns that impose significant long-term costs on the economy.

In building capacity for adaptation, a key concern is ensuring the protection of vulnerable groups and communities. Moreover, for small island states threatened by sea level rise, climate change is an issue akin to survival rather than growth or development. Asia and the Pacific, home to 22 small island states, including Maldives, Cook Islands, Papua New Guinea, and Fiji Islands, is significantly vulnerable to the loss of land and resources, and migration flows arising from such developments. Announced in 2005, the Asia and Pacific Partnership on Clean Development and Climate, also known as APP, covers cooperation on development and technology transfer required for reduction in emissions. A non-treaty agreement between Australia, Canada, India, Japan, the People's Republic of China, the Republic of Korea, and the United States, it allows the states to set emission reduction targets individually.

A declaration on Climate Change, Energy, and Clean Development was also signed by APEC in September 2007. The APEC agenda defined in the declaration ranged from decreasing energy efficiency to forest management, and trade in environmental goods and services (APEC 2007).

The national and the local

Adaptation alone cannot be expected to cope with all the projected effects of climate change, and especially not over the long run as most impacts increase in magnitude.[9] It has been well established that delayed emission reductions lead to investments that lock in more emission-intensive infrastructure and development pathways. This significantly constrains the opportunities to achieve lower stabilization levels and increases the risk of more severe climate change impacts.[10] Mitigation initiatives therefore need to be undertaken in conjunction with, and be integrated into mainstream development policies. National governments need to pursue enabling policies that promote clean

[9] WG2 [Table SPM-1] (SPM p. 17)

[10] WG3 SPM p. 28

development. Regulatory and financial incentives for demand side management of energy and uptake of clean technologies are important areas that call for intervention. A study conducted by TERI (The Energy and Resources Institute), for instance, estimated that environmental costs in India exceed 10% of the GDP as a result of loss in agricultural productivity, loss in timber value due to degradation of forests, depletion of water resources, and health costs due to polluted water and air.[11]

Local community groups and NGOs have contributed cumulatively to abating climate change (Gitonga, cited in Lloyd and Subbarao 2009), and need to be seen as important actors in mitigating and adapting to climate change. Local institutions all over the world have demonstrated the ability to adapt to several environmental hazards over time, such as the increased adaptation to cyclones in Bangladesh and to growing water scarcity in Sub-Sahelian Africa. Similarly, appropriate resource management such as watershed development can allow local communities to assume ownership of their immediate resource base, and help build their capacity to deal with climate vagaries. However, institutional capacity to deal with climate change is not sufficiently developed at the local level. This may partly stem from the fact that climate change poses 'novel' risks,[12] which may lie outside the range of experience, such as impacts related to drought, heat-waves, accelerated glacier retreat, and hurricane intensity.[13] Further, the impacts of climate change are widely acknowledged to be exacerbated by multiple stressors such as population growth and conflict. Thus, institutional mechanisms that address adaptation while also ameliorating some of the other stressors are likely to be most effective.

Even in the developed economies, certain age groups and socio-economic strata are more vulnerable to climate change and to extreme climatic events. This is illustrated by the fact that the elderly were the most affected during the 2003 heat wave in Europe, which resulted in nearly 35 000 deaths. According to the IPCC's Second Working Group report, increases in income levels, education and technical skills, and improvements in public food distribution, disaster preparedness and management, and health care systems through sustainable and equitable development could substantially enhance social capital and reduce the vulnerability of developing countries of Asia to climate change (WG2 Chapter 10, p. 4). Institutional reform within countries should include consolidation of scientific information and empirical data at the grass-roots level, disaster preparedness, and establishment of institutions to closely monitor progress on mitigation.

Since institutional capacity and strength is key in the management of environmental issues, it is vital to develop targeted mechanisms that would enable the integration of climate change and environmental policy into mainstream economic policies. An examination of the role of institutions at all levels, and the possibilities for synergies amongst them, would provide an indication of the current gaps, as well as possible mechanisms to address the same.

Post-2012 regime: towards an equitable, multi-track framework

The search for climate solutions is compounded by the states' unequal contribution to the problem of climate change, unequal capacity to deal with the imminent threats, and the disproportionate impact on the poor and marginalized—those least responsible for the phenomenon of climate change. While this strengthens the argument for collaborative action by states, it also takes away from the ease of arriving at a multilateral solution.

Under the Kyoto Protocol, the operationalization of the adopted principle of common but differential responsibilities has been far from smooth. The Annex 1 countries have not succeeded at achieving their emission reduction targets. Developing

[11] Green India 2047, TERI
[12] IPCC Third Working Group
[13] WG 2 Chapter 17, p. 2

countries continue to demand their exemption from taking up targets, while urging the developed countries to effectively meet their commitment on sharing of funds, knowledge and technology with developing countries.

Reducing disparities through contraction and convergence

In order to allocate responsibility for emission reduction, numerous theories have been suggested, ranging from the simple 'total emissions' estimates to the much more complex 'contraction and convergence' estimates that seek to quantify a country's responsibility at a 'fair' level by which emissions should be reduced. The framework of contraction and convergence provides a flexible methodology to address the problem of allocation of emission rights. The contraction of overall world emissions pursued along with the convergence of countries' average per capita emissions, allows developing countries to partake of the carbon budget. This is achieved while both the developed and the developing countries put in place mechanisms to minimize growth in overall emissions, the developed countries taking into account the developing countries need to exceed their current emission levels in the pursuit of economic growth.

The per capita entitlements approach is an effective one in that it takes into account historical responsibility and is based on the egalitarian distribution of the commons, within which international justice positions of causal responsibility such as the 'polluter pays principle,' come in (Vivekanandan, et al. 2008). This is significant because historical emissions amount to about 1100 tonnes of CO_2 per capita for the US and the UK, while the People's Republic of China's stand at 66 tonnes per capita and India's at 23 tonnes per capita. Currently, the per capita emissions figures for the US, the People's Republic of China, and India stand at 20 tonnes, 6 tonnes, and 1 tonne respectively.

Post 2012, a multi-track framework that takes into account historical responsibility, equity implications, and future emissions would address some of the more critical issues in building a consensus on 'common but differentiated' responsibilities of countries, and enable action by countries at all levels of development, if not in the form of quantitative reduction targets, then by policy-based commitments. This would involve more stringent reduction responsibilities and clear quantitative targets for Annex-I countries, and more sector-specific policy-based initiatives in other countries, including the fast-growing emerging economies. Over time, this flexible mechanism could be made more stringent for developing countries as they reach a certain level of development. This would enable developing countries to participate in the emissions reduction process while also pursuing low-carbon economic growth.

The economic crisis and its implications for climate change policy

The ongoing financial crisis has been a considerable blow to the global economy, with the IMF (International Monetary Fund) estimating that the world economy is projected to contract by 1.3% this year—the deepest recession since the Second World War.[14] The value of the world's companies that have been wiped out stood at about $14.5 trillion by February 2009, which is higher than the GDP of US ($13.8 trillion), nearly six times UK's GDP ($2.5 trillion), and 29 times the debt of the poorest countries, which was $ 0.5 trillion.

Economies in the Asia and Pacific region have been affected significantly in some cases. For instance, in January 2009, Japan's industrial production fell by 10%, the biggest monthly drop since their records began.[15] India and the People's Republic of China's GDP growth forecasts have been adjusted significantly downward as well. The Chinese

[14] Details available at, http://www.cbc.ca/money/story/2009/04/22/imf-economy-world.html?ref=rss

[15] Details available at, http://www.globalissues.org/article/768/global-financial-crisis#Asiaandthefinancialcrisis

economy is expected to see growth of 6.5% in 2009 and the Indian economy to slow to a growth rate of 4.5%.[16] Given this, governments have in several cases announced short-term revival measures, with the crisis taking centre stage. The global financial crisis can affect not only the reduced overall availability of funds for adaptation and mitigation, but also on key long-term aspects such as reduced expenditure on R&D in clean energy technologies.

Despite this, there are several opportunities to integrate climate policy into mainstream economic policy, and it is crucial to ensure that policy-makers make a conscious effort to maximize and utilize these opportunities. The US stimulus package for instance contains provisos for federal 'green' buildings and funding for renewable energy projects. According to a study by ICF International, the $838-billion package would deliver a minimum GHG savings of 61 MT per year, and could result in deeper emission cuts.[17]

The February 2009 report by HSBC, A Climate for Recovery, analyses 20 economic recovery plans, and estimates that about 15% of the $2.8-trillion initiatives can be associated with investments consistent with some degree of mitigation measures. Out of these, the People's Republic of China's stimulus plan involved the largest outlay for such investments (about $221 billion), with the Republic of Korea ranking the first in terms of a plan with the largest percentage of 'green' investments (81%).[18]

These policies can also leverage co-benefits such as energy security, employment generation in the relatively employment-intensive renewable energy sector, as well as costs savings due to energy efficiency initiatives. In addition, the crisis may enable a paradigm shift towards a more long-term perspective in formulating investment decisions, which then increases the potential role of climate change in the same—for instance, insurance companies integrating climate risk in valuations. It is vital to ensure that unsustainable economic policies are modified to take into account broad-based and climate-friendly development, by synergizing public and private sector initiatives, and establishing both enabling policies and targeted regulations that facilitate financial flows where they would be most effective.

Conclusion

The growing concern over climate change has ensured that climate concerns have made inroads into development policy. Over the last few decades, climate change has come to influence the contours of sustainable development discourse and action. There are several common drivers between policies addressing economic development, energy security, and health and climate change mitigation. These indicate the various opportunities available for no-regrets mitigation policies—ones that would enable integrating mitigation into the overall socio-economic policy framework.

While there are synergies that can be easily mapped, with competing objectives and agendas on the table, policy-makers are often confronted by choices that involve critical trade-offs. It is here that multiple stakeholders need to be consulted to chart priority development goals and pathways. That countries and communities the world over enjoy different strengths and capabilities implies that the sustainable development project can only be a collaborative one.

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[16] Details available at, http://www.cbc.ca/money/story/2009/04/22/imf-economy-world.html?ref=rss

[17] Details available at, http://www.bellona.org/articles/articles_2009/senate_oks_stimulus

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Background paper II
Addressing climate change through innovative technologies

Introduction

Climate change has emerged as one of the most pressing development issues of the century, and its implications for the availability for global resources as well as human security necessitate immediate, committed, and widespread action on a global scale. Appropriate technological solutions can facilitate both enhanced adaptive capacity as well as greater mitigation potential at a lower cost.

There are numerous issues that affect the availability of these solutions including lack of capacity, a conducive policy environment for technology R&D (research and development) as well as dissemination, and impediments to technology transfer, which would facilitate enhanced mitigative potential and adaptive capacities in developing economies. This paper discusses the role of technology in climate change adaptation and mitigation, and the issues surrounding availability of suitable technologies such as ensuring favorable policies and technology transfer, with a special focus on the Asia and Pacific region. It then discusses four key mitigation technologies for the Asia and Pacific region, namely, clean coal technologies, nuclear, renewable energy, and energy efficiency technologies.

The paper addresses the following questions:

- What are the projected energy requirements, globally and for the Asia and Pacific region in particular, and what are their implications for future GHG (greenhouse gas) emissions given the current and projected energy mix?
- What are some of the opportunities, costs, and benefits, including co-benefits, of incorporating mitigation technologies in the development process?
- What are some adaptation technologies available, and how can their use and dissemination be scaled-up?
- How can appropriate policies facilitate timely and widespread dissemination of adaptation and mitigation technologies?
- What is the potential role of technology transfer in facilitating availability of technologies to address climate change, and what are some impediments to smooth technology transfer, including skill transfer?
- What are some key mitigation technologies for the Asia and Pacific region, their mitigation potential and issues regarding their dissemination and use?

The development of the modern industrial world has been greatly dependent on technological development, which has been a critical driver of growth for the developed world, as well as a key source of comparative advantage. However, several of these technologies have enabled accelerated depletion of natural resources, including fossil fuels, which have directly caused manifold increases in GHG emissions and contributed to climate change. According to the IPCC (Intergovernmental Panel on Climate Change) Fourth Assessment Report, inter-temporal data reveals that the rate of rising global mean temperature in the last 50 years has been nearly twice that compared to the time before that, beginning with1850, that is, around the time of the Industrial Revolution (Figure 1).

Thus, the need to develop clean technologies that would enable mitigation and facilitate sustainable development and poverty reduction is one of the most crucial needs of the Asia and Pacific region, which includes some of the largest as well as the fastest growing economies of the world. This need is exacerbated by the fact that the region includes some of the most vulnerable nations to sea-level rise, such as the small island states as well as developing economies with long coastlines, such as India.

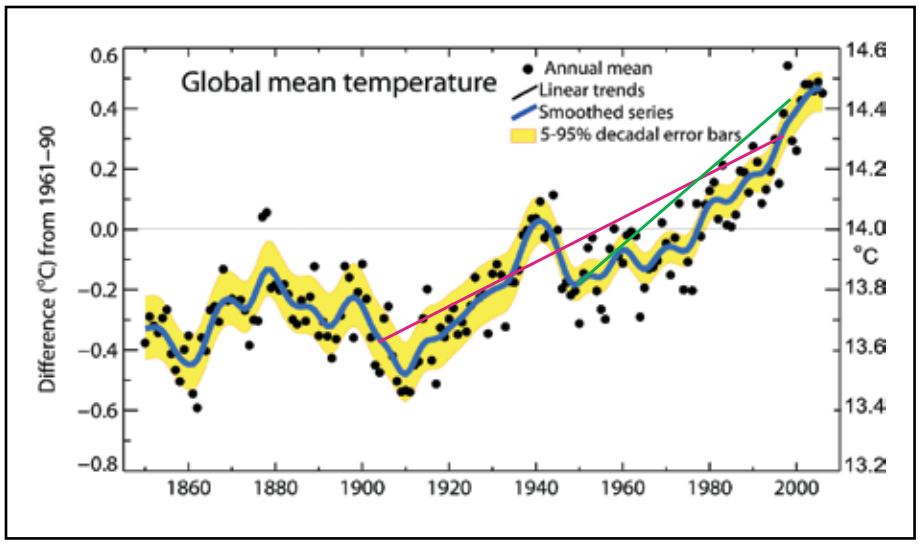

Figure 1 Global mean temperature in the last 50 years

Development and energy needs, and the need for reorienting the energy mix

The rising energy needs required to maintain the high economic growth rates of the region, as well as the altered and scaled-up consumption patterns accompanying the development process, have significant implications for the region's emissions trajectory. Some indicators highlighting these impacts are highlighted below.

The demand for primary energy is projected to increase globally by a factor of 1.6 to 3.5 between now and 2050, and in developing countries by a factor of 2.3 to 5.2.[1] If the region's robust economic growth continues, the energy consumption of developing Asian countries alone will more than double during the next 25 years, while CO_2 (carbon dioxide) emissions will increase more than three-fold as energy supplies become more carbon intensive. Figure 2 illustrates both the magnitude of incremental primary energy demand in the region in the IEA's (International Energy Agency) Reference Scenario, 2006–30, as well as the large share of fossils fuels in the energy mix. Ninety seven per cent of the projected increase in emissions between now and 2030 comes from non-OECD countries— three-quarters from the People's Republic of China, India, and the Middle East alone.[2]

If current trends continue, by 2035, there will be about 250 million more cars and SUVs operating in the People's Republic of China and India. During the past 30 years, the number of vehicles has increased 9-fold in ASEAN countries, 11-fold in India, and 16-fold in the People's Republic of China. The increased demand for transportation will lead to a 2.6-fold increase in oil demand in developing Asia during this period, and a corresponding 3-fold increase in CO_2 emissions.

Presently, under-investment in energy reduces GDP growth in some countries by as much as 1%–4% annually. The IEA estimates that developing countries need an annual investment for electricity supply of $160 billion through 2010, increasing at about 3% per year through 2030.[3]

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[1] http://siteresources.worldbank.org/EXTSDNETWORK/Resources/2007_CleanEnergyFrameworkBooklet_Final.pdf?resourceurlname=2007_CleanEnergyFrameworkBooklet_Final.pdf

[2] WEO 2008 Slide Library

[3] http://siteresources.worldbank.org/EXTSDNETWORK/Resources/2007_CleanEnergyFrameworkBooklet_Final.pdf?resourceurlname=2007_CleanEnergyFrameworkBooklet_Final.pdf

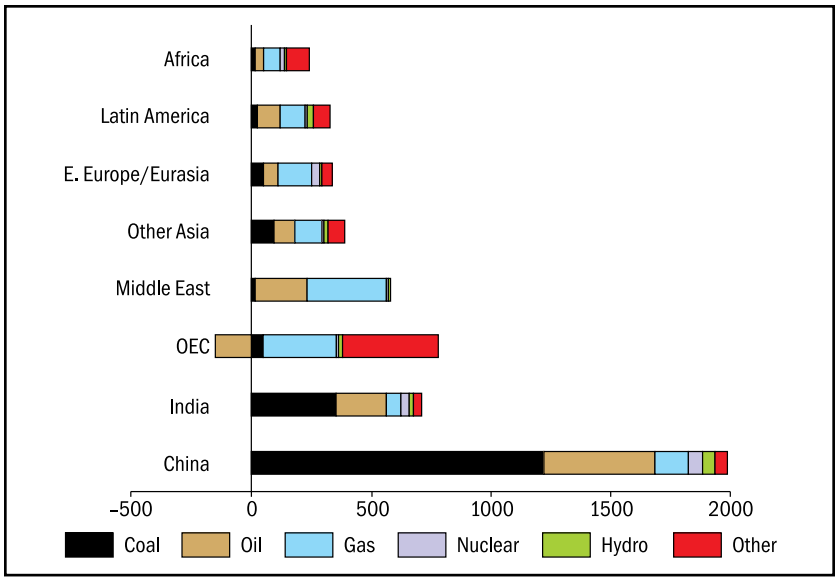

Figure 2 Incremental primary energy demand in the IEA's Reference Scenario, 2006-2030, by Fuel

Source WEO 2008 Slide Library

Incremental primary energy demand in the IEA's reference scenario, 2006–30

Climate-friendly renewable energy resources in a business-as-usual scenario will continue to supply a small (<10%) proportion of the primary energy mix in developing Asia, despite some recent acceleration in growth.

Meeting the energy needs of the hundreds of millions of people in the Asia and Pacific region who lack access to electricity sustainably is a significant challenge, and will imply a rising emissions trajectory, at least in the short-run. Out of the 1.6 billion people who currently lack access to electricity, 400 million are in India alone.

Given these constraints, as well as those imposed by the delayed responses of the natural climate systems to mitigation action, technologies and policies that either reduce the energy needs of development, or shift production and consumption patterns towards alternate sustainable paths are vital.

Energy security and other co-benefits

Mitigation technologies enable reduced climate change vulnerability as well as multiple co-benefits. These, if valued appropriately, can greatly reduce the real costs of their implementation. Energy security is one of the most significant of these. Asia now imports more than 44% of the oil it consumes, up from 7% during the 1970s and 1980s, and 32% in the 1990s. By 2030, between 40% and 75% of natural gas requirements will need to be imported.[4] All of the growth in oil demand in the IEA's reference scenario comes from non-OECD, with the People's Republic of China contributing 43%, the Middle East and India each about 20%, and other emerging Asian economies most of the rest.[5]

According to the IPCC Fourth Assessment Report, 'there is high agreement and much evidence that in all analysed world regions near-term health co-benefits from reduced air pollution, as a result of actions to reduce GHG emissions, can be substantial and may offset a substantial fraction of mitigation costs'.[6]

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[4] FROM IDEAS TO ACTION, Clean Energy Solutions for Asia to Address Climate Change, USAID Report, May 2007

[5] WEO 2008 Slide Library

[6] IPCC Fourth Assessment Report, Working Group III, Summary for Policymakers

Including co-benefits such as health benefits, increased potential for rural employment and increased agricultural production and reduced pressure on natural ecosystems, due to decreased tropospheric ozone concentrations, would further enhance cost savings. In least developed countries, energy substitution can lower mortality and morbidity by reducing indoor air pollution, reduce the workload for women and children, and decrease the unsustainable use of fuelwood and related deforestation.[7]

However, the benefits are highly dependent on the policies, technologies, and sectors chosen. In developing countries, much of the health benefit could result from improvements in the efficiency of, or switching away from, the traditional use of coal and biomass. Such near-term co-benefits of GHG control provide the opportunity for a true no-regrets GHG reduction policy in which substantial advantages accrue even if the impact of human-induced climate change itself turns out to be less than that indicated by current projections.[8]

Establishing appropriate policy measures

According to the Fourth Assessment Report, there is high agreement and much evidence that all stabilization levels assessed can be achieved by deployment of a portfolio of technologies that are either currently available or expected to be commercialized in the coming decades, assuming appropriate and effective incentives are in place for their development, acquisition, deployment, and diffusion and addressing related barriers. However, the report also emphasizes that without substantial investment flows and effective technology transfer, it may be difficult to achieve emission reduction at a significant scale.

Two important sources of technological change are as follows:

- R&D (set of activities in which firms, governments or other entities expend resources specifically to gain new knowledge that can be embodied in new or improved technology).
- Spillovers (transfer of the knowledge or the economic benefits of innovation from one individual, firm, industry or other entity, or from one technology to another).

While technological progress is needed to achieve some emissions reductions, efficiency gains and deployment of existing low-carbon energy accounts for most of the savings. Although 75% of power sector CO_2 emissions in 2020 are already 'locked-in', investments in the next decade will be critical to a low-carbon future in the longer term.

Technology transfer: possibilities and issues

The impacts of climate change are projected to fall disproportionately on developing nations where 80% of the world's population lives. Technology transfer is crucial to equip developing countries to mitigate and adapt to climate change, and governments and businesses both need to take the initiative to develop appropriate solutions for technology transfer. This was emphasized in the Bali Action Plan, which called for 'enhanced action on technology development and transfer to support action on mitigation and adaptation'.

The current literature underscores the inadequacy of presently available UNFCCC funds for mitigation, as well as the need for more favorable for environment–friendly technologies. In addition, a large part of what has been accounted for as TT is only infra and capacity building. Public investment in R&D is one of the vital long-term solutions to the challenge of large-scale availability of technology. However, given the

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7 IPCC Fourth Assessment Report, Working Group III, Summary for Policymakers

8 WG3 Chapter 11 p.623

largely private ownership of current technologies, subsidizing technology transfer may not have a significant impact.[9]

There are numerous opportunity available in the future high-emitting nations in the Asia and Pacific region to 'leapfrog' to next generation low-emitting technologies. The IPR (Intellectual Property Rights) regimes, as they currently stand, pose some barriers to large-scale technology transfer, although given the increasing demand by developing nations for low-carbon technologies – for instance, India's new standards and labelling programme which will require large-scale use of energy-efficient technologies – several initiatives to streamline technology transfer have been proposed, such as a compulsory licensing regime, which would enable the user to pay a royalty and use the technology without the patenter's permission.

Technology partnerships that would involve skill transfer and capacity building can prove very effective in facilitating the widespread dissemination and use of the technology. A global technology fund may provide an additional partial solution, to enable technology and R&D partnerships among developed and developing economies.

In addition, sector-specific technology transfer can provide an effective mechanism for technology partnership and customization, especially since the nature and need of technology transfer in different sectors are different.[10] Other issues that hamper technology transfer are inadequate institutions to allow technology to be transferred, and lack of institutional and skill capabilities.

Regional cooperation

Regional cooperation, in the form of technology partnerships as well as trade in clean technologies and renewable power can be a powerful potential means to facilitate mitigation actions. Identification of R&D requirements at the regional level and the manner in which collaborative efforts can be tied up must form an important component of the regional agenda for innovative technologies. In addition, financial arrangements and the mechanism for steering R&D for identified projects could be flagged and discussed in regional meetings.

The example of the potential for technology partnerships between India and Japan delineated below illustrates how developed and developing economies in the region can form mutually beneficial technology ties that enhance economic and trade partnerships as a whole, while facilitating development and establishment of low-carbon technologies. In addition, the Asia–Pacific Partnership on Clean Development and Climate (APP), announced in 2005, covers cooperation on development and technology transfer required for reduction in emissions. A key policy challenge here is to ensure these networks develop into something tangible and targeted.

Climate change adaptation and the role of technologies: potential and possible impediments

Asia and the Pacific region includes some of the countries most vulnerable to climate change, including small island nations as well as those with long coastlines. Adaptation to climate change is a crucial issue to addressing climate change in the region, and technology can greatly assist in enhancing adaptive capacity, given conducive policies and adequate capacity. Technologies aiding adaptation would include better electronic early warning system, increasing disaster preparedness as well as knowledge, resources, and skills for adapting to climate impacts.

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[9] TERI viewpoint paper—Climate Change and technology: building capabilities

[10] TERI viewpoint paper – Climate Change and technology: building capabilities

In addition to technologies that enhance capacity for detecting and minimizing impacts of extreme events, technologies that would increase natural resource capacity would also increase adaptive capacity in the region—for instance, developing solutions to modified or reduced crop cycles. Other relevant technologies include protection from hotter temperatures through building materials or aeration techniques, from higher sea levels through protective walls or other measures, from the spread of diseases such as malaria and dengue fever, etc.[11]

A key consideration however is the lack of funding available to developing economies to undertake adaptation initiatives, and the consequent inadequate use of appropriate technologies available for the same. In addition to ensuring the availability of technological solutions for adaptation, enhancing capacity in the form of skill transfer would enable further localization and dissemination of these technologies.

An assessment of some key mitigation technologies for the Asia and Pacific region

Clean coal technologies

The demand for coal has been growing faster than any other energy source and is projected to account for more than a third of incremental global energy demand to 2030.[12] Together, the People's Republic of China and India are projected to consume 57% of the world's annual coal supply in 2030. CCS (carbon capture and storage) has been one of the areas identified by the IEA with greatest projected GHG reduction. One of the most obvious reservations regarding CCS, however, is that its current uses largely involve enhanced oil recovery.

While some clean coal technologies are currently experimental in nature, and do not greatly mitigate the other pollutants emitted during coal combustion, clean coal technologies as a whole provide one of the most promising mitigation technologies for the region, given the current and projected nature of the fuel mix, as well as the future potential of these technologies. Through the COAL21 Fund, the Australian black coal industry has committed over $1 billion to help develop low-emissions technologies such as carbon capture and storage.[13] India has made use of supercritical tech in certain sectors mandatory for all ultra mega power plants.

R&D will greatly enhance the mitigation potential of these technologies, and technology transfer, both regionally and globally, will have a key role to play in the same. In addition, implementing supercritical-combustion-based generation plants will enable the fast-growing economies to balance capacity addition with climate change considerations in the short and medium term. It is essential, given the inertia of infrastructure systems, and the long-life of power plants, that new and additional investments in the energy sector maximize the opportunity for mitigation, which would be facilitated by a comprehensive policy that would take into account possible CCS options, and the benefits, costs, and risks of the current and possible mechanisms.

Nuclear

The IPCC has endorsed in an official report entitled, Mitigation of Climate Change, nuclear energy's status as one of a range of 'commercially available climate change mitigating technologies' that contribute to the fight against global climate change.[14]

Nuclear energy offers a lower cost mitigation option in the short-term although in the long term, other mitigation technologies are fairly competitive. Japan and the Republic

[11] http://www.ichrp.org/en/projects/138
[12] WEO 2008 Slide Library
[13] http://www.newgencoal.com.au/
[14] http://www.foratom.org/index.php?option=com_content&task=view&id=414&Itemid=821

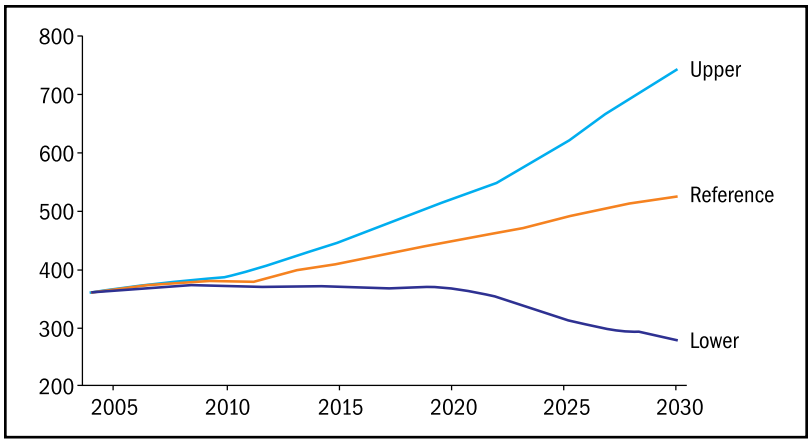

Figure 3 World nuclear capacity forecase (GWe)

of Korea retain ambitious targets of producing 40% of their electricity from nuclear, while India and the People's Republic of China are investing heavily in enhancing nuclear generation capacity. India aims to increase the production of nuclear power generation from its present capacity of 4000 MWe to 20 000 MWe in the next decade, and the Indo-US civilian nuclear agreement is one of the several policy measures it is putting into place to achieve the same.

However, the industry's expansion faces constraints, the most serious of which is its limited new-build capacity. Based on IAEA (International Atomic Energy Agency) forecasts of demand growth, the supply chain will have to expand to cope with more than 50 new power stations under construction simultaneously, more than doubling current capacity.[15] Other concerns regarding using nuclear energy for mitigation include ensuring appropriate waste management techniques and strategic considerations.

Renewable energy technologies

According to the IEA, renewable energy sources (excluding combustible biomass and hydropower) account for less than 2% of world power generation capacity. Solid biomass accounts for 10% of global energy use. Hydropower constitutes 2.2% of global primary energy use. The bulk of solid biomass (87%) is produced and consumed in non-OECD regions, where developing countries, situated mainly in South Asia and sub-Saharan Africa, use non-commercial biomass for residential cooking and heating.

In 2004, US $150 billion was invested globally in conventional technology while only US $30 billion was invested in renewables. Looking to the future, if investments in renewable energy sources were to satisfy 4% of current energy consumption in the region, the renewable energy market could reach US $10 billion annually in the Asia and Pacific region within 10 years.

The scale-up of these renewable energy options is constrained by their newness, a limited appreciation of their potential, market imperfections, higher costs of some options, and insufficient capacity to develop and implement these technologies on a large-scale.[16] The costs of power generation from renewables are set to fall in response to increased deployment, which accelerates technological progress and increases economies of scale. Some studies estimate that with research and development and economies of scale, the costs of most renewable energy technologies is reduced by 10-20% each time installed capacity doubles.[17]

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[15] http://www.platts.com/Nuclear/Resources/News%20Features/nukegrowth/index.xml

[16] http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTENERGY/,contentMDK:20604619~menuPK:1673091~pagePK:148956~piPK:216618~theSitePK:336806,00.html

[17] NREL 2003, Assessment of Parabolic Trough and Power Tower Solar Technology Costs and Performance Forecasts, NREL, Chicago October 2003

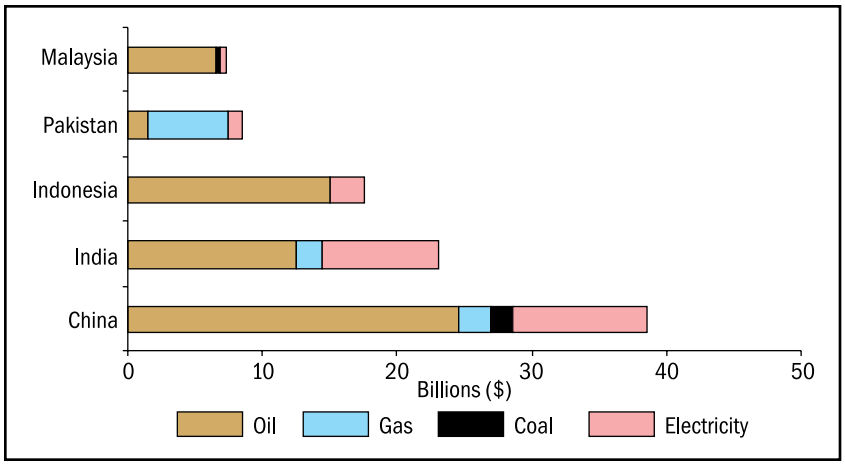

Figure 4 Indicative energy subsidies for selected Asian economies (2007)
Source WEO Slide Library

Solar technologies are amongst the most widespread amongst the renewable energy technologies, and have great potential to re-orient the energy mix in the Asia and Pacific region. For instance, solar design of buildings is far more economical than the combination of conventional building, heating, and cooling practices, even ignoring the environmental costs of the latter. On a life-cycle basis solar heating of water is also more economical than fossil fuel heating.[18] Solar thermal technologies, in particular, offer significant implementation potential for the Asia and Pacific region. The solar thermal power industry is growing rapidly with 1.2 GW under construction as of April 2009 and another 13.9 GW announced globally through 2014.[19] Solar thermal applications in developing countries to provide heat provide another possible application of these technologies, and policies to scale up the same are being implemented in the region—for instance, the Indian government expressed recently its goal to deploy a further one million solar domestic hot water systems by 2012.[20]

Diverting energy subsidies some fossil fuels towards renewable energy and other mitigation technologies can provide a revenue-neutral means to ensure resources for developing and disseminating the appropriate mitigation technologies. Other mechanisms that would enable the large-scale implementation of renewable energy capacity include enhanced financing mechanisms, investment in research and development to reduce the high upfront costs many renewable technologies require as well as regional and global technology and skill transfer partnerships.

Energy efficiency technologies

The IEA has identified energy efficiency technologies with offering the maximum potential for mitigation opportunities. There is significant potential for technology partnerships and linkages in the sector, especially between the developed and developing economies in the region itself. For instance, in India, the industrial sector consumes about half of the total commercial energy available, 70% of which is in energy-intensive sectors such as fertilizers, aluminium, textiles, cement, iron and steel, and paper—15%–25% of this is avoidable. About 5%–10% energy saving is possible simply by better housekeeping measures, and another 10%–15% is possible with small investment like low-cost retrofits and use of energy-efficient devices and controls. Juxtaposed against

[18] http://www.rprogress.org/energyfootprint/carbon_accounting/?id=2
[19] http://www.renewableenergyworld.com/rea/news/article/2009/05/global-concentrated-solar-power-industry-to-reach-25-gw-by-2020?cmpid=WNL-Friday-May8-2009
[20] TERI 2001, Survey of Renewable Energy in India [Project report 2000 RT45]

the impressive energy savings that Japan has achieved in the sector, the potential for effective sector-specific technology and skill collaborations is considerable. The Japanese environment ministry forecasts that exports will help turn energy conservation into a $7.9- billion industry in Japan by 2020, about 10 times its size in 2000.

Some measures that would streamline the introduction of energy efficiency technologies include measures that would facilitate shifts towards cogeneration, tapping waste heat for process heat, providing support to medium- and small-scale industry such as tax exemptions that would enable adoption of sub-sectoral technology options and reducing the lack of technical knowledge in the financial sectors makes financing for energy-efficient technologies a challenge. Other supportive policies such as energy efficiency promotion, fiscal measures like differential taxes for adoption of more energy-efficient technology and practice, tax benefits for institutions adopting these technologies, and better depreciation benefits could also be considered. A policy that seems especially promising is the Perform Achieve and Trade scheme being implemented in India, by the Bureau of Energy Efficiency under the National Action Plan on Climate Change—it is a market-based mechanism to enhance energy efficiency in the 'Designated Consumers' (large energy-intensive industries and facilities). The People's Republic of China's 20% energy intensity target in the Eleventh Five-year Plan is the largest CO_2 mitigation action in the world.[21]

Conclusion

The global economic downturn may divert attention from the required investment and dissemination of technologies to address climate change, but it is critical to maintain the focus on decarbonizing development paths that facilitate access to appropriate adaptation and mitigation technologies in a timely manner. The technological solutions that have the potential to ensure a low-carbon future development path are already in place, and it is vital to ensure that there are appropriate policy measures in place that facilitate removal of barriers to the large-scale commercialization and deployment of these solutions.

[21] http://en.cop15.dk/blogs/view+blog?blogid=924

Background paper III
Climate Change: implications for financing

Introduction

The projected impacts of climate change, including as a potential stress multiplier to other critical issues such as biodiversity conservation and food security, necessitate concrete action at different levels of policy and economic activity. However, the scarcity of resources and capacity imply that the trade-offs between allocations across issues have to be considered carefully. In addition, the current patterns of production and consumption are typically premised on GHG (greenhouse gas) emissions being an uncompensated externality, that is, the societal costs of these emissions are not fully accounted for in the present markets. Despite these significant constraints, there are numerous opportunities to integrate mitigation measures in current and proposed economic policies, as well as ensuring financial resources for climate action by integrating climate change mitigation objectives with other synergistic policy considerations, such as energy security, avoiding drain on foreign exchange reserves, ensuring local and regional environmental quality, and reducing capital investments in infrastructure needed by the energy supply sector into economic and social activities. This paper examines several such initiatives, their progress and potential, as well as identifying some potential initiatives that would contribute towards ensuring financial resources for adaptation and mitigation. It also discusses overall issues with climate change financing that affect both adaptation and mitigation, as well as two critical issues each for adaptation and mitigation financing. Some key questions addressed in the paper are as follows.

- What is the magnitude of the financing gaps for climate change adaptation and mitigation? What are the timelines that must be adhered to, to minimize and avoid the impacts of dangerous climate change?
- What are the implications of the financial crisis for the availability of financial resources to address climate change?
- What are some of the key adaptation and mitigation-related issues that must be addressed with regard to financing?
- What are some of the policies that have the potential to raise financial resources for climate change, by facilitating the development of carbon markets, or facilitating optimal utilization of financial resources in a broader policy context?

Financing adaptation and mitigation: need and potential

The impacts of climate change are projected to be widespread and in several cases irreversible, with adverse implications for food security, water availability, human health, and biodiversity. In addition, the largely long-term and gradual nature of these impacts implies a lag between implementation of climate policies and their effect. This in turn has implications for allocating appropriate resources for climate change adaptation and mitigation, particularly with regard to scarce financial resources.

The UNFCCC (United Nations Framework Convention on Climate Change) paper on investment and financial flows unequivocally states that 'If the funding available under the financial mechanism of the Convention remains at its current level and continues to rely mainly on voluntary contributions, it will not be sufficient to address the future financial flows estimated to be needed for mitigation and adaptation'. It estimates requirements of additional investment and financial flows worth $200–$210 billion to reduce CO_2 emissions by 25% below the 2000 levels in 2030. It also concludes that the additional global investment and financial flows needed in 2030 to address

climate change are large as compared to the funding available under the Convention and its Kyoto Protocol.

There is however vast potential to integrate adaptation and mitigation measures in mainstream economic activities such that the incremental investment as well as economic costs of the climate change component of financing is minimized. Two such policy options, for the developed and developing world, are as follows.

Integrating climate change into business cycles: In the developed economies, while the opportunities for new infrastructure opportunities may be relatively limited, those for the renewal of existing infrastructure may be higher for example, future energy infrastructure investment decisions, expected to total over US $20 trillion between now and 2030, will have long-term impacts on GHG emissions, because of the long life-times of energy plants and other infrastructure capital stock. Since the total investment in new physical assets is projected to triple between 2000 and 2030, this provides a window of opportunity to direct the financial and investment flows into new facilities that are more climate-friendly and resilient.[1] Initial estimates show that returning global energy-related CO_2 emissions to 2005 levels by 2030 would require a large shift in the pattern of investment, although the net additional investment required ranges from negligible to 5%–10%.[2] For instance, much of EU (European Union) power capacity needs to be replaced within the next 20 years (at a cost of 1.2 trillion euros).[3]

Integrating climate change into mainstream development: Adaptation and mitigation initiatives can be integrated into economic and social development policies with multiple co-benefits. By 2015, for example, fully half of the People's Republic of China's urban residential and commercial buildings will have been built after 2000, and that stock will remain in use for another 50 to 100 years. [4] Under the Republic of Korea's Green Growth Plan, the government will invest 3 trillion Won (about $2.7 billion) in the next five years to foster the green energy sector. In addition, there are projected investments of 11.5 trillion Won (about $11 billion) up to 2030 in research and development into green technologies, with an estimated job creation of about 950 000 new jobs in the green energy industry by 2030.[5] Asia and the Pacific region is estimated to need up to $6.4 trillion in new energy infrastructure by 2030, which provides enormous potential for mainstreaming climate change into development policy. While low-carbon infrastructure options usually involve incremental investment and economic cost in respect of capital plant and equipment, it is vital to consider the longer-term benefits of these investments, such as the co-benefits of corresponding avoided emissions, while taking these policy decisions.

However, while there are several opportunities to integrate climate policy into mainstream economic policy, it is crucial to ensure a conscious effort on the part of policy-makers to maximize and utilize these 'policy windows' before it becomes too late, that is, economically unviable. This includes looking beyond large-scale investments that are relatively carbon- intensive, for infrastructure, including power plants that have long lifetimes.

According to the Fourth Assessment Report, bottom-up studies suggest that mitigation opportunities with net negative costs have the potential to reduce emissions by about 6 $GtCO_2$-eq/year in 2030.

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1 http://unfccc.int/files/cooperation_and_support/financial_mechanism/financial_mechanism_gef/application/pdf/dialogue_working_paper_8.pdf

2 GW3 [4.1, 4.4, 11.6] (SPM p.18)

3 http://www.wwf.org.uk/filelibrary/pdf/allianz_rep_0605.pdf

4 http://siteresources.worldbank.org/EXTSDNETWORK/Resources/2007_CleanEnergyFrameworkBooklet_Final.pdf?resourceurlname=2007_CleanEnergyFrameworkBooklet_Final.pdf

5 http://www.iea.org/Textbase/Papers/Roundtable_SLT/korea_oct08.pdf

Also, simply the presence of resources to adapt does not translate into automatic adaptive capacity. An analysis by the Yale School of Forestry and Environmental Studies found that despite the presence of adequate resources for adaptation to climate variability in the US for several key aspects, adaptive capacity was significantly lower than expected, possibly due to climate change not comprising a very visible part of the traditional economic policy agenda.[6] Clearly, in developing economies, which have both greater vulnerability and deficient resources both for adaptation and mitigation, the challenge is much greater.

The global economic downturn and its implications

The global financial crisis can potentially impact funding to address climate change not only in terms of reduced overall availability of funding and falling carbon credits prices, but also on key long-term aspects such as reduced expenditure on R&D in clean energy technologies. This is exacerbated by the fact that private-sector investments comprise the largest share of investment and financial flows (86%) for climate change.

There have been some positive developments with regard to the availability of financial resources to address climate change, although the scale of these efforts has not been in accordance with the resources required. Private equity investments in clean energy (not including energy efficiency) have increased dramatically over the last half decade, from US $760 million in 2001 to more than US $7 billion in 2005. For technology R&D (research and development) and deployment, additional investment and financial flows requirements are estimated at about US $35–$45 billion by the IPCC.[7]

Renewable energy companies are also attracting venture capital. In this case, the attraction is due in part to future global market projections, some of which show solar photovoltaic and wind industries each growing to US $40–$50 billion per year during the period 2010–14.

During the financial crisis, there are clear opportunities to integrate climate change financing into stimulus packages, as evinced by some of the recovery policies under consideration—the US stimulus package for instance contains provisos for federal 'green' buildings as well as funding for renewable energy projects for several billion dollars. According to a study by ICF International, the $838-billion package as it currently stands would deliver minimum GHG emissions savings of 61 MT (million tonnes) per year, as well as possibly resulting in deeper emission cuts.[8]

In addition, these policies can leverage co-benefits such as energy security, employment generation opportunities in the relatively employment-intensive renewable energy sector, as well as costs savings due to energy efficiency initiatives. Further research related to the longer-term net impacts of such policies would be crucial, such as examining the net employment generation potential of renewable energy industries vis-à-vis the shrinking of the fossil fuels sector, and the long-term benefits versus higher upfront costs of installing energy efficiency equipment. The downturn may also cause a paradigm shift towards a more long-term perspective in formulating investment decisions, if more stringent regulations requiring the same are put in place, which may then indirectly increase the role of climate change in these valuations—for instance, insurance companies integrating climate risk in their valuations in insurance policies.

While the financial resources required to cope with climate change are significant, adequate measures are likely to lead to immense savings in the avoided costs that would

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6 Repetto, The Climate Crisis and the Adaptation Myth, Yale School of Forestry and Environmental Studies Publication Series Working Paper No. 13

7 http://unfccc.int/files/cooperation_and_support/financial_mechanism/financial_mechanism_gef/application/pdf/dialogue_working_paper_8.pdf

8 http://www.bellona.org/articles/articles_2009/senate_oks_stimulus

be incurred, for instance in the case of more frequent extreme events. The costs due to Hurricane Ivan that hit Grenada in 2004 amounted to twice the country's GDP.[9] However, it is a significant policy challenge to identify initiatives wherein the cost of adaptation is lower than the incremental reduction in climate risk, especially after taking the time value of resources into account (the costs that are to be met now, while the benefits of risk mitigation may be decades in the future). Despite this, given the relatively greater vulnerabilities of developing countries' populations, financial flows to these countries that facilitate enhanced adaptive capacity are a crucial aspect of any international climate agreement.

In addition, gradual climate change may lead to rising development costs, for instance in terms of human health impacts and food production, or even in subtler ways. According to some projections, each increase of one degree Celsius in air temperature reduces the efficiency of nuclear power plant by between 1% and 2% but at the same time increases demand by 5000 MW.[10] In some countries, including India, if climate change accelerates the loss of glacier water, it may cause problems for hydropower, agriculture, and consumers.[11]

A February 2009 report by HSBC, called A Climate for Recovery, analyses 20 economic recovery plans, and estimates that about 15% of the $2.8 trillion initiatives can be associated with investments consistent with some degree of mitigation measures. Out of these, the People's Republic of China's stimulus plan involved the largest outlay for such investments (about $221 billion), with the Republic of Korea ranking the first in the terms of a plan with the largest percentage of 'green' investments (81%).[12]

Key adaptation financing issues

Lack of adequate funding

The spread of estimates of the funds required for climate change adaptation is large, with different estimates capturing different levels of adaptation measures. The IPCC affirms that 'comprehensive multi-sectoral estimates of global costs and benefits of adaptation are currently lacking'. The GEF (Global Environment Facility), as an operating entity of the financial mechanism of the UNFCCC, has allocated over US $3.3 billion to projects addressing climate change since its inception (1991), with further co-financing of US $14 billion.[13] The GEF finances adaptation through the GEF Trust Fund (under the Strategic Pilot on Adaptation) and two new climate change funds: the Least Developed Countries Fund and the Special Climate Change Fund. Total funds currently available for adaptation total $320 million[14] (total pledges), in four complementary adaptation funds.

- SPA (Strategic Priority on Adaptation)– (GEF Trust Fund): $50 million
- LDCF (Least Developed Countries' Fund)–(UNFCCC): $180 million
- SCCF (Special Climate Change Fund)–(UNFCCC): $90 million
- Adaptation fund under discussion (Kyoto Protocol) (to be financed with 2% of the CERs [certified emission reductions] issued for projects of the CDM [Clean Development Mechanism] and funds from other sources)—estimated $80–$300 million/year between 2008–12.

In addition, the World Bank Climate Investment Funds consisting of the CTF (Clean Technology Fund) and the SCF (Strategic Climate Fund) are being established by the

[9] http://www.wwf.org.uk/filelibrary/pdf/allianz_rep_0605.pdf
[10] http://www.wwf.org.uk/filelibrary/pdf/allianz_rep_0605.pdf
[11] http://www.wwf.org.uk/filelibrary/pdf/allianz_rep_0605.pdf
[12] HSBC Global Research, A Climate for Recovery: the colour of stimulus goes green', February 2009
[13] http://unfccc.int/files/cooperation_and_support/financial_mechanism/financial_mechanism_gef/application/pdf/dialogue_working_paper_8.pdf
[14] www.povertyenvironment.net/?q=filestore2/download/1817/PEP13-GEFfunding-Hale.ppt

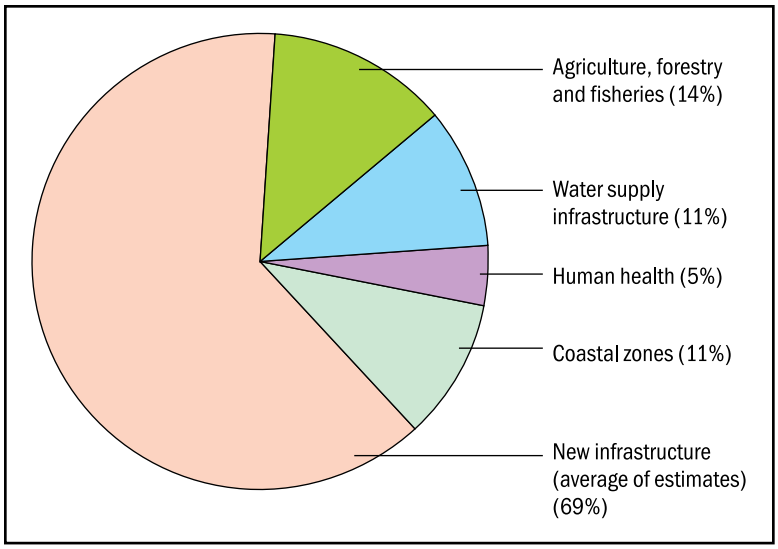

Figure 1 Sectoral global costs of additional investment and financial flows needed for adaptation

Source Report on the 'Analysis of existing and potential investment and financial flows relevant to the development of an effective and appropriate international response to climate change', UNFCCC dialogue on long-term cooperative action to address climate change by enhancing implementation of the Convention, Dialogue working paper 8 (2007)

Bank jointly with the regional development banks (AfDB, ADB, EBRD, and IDB), with a current pledge of over US $6.1 billion. Maintaining transparency and accountability is clearly important to ensure adequacy and efficacy of the funding process, as ensuring that the vulnerable developing nations are not compelled to take loans for adaptation measures that should be funded by the developed economies, in keeping with the common but differentiated responsibility principle.

Insurance

To date, most adaptation practices have been observed in the insurance sector. Climate change is increasing the potential for property damage at a rate of between 2% and 4% a year.[15] As a result of climate change, demand for insurance products is expected to increase, while climate change impacts could also reduce insurability and threaten insurance schemes.[16]

Risk management regarding low-carbon technologies along with integrating climate risk in insurance are two key developments in the insurance sector with high potential for increasing availability of financing for climate change mitigation and adaptation. Some examples of such initiatives include multi-peril cover for renewable technologies, loss of revenue cover for renewable technologies, identifying potential new liabilities from carbon emissions or using environmental due diligence screening of a company.[17]

Poverty and lack of adaptive capacity

Poverty is the largest barrier to adaptation, and yet it is clear now that developing countries are the most vulnerable to climate change. There is also the challenge of incorporating adaptation and mitigation strategies into development policy. In this

[15] http://www.wwf.org.uk/filelibrary/pdf/allianz_rep_0605.pdf
[16] http://www.gtp89.dial.pipex.com/17.pdf
[17] http://www.wwf.org.uk/filelibrary/pdf/allianz_rep_0605.pdf

regard, policies that explore tailoring development policies to integrate some level of climate change adaptation may provide a means to integrate adaptation into mainstream development policy. However, new and additional funds would be needed, as otherwise development funds would get diverted to addressing climate change. Establishing timely adaptation mechanisms for developing countries are crucial, given their relatively higher vulnerability to climate change.

For instance, the potential to incorporate measures that increase adaptive capacity in programmes like the NREGA (National Rural Employment Guarantee Act) in India is intriguing, given the level of involvement of local institutions in the programme, which has also been indicated to be crucial in establishing long-term adaptation measures. Of the one million odd works carried out under NREGA, as many as 600 000 were related to replenishing, repairing or creating water bodies.[18] Similar initiatives that would enhance local adaptive capacity could be incorporated in other poverty alleviation and employment generation policies.

A significant share of the additional investment and financial flows for adaptation are projected to be required in non-Annex I Parties ($28–$67 billion).[19] ODA (Official Development Assistance) funding, while comprising a small fraction of total climate change financial flows, nevertheless may form a significant source of adaptation funding for certain developing counties. However, it is vital to ensure that financial flows to developing countries for mitigation and adaptation are new and additional to ODA.

Key mitigation financing issues

In 2030, macro-economic costs for multi-gas mitigation, consistent with emissions trajectories towards stabilization between 445 PPM (parts per million) and 710 PPM CO_2-eq, are estimated at between a 3% decrease of global GDP and a small increase, compared to the baseline. However, regional costs may differ significantly from global averages.[20] While the percentage seems modest, the absolute level is very large. In addition, there would be extremely large requirements of incremental investment costs.

As regard long-term mitigation, in 2050 global average macro-economic costs for multi-gas mitigation towards stabilization between 710 PPM and 445 PPM CO_2-eq, are between a 1% gain to a 5.5% decrease of global GDP.[21] For specific countries and sectors, costs vary considerably from the global average. In addition, there are numerous co-benefits associated with mitigation, including health benefits and enhanced energy security. This is because there are several common drivers between policies addressing economic development, energy security, health, and climate change mitigation. These indicate the various opportunities available for no-regrets policies present in mitigation measures, and ones that would enable integrating mitigation into the overall socio-economic policy framework.

Climate and energy systems inertia, and its implications for mitigation

It has been well established that delayed emission reductions lead to investments that lock in more carbon-intensive infrastructure and development pathways. This significantly constrains the opportunities to achieve lower stabilization levels and increases the risk of more severe climate change impacts.[22] When considered in conjunction with the fact

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18 http://timesofindia.indiatimes.com/articleshow/2749931.cms

19 http://unfccc.int/files/cooperation_and_support/financial_mechanism/financial_mechanism_gef/application/pdf/dialogue_working_paper_8.pdf

20 IPCC WG3 SPM p.16

21 IPCC Fourth Assessment Report, Climate Change 2007: Synthesis Report, Summary for Policymakers

22 IPCC WG3 SPM p.28

that mitigation efforts have visible long-term impacts in the long run, this underscores the need for scaling up mitigation efforts in the present. Model experiments show that even if all radiative forcing agents were held constant at year 2000 levels, a further warming trend would occur in the next two decades at a rate of about 0.1 °C per decade, due mainly to the slow response of the oceans.[23]

Energy system inertia provides another dimension to the time scales involved. It has taken at least 50 years for each major energy source to move from 1% penetration to a major position in global supplies. These facts imply that since the effect of most clean energy policies shall take time to be translated into lowered risk of climate change impacts, it is crucial to secure climate change financing as well as initiating and scaling up climate policies. Given the high initial capital costs and long-term payback nature of several such initiatives, securing financing is a significant challenge for the institutions involved. The IEA estimates a financing gap in the energy sector in developing economies of about $80 billion per year.[24]

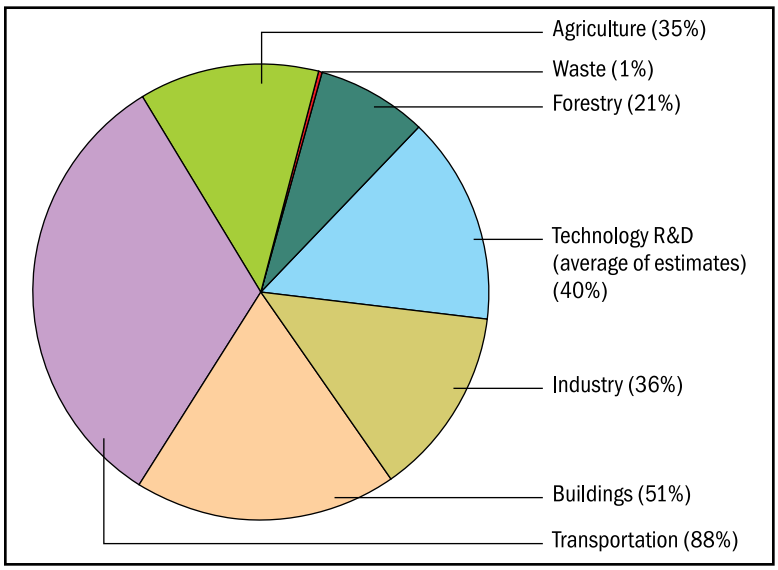

Figure 2 Some Sectoral Global Additional Investment and Financial Flows Necessary for Mitigation in 2030 (USD, Billion)

Source Report on the 'Analysis of existing and potential investment and financial flows relevant to the development of an effective and appropriate international response to climate change', UNFCCC Dialogue on long-term cooperative action to address climate change by enhancing implementation of the Convention, Dialogue working paper 8 (2007)

Appropriate carbon pricing

An appropriate price on carbon would be a crucial step towards ensuring financing sources for mitigation, and would provide a market mechanism towards ensuring mitigation action. The global carbon market was worth about $116 billion at the end 2008, rising 84% from the previous year due to higher trading volumes and prices. Research by New Carbon Finance predicted that the market's value could rise to $150 billion in 2009, in spite of the gloomy backdrop of a global recession, and to $550 billion by 2012.[25] In a carbon market such as the CDM, developing countries face sellers' side carbon prices, and the developed countries, buyers' side prices. However, the incentive effects for adoption of clean technologies are identical on both sides of the market.

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[23] IPCC 4th Assessment Report, (SPM p.12)

[24] http://siteresources.worldbank.org/EXTSDNETWORK/Resources/2007_CleanEnergyFrameworkBooklet_Final.pdf?resourceurlname=2007_CleanEnergyFrameworkBooklet_Final.pdf

[25] http://www.ipsnews.net/africa/nota.asp?idnews=45957

The development of a wider and deeper carbon market would greatly assist in increasing the availability of resources in developing countries for mitigation opportunities as well, as evinced by the growing market for CDM (Clean Development Mechanism) credits. Efforts to streamline the CDM accreditation process to enable smaller businesses in developing economies to avail of these emissions reductions opportunities, while maintaining the integrity of the emissions reductions is a key challenge, as is the question of eligible technologies and processes. According to the World Bank, the IRR (Internal Rate of Return) increase through JI and CDM at US $4/tonne CO_2 is between 0.5% and 2.5% in hydro, wind, and geothermal projects and between 5% and 15% in methane reduction projects at landfills.[26]

Innovative policies and integrative initiatives

Apart from integrating adaptation and mitigation into current policies, there are numerous untapped policy mechanisms that offer potentially significant opportunities for financing adaptation and mitigation. One such policy initiative is integrating those large emitters in the climate policy process that have not yet been included, either through a tax, or integrating them in a cap-and trade regime.

In addition, some studies estimate that if the EU–ETS credits are auctioned, governments may be able to collect at least €30 billion annually from 2012 onwards.[27] In non-Annex 1 nations as well as those without currently binding targets, developing voluntary carbon markets can provide a powerful instrument for raising financial resources for mitigation. With only 10% auctioning of emission allowances, revenues in OECD countries would outweigh current public sector energy R&D spending by a factor of five.[28]

Another policy mechanism that could have significant potential returns in the medium and long term is scaling-up financing for energy efficiency projects, particularly in the small and medium sector. The Bureau of Energy Efficiency in India is exploring a program for the same, under the range of initiatives to operationalize the National Action Plan on Climate Change. According to the WWF, the EU Directive on Energy End-Use Efficiency and Energy Services – if adequately implemented – could bring a net economic gain for the entire EU economy of approximately 10 billion euros per year.[29]

Removing distortive subsidies to fossil fuels, and diverting them to subsidize clean energy would provide revenue-neutral policy mechanisms to finance mitigation, as well as enhance energy security in the region. For instance, kerosene subsidies in India, while having aided the poor to obtain lighting in the past, are not only incompatible with a climate change mitigation policy, but also divert resources which may effectively build renewable energy infrastructure. Budgetary subsidies to kerosene in India were Rs 967 million in 2006/07.

Conclusion

Ensuring timely availability of resources for adaptation and mitigation is as important as ensuring their adequacy, given the implications of the delayed responses of natural and man-made systems. The global economic downturn indicates the inevitable adverse consequences of unsustainability and the lack of appropriate policies in a particular dimension of economic activity. It is vital to ensure that unsustainable economic activity and policies are modified to take into account broad-based and climate-

[26] http://www.wwf.org.uk/filelibrary/pdf/allianz_rep_0605.pdf
[27] http://www.euractiv.com/en/climate-change/climate-change-policy-financial-crisis/article-177004
[28] WEO 2008 Slide Library
[29] http://www.wwf.org.uk/filelibrary/pdf/allianz_rep_0605.pdf

friendly development, by synergizing public and private sector initiatives and establish both enabling policies and targeted regulations that facilitate financial flows where they would be most effective.

Bionotes

Ursula Schäefer-Preuss

Ursula Schäefer-Preuss is Vice-President of ADB (Asian Development Bank) for Knowledge Management and Sustainable Development. She assumed office in November 2006. She is responsible for ADB's Regional and Sustainable Development Department, Economics, and Research Department, and the Office of Cofinancing Operations.

Prior to joining ADB, she was the Director-General of the Federal Ministry for Economic Cooperation and Development in Bonn/Berlin, Germany. She was responsible for the development policy framework for various countries and regions. She was also engaged in bilateral cooperation with countries in Asia, Latin America, and Europe. Previously, she was Chief of Cabinet of the Federal Minister for Economic Cooperation and Development from November 1998 to 2000.

Haruhiko Kuroda

Haruhiko Kuroda is the President of ADB (Asian Development Bank) and the Chairperson of ADB's Board of Directors. He was elected President by ADB's Board of Governors in November 2004 and was re-elected in November 2006 for a new five-year term.

Before joining ADB, Mr Kuroda was Special Advisor to the Cabinet of Japanese Prime Minister Junichiro Koizumi and a professor at the Graduate School of Economics at Hitotsubashi University in Tokyo. In a career spanning nearly four decades, Mr Kuroda has represented Japan's Ministry of Finance at a number of international monetary conferences as Vice Minister of Finance for International Affairs.

Mr Kuroda holds a BA in Law from the University of Tokyo and a Master of Philosophy in Economics from the University of Oxford.

R K Pachauri
Director-General, TERI and Chairman IPCC

Rajendra K Pachauri is Director of the newly established Yale Climate and Energy Institute (YCEI) and President, TERI North America. He has been the Chairman of IPCC (Intergovernmental Panel on Climate Change) since 2002, and Chief Executive of TERI (The Energy and Resources Institute) since 1982. He accepted the Nobel Peace Prize in 2007 on behalf of IPCC, which shared the honour with former Vice President Al Gore. He has been conferred with several awards including 'Padma Vibhushan' the second highest civilian award in 2008, 'Officier De La Légion D'Honneur' by the Government of France in 2006, and 'Padma Bhushan' in 2001 for his outstanding contribution in the field of science, engineering, and environment. He is actively involved in several international forums dealing with climate change policies and has been associated as faculty with academic and research institutions of national and international repute. He has authored 23 books and several papers and articles.

Ban Ki-moon

Ban Ki-moon's career encompasses many years of service in government and on the global stage, including as his country's Minister of Foreign Affairs and Trade; postings in New Delhi, Vienna, and Washington DC; and responsibility for a variety of portfolios, including foreign policy, national security, and policy planning. His ties with the United Nations date back to 1975, when he worked for the foreign ministry's United Nations division. He holds a bachelor's degree in international relations from Seoul National University and a master's degree in public administration from the Kennedy School of Government at Harvard University.

GOH KUN

Acting President (2004) and Prime Minister (2003/04)
Mayor of Seoul Metropolitan Government (1998–2002); Prime Minister (1997/98)
Co-President of Korea Federation for Environment Movement (1996/97)
President of Myong Ji University (1994–97)
Mayor of Seoul Metropolitan Government (1988–90)
A Member of the 12th National Assembly (1985–88)
Minister of Home Affairs (1987), of Agriculture (1981/82), of Transportation (1980/81)
Governor of the Jeonnam Province (1975–79)
Director-General of the Bureau of the New Village Movement, Ministry of Home Affairs (1973–75)

Bindu N Lohani

Bindu N Lohani is the Vice-President (Finance and Administration) of ADB (Asian Development Bank) and is a member of ADB's Management Team. He assumed the position in April 2007. Dr Lohani is responsible for the functional areas of treasury, controllership, information technology, budget and human resources, administrative services, and the offices of the Secretary and General Counsel.

Prior to this, Dr Lohani was the Director General of ADB's Regional and Sustainable Development Department and concurrently, he was ADB's Chief Compliance Officer and the Special Advisor to the President on Clean Energy and Environment. Dr Lohani began his career in ADB in 1985 in Infrastructure Department and has assumed various responsibilities, including the Secretary of ADB. Before joining ADB, Dr Lohani worked with the Government of Nepal. He was also Division Chairman at the AIT (Asian Institute of Technology).

Dr Lohani is an elected member of the National Academy of Engineering (NAE) and elected Fellow of American Academy for Advancement of Science (AAAS) of the United States. He has also been conferred with various awards and medals.

Hideki Minamikawa

Mr Minamikawa joined the Environment Agency (promoted to the Ministry of the Environment in 2000) in 1974. His previous posts include Director-General of Environmental Health Department; Director-General of Waste Management and Recycling Department; and Director-General of Nature Conservation Bureau. From September 2006 to June 2008, he was the Director-General of Global Environment Bureau and was in charge of international negotiations on climate change as well as making policies for domestic GHG emission reduction and protection of the ozone layer. He has also contributed to the promotion of international cooperation. He assumed the present position in July 2008.

Khempheng Pholsena

Khempheng Pholsena is Minister to the Prime Minister's Office, the Lao People's Democratic Republic, in charge of Water Resources and Environment Administration, and Chairperson of the Lao National Mekong Committee, GMS Minister. From 2004 to 2007, she held the position of Vice-President, Finance and Administration, Asian Development Bank in Manila, Philippines.

Khempheng was Vice-Minister of Foreign Affairs from 2003 to 2004. From 2001 to 2003, she was Vice-President of the Committee for Planning and Cooperation and responsible for coordination of ODA for Development Cooperation including round-table process of coordinating international donors and development planning

of the government. The main area of her involvement are in country development strategies, including sustainable economic growth and poverty eradication; economic policy, reform and financial management; environmentally sensitive negotiations; and international aid and cooperation.

Rachmat Witoelar

Rachmat Witoelar, a former Indonesian Ambassador to Russia (1993–97) is currently the Minister of State for the Environment of the Republic of Indonesia. He was the President of the Governing Council UNEP (2005–07) and the COP 13 United Nations Framework Convention on Climate Change (2007–08). Mr Witoelar is actively engaged in national and international organizations. He was founder and the Chairman of the Indonesia Council of World (ICWA), which established in 1998. At present, he is serving as the member of the ICWA government board. He is also the Secretary of the Barisan Nasional (Barnas 1999 –till now) and had a long tenure as a member of The Indonesia Parliament (1971–93). During this period Mr Witoelar chaired the Commission V (1976/77) and VI (1977/78) of The Parliament, and also was actively involved in the Asian International Parliamentary Organization (AIPO 1983–91) and as a regular delegate to the International Parliamentary Union (IPU 1977–90). Recently, he received Honorary Professorship in Environmental Management from Griffith University, Australia on 20 March 2008.

Charles O Holliday, Jr

Chad Holliday has been the Chairman of the Board of DuPont since 1 January 1999. He served as Chief Executive Officer from 1 February 1998 until 1 January 2009. He is a member of the National Academy of Engineering. He is also the former Chairman of the Business Roundtable's Task Force for Environment, Technology, and Economy; the WBCSD (World Business Council for Sustainable Development); The Business Council; and the Society of Chemical Industry – American Section. Mr Holliday serves on the Board of Directors of Deere & Co. He is Chair Emeritus of the Board of Directors of Catalyst. He is also Chairman of the US Council on Competitiveness and is a founding member of the International Business Council. He co-authored the book *Walking the Talk* which details the business case for sustainable development and corporate responsibility.

Shigeru Kiyama

Mr Shigeru Kiyama became Senior Special Advisor for Climate Change in October 2008. He has previously served in the JBIC (Japan Bank for International Cooperation), which extended concessionary loans (Japanese ODA loans, and so on and was predecessor of the present JICA as Resident Executive Director for Africa; Director General, Treasury Department; Director General, Development Assistance Department I (ASEAN); Director General, Development Assistance Department II; (the People's Republic of China, Viet Nam, Sri Lanka); Senior Advisor for NGO; Deputy Director General, Policy Planning and Coordination Department; Deputy Director General, Project Development Department.

Hoesung Lee

Hoesung Lee is Vice-Chair of the United Nations IPCC (Intergovernmental Panel on Climate Change) and Professor of Energy/Environmental Economics at Keimyung University. He was co-Chair of IPCC Working Group III in 1992–97 for the Second Assessment Report and since then lead author and review editor. He was founder and first president of the Korea Energy Economics Institute—a government's energy policy research agency. Dr Lee served as President of the International Association of Energy Economics—headquartered in the United States with the mission of advancing energy economics. He was senior advisor to the Minister of Energy and Resources and the Minister of Environment. Dr Lee served on the board of numerous corporations and organizations domestic as well as international, including Hyundai Corporation and Institute for Global Environmental Strategies, headquartered in Japan. He has published research articles and books on energy economics and climate change policy.

Ira C. Magaziner

Ira C Magaziner currently serves as the Chairman of the Clinton Climate Initiative and the Clinton Foundation HIV/AIDS Initiative, and as a board member of the Alliance for a Healthier Generation and the Clinton Hunter Development Initiative. From 1993 through 1998, he served as Senior Advisor to President Clinton for Policy Development at the White House, where he supervised the development and implementation of the administration's policy for commercialization of the Internet and supervised the development of the President's Health Reform Initiative. Prior to his White House appointment, Mr Magaziner earned respect as one of America's most successful corporate strategists at SJS Inc., which he founded, and at the Boston Consulting Group.

Emil Salim

Emil Salim was a former government Minister of the Republic of Indonesia, but the role he has been playing on the environment agenda is global, beyond his country's border. He chaired various positions at the global level like Chairperson of the Tenth United Nations Commission on Sustainable Development (2001/02), Chairperson of the Preparatory Committee for the World Summit (2002), Head of Indonesia Delegation for UNFCCC (2007), and Indonesian delegation member for the World Ocean Conference (2009). He also occupied different key posts in the government spanning over 30 years as State Minister for Administrative Reform and Vice Chairman of the National Planning Board (1970–73); Minister of Transportation, Communication, and Tourism (1973–78); Minister of Development Supervision and Environmental (1973–83); and Minister of Population and Environment (1983–93). He has been teaching in University of Indonesia since 1972. He established a number of environmental NGOs in Indonesia. Currently, he is an Advisor to the President of Republic of Indonesia.

Prabir Sengupta

Prabir Sengupta has held many important positions in the provincial Government of Assam and in the Government of India. He has been Secretary to the Government of India on a consecutive basis in the Ministries of Industry, Petroleum and Natural Gas, Defence and Commerce. He participated in a number of bilateral and multilateral discussions as also for signing of important agreements. After his stint in the Government of India, he became the Director of Indian Institute of Foreign Trade, a management and research institute and was able to raise level of the Institute to 6th or 7th rank among all the Indian institutes including the Indian Institute of Management (IIM). In TERI, Shri Sengupta has been involved in issues relating to trade, energy, and environment and has been associated with a number of TERI projects.

Maurice Strong

Maurice Strong's current appointments include: Chairman of Cosmos International Group; Honorary Professor of Peking University (Beijing), Tongji University (Shanghai), and Environmental Management College of China; Honorary Board Chairman of Peking University Environment Fund; Honorary President, Oriental Environment Research Institute (the People's Republic of China); Special Senior Advisor of China International Institute of Multinational Corporations; Member of United States National Academy of Science; Vice-Chairman, Chicago Climate Exchange; Member of Korean Academy of Science and Technology.

Some of Mr Strong's past appointments include: Under Secretary General and Special Advisor to the Secretary General of the United Nations; Senior Advisor to the President World Bank; Member, Foundation Board, World Economic Forum; First Executive Director of the United Nations Environment Programme; First President of the Canadian International Development Agency.

Larry Brilliant

Larry Brilliant is the President of the Skoll Urgent Threats Fund and Advisor to Google.org, and to Jeff Skoll. The Skoll Urgent Threats Fund does grant making and advocacy to help solve issue related to climate change, nuclear weapons, water scarcity, emerging potential pandemics, and conflicts in the Middle East. Larry is a physician–epidemiologist who lived in India for 10 years working on the successful WHO (World Health Organization) smallpox eradication programme. He also founded The Seva Foundation. He was VP of Google and first Executive Director of Google.org. He has written and spoken widely on climate change, pandemics, early warning systems, and philanthropy. Larry chairs the National Biosurveillance Advisory Subcommittee and is a member of the Council on Foreign Relations.

Zhou Dadi

Zhou Dadi's experience focuses on energy policy and energy system analysis. He has worked towards the development of sustainable energy strategy, and promoting policy on energy conservation, and policy of environmental protection including climate change of the People's Republic of China. He has been the chief investigator for many important national and international projects and programmes. He is the chief advisor on the national energy strategy. He was the LA and CLA of the WG3 of IPCC for the Second, Third, and Fourth Assessment Reports. Due to his contribution towards sustainable energy development and climate change policy, Zhou was awarded with the OECD CTI awards of the year 2000 and the 2007 Climate Protection Award of US EPA. Since May of 2008, Zhou is Senior Associate of Carnegie endowment for international peace.

Yoichi Kaya

Yoichi Kaya is currently the Director General, RITE (Research Institute of Innovative Technologies for the Earth); Guest Professor, Keio University; and Program Director, Japan Science and Technology Agency. He is the recipient of seven awards from four Japanese academic institutions as also three publication awards. He served as the President, Institute of Electrical Engineers of Japan in 1993/1994 and President, Japan Association of Energy and Resources in 1997–2000. He is also the Chairman, Committee on Global Environmental Policy, Industrial Policy Council, METI.

Hiroyuki Watanabe

Hiroyuki Watanabe joined Toyota in 1967 upon completing postgraduate studies in aeronautical engineering at Kyushu University. In 1986, Dr Watanabe became the chief engineer responsible for the Toyota Crown, which is the best-selling luxury car in Japan. Named to the Board of Directors in 1996, he directed Toyota's R&D works on hybrid and fuel cell vehicles, and was responsible for Toyota's Future Project Division and worldwide operations in after-sales service and parts. In 1999, he was made a managing officer, and in 2001, a senior managing director, responsible for R&D, product development, environmental affairs, quality control, and IT & ITS development and operations. In June 2005, he became a senior technical executive.

Lorie Wigle

Lorie Wigle leads Intel's Eco-Technology effort, which is focused on the sustainable manufacturing and usage of Intel's products. This corporate-wide function drives Intel's market position across energy-efficient performance and design for the environment. In this capacity, Lorie also drives external programmes related to client, server, and data centre efforts including Intel's participation in Green Grid and the Climate Savers Computing Initiative. Recently, Lorie's team also launched the Intel Open Energy Initiative to focus internal and external efforts on promoting standards and computing solutions in the electricity industry. Lorie has been with Intel for 25 years in a wide variety of Marketing and Product Planning roles and was the General Manager of Intel's Internet Imaging Services group. She has an MBA from Portland State University and a BA degree from the University of Oregon.

Dato Lee Yee Cheong

Lee Yee Cheong is the Chairman of the Governing Board of the UNESCO International Science, Technology, and Innovation Centre for South–South Cooperation; President of the ASEAN Academy of Engineering and Technology; a Director of UMW Holdings Berhad; a Commissioner of the Energy Commission of Malaysia; an Adjunct Professor of the National Energy University (UNITEN) Malaysia; and the Special Advisor on Sustainable Energy to the co-chairs of the Inter Academy Council. He was former President of the World Federation of Engineering Organisations and Co-Chair of 'Science, Technology, and Innovation' Task Force of the UN Millennium Project.

Yvo de Boer

Yvo de Boer has been the Executive Secretary of the UNFCCC (United Nations Framework Convention on Climate Change) since 2006. Before joining the UNFCCC, he was Director for International Affairs of the Ministry of Housing, Spatial Planning, and Environment of the Netherlands. Prior to his position as Executive Secretary, Mr de Boer has served as Vice-President of the Conference of Parties to UNFCCC and as Vice-Chair of the Commission on Sustainable Development.

Nitin Desai

Nitin Desai had a long stint as a government official in India and then joined the UN in 1990. In India, he was in the Planning Commission (1973–88) and later in the Ministry of Finance as the Chief Economic Adviser (1988–90). In the UN, where he was Under Secretary General for Economic and Social Affairs, his major work was the organization of a series of global summits, including the Rio Earth Summit (1992), and the Johannesburg Sustainable Development Summit (2002). After his retirement, he has been involved in a variety of public policy activities nationally and internationally. He is a member of the National Security Advisory Board and the Prime Minister's Council on Climate Change.

Conor McCoole

Conor McCoole is Managing Director and Head of Standard Chartered's award winning project finance team in Asia. His primary responsibility is to originate and oversee financial advisory and debt arranging mandates for projects across Asia. Standard Chartered has project and export finance teams in Singapore, Hong Kong, Beijing, Mumbai, Seoul, and Tokyo and has completed transactions in the power, infrastructure, oil and gas, and telecom sectors. The team was recognized as the Best Project Finance House in Asia by Project Finance International, Euromoney, The Asset and Finance Asia in 2007. Conor has extensive finance experience gained over 16 years at Standard Chartered Bank, Barclays Bank, and UFJ Bank with a focus on energy and power sector. He has completed project financings for power (gas, coal, hydro, and geothermal), gas field developments, LNG plants, petrochemicals, ports, oil terminals, and offshore oilrigs.

Kirit S Parikh

Kirit S Parikh has been a Professor of Economics since 1967. He is Member, Planning Commission, Government of India and the architect of India's Integrated Energy Policy; former (Founder) Director (Vice Chancellor), IGIDR (Indira Gandhi Institute of Development Research), Mumbai and Chairman, IRADe (Integrated Research and Action for Development), New Delhi. He was a Member of the Economic Advisory Council of the prime ministers of India, Atal Behari Vajpayee, P V Narasimha Rao, Chandra Shekhar, V P Singh, and Rajiv Gandhi.

He is a Fellow of the National Academy of Sciences, India. He has had numerous awards. He was honoured with the Padma Bushan by the President of India in March 2009. Dr Parikh has authored, co-authored, and edited 25 books covering a wide range of areas and has also published numerous articles.

Raj Singh

Raj Singh joined the Swiss Re from Allianz SE where he held the position of Group Chief Risk Officer from 2002. From 1989 to 2001, Mr Singh worked for Citigroup, where he held a number of senior positions, mainly in the area of credit and structured finance. Lastly, he was Managing Director Risk/Merger and Acquisitions for Citibank Northern Europe and with site responsibility for Citibank Belgium. Mr Singh is a Member of the International Financial Risk Institute, founding Chairman of the Chief Risk Officers Forum, and an associate of the American Banking Association.

Vinod Thomas

Vinod Thomas is the Director-General and Senior Vice President, IEG (Independent Evaluation Group) at the World Bank Group. His previous positions include Country Director for Brazil and Vice President of the World Bank, Vice President of the World Bank Institute, and Chief Economist for the World Bank in the East Asia and Pacific Region. He was the Staff Director for the 1991 World Development Report entitled The Challenge of Development and the author of numerous books, articles, and reports. Mr Thomas holds a PhD in Economics from the University of Chicago.

Craig A. Hart

Craig Hart is counsel to Alston & Bird's Energy Infrastructure, Climate Change and Technology Practice in Washington, DC. He concentrates his legal practice in international finance and banking, especially in energy project finance, capital markets, and carbon finance with focus on renewable energy and carbon mitigation technologies. He has substantial experience in financings in the People's Republic of China and the Middle East. He is active in environmental education through the Energy + Environment Foundation which seeks to strengthen energy and climate curriculum at schools in developing countries, and previously directed the climate change program at the Center for International Environmental Law. He holds bachelors and law degrees from the University of California at Berkeley, masters in economics from New York University, and a Ph.D. from the Massachusetts Institute of Technology.

Gloria Macapagal-Arroyo

The President of the Philippines, Gloria Macapagal-Arroyo, holds many records. Elected as Senator during her first try in politics in 1992, she was re-elected Senator in 1995 with nearly 16 million votes, the highest number of votes in Philippine history at that time. She was elected Vice President of the Philippines in 1998 with almost 13 million votes, the largest mandate in the history of presidential or vice presidential elections. She was sworn in as the 14th President of the Philippines on 20 January 2001 by Chief Justice Hilario Davide, Jr. after the Supreme Court unanimously declared the position of President vacant, the second woman to be swept into the presidency by a peaceful People Power revolution (EDSA II). In 2004 she won the Presidential elections for a fresh mandate, winning with one million votes over her closest opponent.

The President is the daughter of the late President and Mrs. Diosdado Macapagal, who were well known for their integrity and simple but dignified lifestyle. During the Presidency of Diosdado Macapagal, The Philippines was second only to Japan in economic progress in Asia.

President Gloria Macapagal-Arroyo, born on 5 April 1947, was valedictorian of her high school class at Assumption Convent, was consistently on the Dean's List in Georgetown University in Washington DC, and graduated magna cum laude at Assumption College in Makati. She obtained a Master's degree in Economics from the Ateneo de Manila University and a doctorate degree in Economics from the University of the Philippines.

Macapagal-Arroyo joined the Philippine government in 1986 as Undersecretary of Trade and Industry. During her tenure in the Senate, she authored 55 laws on economic and social reform and was named outstanding Senator several times. When she was elected Vice President, she was appointed as concurrent secretary of Social Welfare and Development, a post she held until her resignation from the cabinet on 12 October 2000.

Her immediate family, namely the First Gentleman, Atty. Jose Miguel Tuason Arroyo (a grandson of the late Senator Jose Arroyo of Iloilo), her three children, Congressman Juan Miguel (Mikey), Evangelina Lourdes (Luli), and Diosdado Ignacio (Dato), and three granddaughters, proudly support the family's presidential matriarch, as she pursues her mandate and leads the Filipino nation.

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