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Report Overview

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Climate Compatible Development in the Infrastructure Sector

An overview of the opportunities and challenges at the nexus of climate change, infrastructure and development

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Key Points

- Infrastructure policymakers and practitioners have a crucial role to play in meeting the challenge of climate change in the developing word. This applies both to **mitigation**, i.e. reducing greenhouse gas emissions in ways that facilitate continued growth and sustained poverty reduction; and to **adaptation,** i.e. protecting vulnerable populations from the impacts of climate change.
- Three key challenges are: raising the necessary finance; developing and transferring technology; and developing the capacity of governments to formulate and implement climate change policy in the infrastructure sector.
- But climate change has also created developmental opportunities in the infrastructure sector, including access to new sources of finance, the potential for green job creation, and profiting from synergies between climate change initiatives and developmental priorities.
- The analysis in this report suggests that donor climate-related infrastructure funding may be excessively skewed towards mitigation at the cost of adaptation, and that mitigation funding may be excessively skewed towards the energy sector at the cost of the buildings sector.

Climate change is recognised as one of the most significant threats to development during the 21st Century and beyond. Infrastructure and the engineering profession have a crucial role to play in efforts to reduce emissions in order to stabilise global warming, and to adapt to the climatic changes that have become inevitable.

Action in the infrastructure sector is urgent, as infrastructure assets have a long life span and rates of infrastructure investment are high in many developing countries. Inaction could lead to countries becoming 'locked-in' to high-carbon growth paths during a period which is critical for the climate, and developing infrastructure stocks that are not suited to new climatic conditions. Such an outcome would compromise developmental goals.

Given the high stakes and the urgency of action, it could not be more important at the current time to gain an improved understanding of the challenges and opportunities at the nexus of climate change, infrastructure and development. That is the aim of this report, approached through the following objectives:

1. Describe the transformation required in the infrastructure sector to promote low-carbon growth and climate-resilient development.
2. Identify the key challenges to achieving this transition within the required timeframe in the developing world, and the strategies that have been developed to date to meet these challenges. Take preliminary steps towards identifying the further action likely to be required.
3. Explore potential developmental opportunities associated with international and national efforts at mitigation and discuss, in general terms, how they can be realised.
4. Identify and assess approaches to maximising the developmental outcomes of adaptation investment in the infrastructure sector.
5. Analyse climate-related infrastructure funding flows from donors and the Clean Development Mechanism (CDM), compare these with estimated needs, and draw preliminary conclusions from the trends observed.
6. Develop an improved understanding of the reality of climate change policy development in the infrastructure sector by studying the infrastructure-related low-carbon growth strategies of nine countries.
7. Draw conclusions and make recommendations based on the above, and identify priority areas for further study.

The report structure reflects these seven objectives, preceded by a brief introductory section covering some fundamental concepts around climate change and the relationship between climate change and development. The definition of infrastructure used here is broad and encompasses the OECD definition of economic infrastructure to

include transport, energy, information and communication technology, irrigation, drinking water and sanitation[1] as well as the UK Institution of Civil Engineer's definition of civil engineering infrastructure which covers bridges, roads, canals, dams, tall buildings and other large structures[2].

Climate change

The Intergovernmental Panel on Climate Change (IPCC) has predicted that the earth will be between 1.8°C - 4°C warmer by the end of the 21st Century compared to the end of the 20th Century. The principal cause of global warming is human activity that releases greenhouse gases into the atmosphere, particularly the burning of fossil fuels. Two degrees centigrade is widely considered the maximum temperature increase to avoid irreversible damage to the global climate and ecosystems. For the world to have a 50% chance of keeping within the 2°C ceiling, global emissions of greenhouse gases need to peak by 2020 at the latest, be cut by at least 50% of their 1990 levels by 2050, and continue to decline thereafter[3]. It now seems highly unlikely that this will be achieved. The severity of impacts will depend on the point at which temperatures are stabilised, but projected impacts include increased precipitation, more frequent extreme weather events, flooding, drought, sea level rise, increased risk of species extinction and the collapse of ecosystems, and increased disease burden at lower latitudes.

Responses to climate change are classified as *mitigation* or *adaptation*. Mitigation refers to efforts to reduce current or future emissions. Adaptation refers to initiatives or measures to reduce the vulnerability of natural and human systems against climate change effects[4].

The key economic tool in reducing emissions is creating a price for carbon, thereby incentivising a change in behaviour through market forces. Emissions trading (whereby emissions are capped and emissions permits are issued to companies which can then be traded) and taxing carbon represent two important ways to establish a carbon price. Thirty-seven countries and the EU have voluntarily agreed to binding emissions reductions targets through the Kyoto Protocol. International negotiations on more widespread emissions limitations are ongoing under the United Nations Framework Convention on Climate Change (UNFCCC).

Climate change and development

Developing countries bear little historic responsibility for the emissions that are causing climate change[5], but stand to suffer the most severe consequences, for three main reasons. Firstly, climatic impacts will be more acute at lower latitudes where most developing countries are located. Secondly, developing countries are more dependent on climate-sensitive sectors such as agriculture and fishing. Finally, poorer countries have lower capacity to adapt due to their weaker institutions, lower human and financial capital, and constrained access to technology and credit[6]. Within developing countries it is those individuals in the lowest income brackets, or who experience heightened vulnerability for other reasons, that are most vulnerable to the impacts of climate change[7].

Poorer countries also face risks to their opportunities for economic growth as a result of global efforts to stabilise the atmospheric concentration of greenhouse gases (GHGs). Historically, economic growth has been closely linked with increased GHG emissions. Developing countries will need to break this link if they are to experience rapid growth in a carbon-constrained world; they will need to 'leapfrog' the polluting production methods used by the developed world and move straight to low-carbon growth paths. But there are massive financial, technological and capacity challenges associated with achieving this.

The perspectives and priorities of developing countries in relation to climate change mitigation and adaptation differ depending on their stage of economic development (among other factors). In general, less developed countries will place greater emphasis on adaptation, at least in the short-term. This is because least-developed or low-income countries have relatively low emissions due to their lower levels of industrialisation, while at the same time many of them are highly vulnerable to the impacts of climate change. More industrialised developing countries face the prospect of emissions limitations (agreed in international negotiations) in the relatively near future so will need to devote significant resources to mitigation in order to enable continued rapid growth, while also taking measures to cope with climate change impacts.

Despite these well-warranted differences in perspective, many would argue that it is in the best interests of lower-income countries to integrate mitigation considerations into policy decisions at the earliest possible stage[8]. This would provide access to the opportunities associated with mitigation discussed later in this report, and support the development of a growth trajectory that is sustainable in the long term. It is important to recognise that capacity and financial limitations may make this difficult to achieve in many countries.

Climate change has far-reaching implications for development as

described above, but the economic and social impacts of global warming will depend not only on progress in the international arena, but also critically on the developmental paths that countries adopt. A broad range of developmental choices - in which infrastructure policy plays a key role - impact countries' capacity to cope with emissions reductions and climate impacts, including geographical distribution of activities, urban design and transport infrastructure, land use, and energy security[9].

How Climate Change will affect the Infrastructure Sector in the Developing World

Mitigation

Over half of global GHG emissions result from the construction and use of infrastructure assets, so progress in reducing infrastructure-related emissions is crucial to global efforts to avoid dangerous climate change. Key infrastructure sectors for mitigation are energy, transport and buildings. The manufacture of cement and steel also makes up a significant share of global emissions.

While all sectors play an important role, it is a transition in the energy sector that will be at the core of a strategy to meet climate change and developmental goals[10]. Efforts to achieve this transition are grouped into three categories: reducing demand; switching to cleaner fuels; and carbon capture and storage[11]. Many of the technologies that will be required to reduce emissions from energy production do not yet exist or are still under development, so the rate of technological development in the energy sector will directly influence the ability of countries to grow while restricting their carbon emissions[12].

Of the four sectors listed above, it is the buildings sector that has the greatest potential for rapid and cost-effective emissions reductions. The majority of the technologies required to make the transition already exist, and most interventions will result in improved operating efficiency and thus an overall cost-savings during the building's lifetime[13]. However, action is currently severely sub-optimal due to market and information barriers, low awareness amongst landlords and tenants, limited access to finance, and the fragmentation of the construction industry.

In the transportation sector, the magnitude of emissions depends on three factors; the design of vehicles, the fuel they use, and the transport infrastructure provided[14]. Cleaner fuel sources and more efficient engines play a key role, but achieving emissions reductions on the scale required will also depend upon the development of infrastructure that enables 'modal shifts' to forms of transport that produce less emissions and supports the minimisation of the number and length of journeys. Technical and urban planning solutions will be required to reduce emissions without compromising economic growth and other developmental goals.

A high proportion of the world's cement and steel production takes place in the developing world, but in many countries production facilities are outdated and inefficient. Technology transfer and carbon capture and storage will play a key role in reducing emissions from the production of construction materials.

Action in the infrastructure sector is urgent as infrastructure assets have a long life span. Countries experiencing rapid growth face a critical window of opportunity to develop a low-emissions stock of infrastructure, or risk becoming 'locked-in' to high-carbon growth during a period which is critical for the climate.

Adaptation

Climate change impacts will affect the infrastructure sector through two main channels. First, new climatic conditions will need to be taken into account at every stage of the project cycle for **baseline infrastructure**. Climate change will result in an overall increase in costs, as: some prospective sites become unviable; new facilities are constructed to be more resilient; operation, maintenance and insurance costs increase; and some infrastructure requires retrofitting to withstand climate change impacts[15]. The task of adapting the infrastructure sector to climate change is complicated by a high degree of uncertainty around future impacts. But certain actions are clearly cost effective. These include changing design standards and submitting long-lived infrastructure to climate-robustness assessments. Most infrastructure currently being planned will be affected by climate change, so the mainstreaming of climate risk assessments into infrastructure planning is urgent to avoid negative outcomes ranging from sub-optimal investment to catastrophic failures.

Second, a range of **dedicated adaptation infrastructure** will be required, including coastal zone protection to withstand sea level rise, riverine flood protection, and water supply and agricultural infrastructure for areas suffering drought and saline intrusion. Vulnerability to climate impacts is a function of three factors: *exposure* to risk, *sensitivity* to that risk, and *adaptive capacity*[16]. Ideally, investment decisions would be made on the basis of a joined-up risk assessment of these three factors, but accurate information on all three is severely limited. The prevailing wisdom is to opt for investments that are robust under most climate scenarios until better information is available[17]. These are often termed

'no regrets' or 'low regrets' options, and are typically investments that are priorities for development even without climate change.

Given that vulnerable people's exposure to climate change impacts is a function not only of their exposure to risk, but also their socio-economic circumstances, it will be important to combine 'hard' approaches (i.e. investments in physical infrastructure) with interventions aimed at building capacity and resilient livelihoods.

Key Challenge 1: Finance

Sourcing the funding required to realise the changes described above is universally regarded as a challenge of daunting proportions. According to recent estimates, hundreds of billions of dollars annually are required for mitigation needs associated with the infrastructure sector in the developing world between now and 2030[18], and (very) approximately $75 billion annually for adaptation needs in the infrastructure sector from 2010-2050[19]. Given the global distribution of responsibility for emissions, and the current distribution of wealth, there is a powerful ethical argument that the vast majority of this funding should be supplied through transfers from developed countries. The ethical case for such transfers is supported by pragmatic arguments that it is far beyond the capacity of most developing countries to supply funding on the scale required.

North-South financial transfers are currently occurring through two channels: bilateral and multilateral donor flows; and carbon market mechanisms such as the Clean Development Mechanism (CDM), which allows industrialised countries with emission-reduction targets to implement emission-reduction projects in developing countries in order to meet those targets. However, funding flows remain inadequate by a large margin. Delaying action will only increase the eventual cost of temperature stabilisation[20] (as well as resulting in increasingly severe impacts), so new and innovative strategies are urgently needed to increase the volume of funding flows.

Market mechanisms, and particularly the CDM, are widely expected to make an increasing contribution to North-South financial transfers for climate change mitigation in the coming decades. Such mechanisms will also contribute to optimising the global distribution of mitigation investment, as many of the most cost-effective abatement opportunities are in the global South. But many argue that CDM financial flows are not reaching some of the sectors and countries where they are most needed. At present, CDM finance is limited to narrow range of countries with relatively strong investment environments (generally the more industrialised developing countries), and the Mechanism is dominated by energy projects and is raising little funding for the key infrastructure sectors of transport and the built environment. One proposed approach to reforming the CDM with particular relevance for the infrastructure sector is 'sectoral CDM' whereby emissions reductions would be rewarded across sectors, as opposed to the current scheme in which reductions are associated with a project. Proponents argue that this would improve the sectoral allocation of funding and create the right incentives, and the necessary scale of funding, for governments to achieve sector-wide transformations to low-carbon growth paths[21].

Few would dispute that carbon markets have a vital role to play in mobilising North-South financial transfers for climate change, but there are many funding needs that they cannot meet. Donor funding provides a vital source of support in the poorest countries which have limited resources and struggle to attract private investment, and also facilitates activities such as capacity-building, technology transfer, and risk mitigation which play an essential 'leveraging' role in making the transition to a climate-friendly and resilient world, and have no obvious alternative source of finance. However, donor funding to date falls far short of the volume estimated to be required (discussed further in the analysis of funding flows below). Scaled-up funding is urgently required, while it will also be important to make the best use of the limited funds available by exploiting synergies with existing financial flows - including existing aid transfers - and to ensure that donor contributions are well coordinated across sectors, countries and regions.

International financial transfers will need to be combined with national policies in developing countries to encourage climate-friendly and resilient domestic investment in order to mobilise change on the scale required. Appropriate national policies will differ between countries depending on their stage of economic development among other factors. Examples include pricing carbon, regulating for energy efficiency, and revised zone planning and building codes that take into account new climatic conditions.

Approaches to raising climate-related infrastructure finance differ depending on whether they are directed at mitigation or adaptation. There is greater scope to leverage private finance for mitigation than adaptation in the infrastructure sector, principally because most emission-producing infrastructure is privately owned, whereas a great deal of the infrastructure that needs to be climate-proofed is publicly owned. Further, there is limited scope for

private investment in dedicated adaptation infrastructure as it does not create commercial revenue[22]. This implies that the principal source of adaptation infrastructure funding is likely to be donor transfers and developing country government budgets (although private agents will also carry part of the burden as they invest in adapting their assets), while it is anticipated that the private sector will make a significant contribution to funding mitigation investment. However, raising private finance for infrastructure in the developing world has proved consistently challenging, especially for countries with weaker investment environments. Increased risk mitigation from public sources (including donors) in the form of guarantees, grants and loans could help to encourage private green infrastructure investment in the developing world.

Key Challenge 2: Technology

Technological progress plays a crucial role in reducing carbon emissions from the infrastructure sector. While less critical for adaptation, protecting communities from the impacts of climate change will also require technological innovation.

Considering mitigation, many of the technologies required to reduce emissions and achieve low-carbon growth are similar across the globe, and it seems likely that richer countries will take a lead in developing these technologies. Technology transfer from the global North to the global South is therefore crucial to enable the shift to low-carbon economies within the timescale required. The active support of donors and international organisations will play a key role in efforts to achieve this, through initiatives such as international and regional organisations to promote technology transfer, international financial transfers, and possibly changes to international intellectual property laws.

However, international initiatives alone will not be enough to achieve technology transfer on the scale and within the timescale required, as many developing countries are limited in their capacity to absorb new technologies. Efforts to promote the dissemination of technologies will stand a far higher chance of success if they are combined with initiatives (on the part of donors and developing country governments) to enhance absorptive capacities[23]. Key constraints include low levels of technical expertise, weak legal frameworks to protect intellectual property rights, and the absence of institutions able to promote and coordinate technology transfer.

Some low-carbon technologies (such as low-cost, decentralised renewable energy for sub-Saharan Africa) and many adaptation technologies (such as small-scale irrigation) are specific to developing country contexts. For these technologies more localised development strategies will be required, such as regional innovation centres, and South-South technology transfer will play a more important role than North-South technology transfer. Again, donors could play an important role in supporting such initiatives through funding and technical assistance.

Key Challenge 3: Capacity

The scale and urgency of the climate change challenge demands an ambitious response, yet developing countries can only take actions that are consistent with their capacity level[24]. National governments' success in coping with climate change will depend to a large degree on their ability to develop coherent climate change policy frameworks that: integrate climate change objectives with national plans and budgetary frameworks; facilitate integrated climate change planning across sectors and scales; and support the mainstreaming of mitigation and adaptation objectives routinely into policy decisions across a broad spectrum.

This is difficult to achieve in many developing countries due to institutional weaknesses, poor access to information and modelling, low levels of human capacity, and inadequate financial resources. Climate change policy development is uniquely challenging because the issue spans across multiple sectors and scales, and so requires extensive coordination between government agencies that normally work in silos. Building the capacity of developing country governments to formulate and implement climate change policy will therefore form an important part of programmes to support developing countries in meeting the challenge of climate change.

In the infrastructure sector, the challenges are exacerbated by existing capacity barriers in institutions responsible for infrastructure development. Capacity-building strategies will need to be based on an understanding of which agencies are the most appropriate to take a leading role in climate change infrastructure policy, and their existing capacity and institutional characteristics.

Support from high-income countries is critical in building capacity. Donors are well positioned to work through existing channels of development assistance to build capacity for integrating climate change into developmental decisions in the relevant institutions. However, the process of capacity-building is complex, context-dependent and requires a long time horizon. In the short-term, at least for countries with lower capacity, a combination of 'project approach' interventions relying on foreign technical and

management expertise and more gradual interventions focused on building the requisite capacity in the partner country is likely to be required to meet needs within the timescale required. One proposed model for achieving this is "a step by step approach, whereby countries in each step assess their existing capacities and select future actions that are consistent with the capacity level it can reasonably reach within a given time frame"[25].

Maximising the developmental outcomes of mitigation in the infrastructure sector

The consequences of climate change are often seen as overwhelmingly negative for developing countries, but developmental opportunities are also created by international and national policies for mitigation and adaptation in the infrastructure sector. Taking advantage of these opportunities can help to counteract the negative economic and social impacts that result from new climatic conditions and offset the dampening effect on growth that many developing countries fear will result from emissions limitations.

Opportunities for developing countries arising from *international* efforts at mitigation include: access to new sources of finance, since many of the most cost effective mitigation opportunities are in the developing world; accelerated rates of technology transfer; and access to new international markets for green products. Harnessing these opportunities will require proactive policy development on the part of governments, a key element of which would be a coherent and clearly articulated national mitigation strategy. Such a strategy would position the country to attract international funding, and give business the confidence to make low-carbon investments in the knowledge that future policy development will be consistent with a positive return on their investment[26].

Countries in the process of transition to a low-carbon economy will also experience a transition in the labour market, which is projected to generate additional 'green' jobs in the infrastructure sector, particularly in renewable energy and the buildings sector. The buildings sector holds unique potential for pro-poor green job creation: firstly, because the construction sector is principally made up of small and medium enterprises (SMEs) that tend to employ a high proportion of unskilled workers and recycle much of their profits back into their communities; secondly, work to improve the energy efficiency of buildings will almost always be carried out on site, so much of the benefit will accrue locally. Proactive policy development on the part of governments will be required to harness the poverty-reduction opportunities associated with green jobs, including programmes to build the capacity of green workers[27].

When taking decisions on how to invest international or national mitigation funding, developing country policymakers can take advantage of the many synergies that exist between national mitigation strategies and national development priorities. For example, in developing countries where a high proportion of the population still lack access to electricity, investment in decentralised forms of energy, such as solar or wind power could achieve both green growth and more inclusive growth (further examples are given in Annex A of the main report). Identifying and exploiting these synergies can support efforts to achieve long-term developmental goals and will also serve to enhance the relevance and popularity of mitigation projects. Climate change infrastructure investment decisions should ideally be informed by a thorough analysis of potential mitigation-adaptation-development synergies, and their relationship with developmental paths, in order to generate the greatest economic, social and environmental value[28]. Donors may be able to assist by supporting the development of decision frameworks to guide this process.

Countries with smaller economies could better position themselves to profit from international funding flows associated with mitigation by forming economic alliances with neighbouring countries, and thus creating larger markets that are more attractive to entrepreneurs. Enhanced regional cooperation would also facilitate regional technology transfer and cross-border access to renewable power sources such as hydroelectric dams. Efforts to enhance regional cooperation would need to overcome political and institutional challenges. A starting point would be to build upon existing models of regional cooperation and existing regional ties.

Maximising the developmental outcomes of adaptation infrastructure investment

Donors will provide or leverage increasing volumes of funding for adaptation in the coming decades, much of which will be allocated to the infrastructure sector[29]. Developmental outcomes will depend on how this funding is apportioned and managed. As discussed above, the most vulnerable groups in society have lowest adaptive capacity, but hold least responsibility for the emissions that have caused climate change, so there is an ethical and pragmatic case for maximising the developmental outcomes of adaptation-related infrastructure investment for these groups. A feature of such an approach would be to combine investment in physical infrastructure assets with

programmes to build capacity to cope with impacts and improve the resilience of livelihoods within communities in the project vicinity.

Three tried and tested methods for generating pro-poor outcomes from infrastructure investments are: stakeholder engagement, incorporating explicit efforts to include the poorest and most vulnerable stakeholders; community-led projects; and pro-poor employment creation.

Stakeholder engagement enhances developmental outcomes in many ways, but in the context of adaptation infrastructure investment, it would support the development of appropriate solutions, informed by stakeholder perceptions of risk, vulnerability and capacity, as well as raising awareness amongst stakeholders of the likely impacts of climate change.

Many adaptation infrastructure projects are well suited to small-scale, low or medium-technology community-driven schemes, for example irrigation, rainwater storage, small dams and flood defences, and maintenance and rehabilitation of drainage systems and gravel roads. Implementing these projects as community-driven schemes can generate employment within the community, create ownership amongst community members, empower the vulnerable, and increase social capital, which is a key element of adaptive capacity.

The developmental outcomes of adaptation-related infrastructure investment could also be enhanced through greater regional cooperation. Climatic phenomena do not respect borders so coping effectively with impacts such as water scarcity, flooding and sea level rise will require close cooperation between neighbouring countries. Cooperation between countries would also facilitate the pooling of information and resources for tasks including the generation of climate models, and capacity-building and vulnerability and risk-assessment exercises. Again, regional cooperation holds particular significance for poorer countries with smaller economies.

Analysis of climate-related infrastructure investment needs, donor and CDM infrastructure funding flows, and low-carbon growth strategies in nine countries

Estimates of funding required by infrastructure sector and region

According to estimates in the report "Pathways to a Low Carbon Economy: Version 2 of the Global Greenhouse Gas Cost Abatement Curve" (2009): 67% of global abatement potential[30] is in the developing world and, in order to achieve the optimum global abatement curve:

- the infrastructure sector requiring greatest investment is the buildings sector by a significant margin ($155 bn and $248 bn annually globally[31] in 2015 and 2030 respectively), although, due to the resulting cost savings, the net cost to society of acheiving optimum abatement in the buildings sector is negative in the long term;
- the power sector comes in second in terms of capital expenditure ($65 bn and $185 bn annually in 2015 and 2030 respectively), but the operational cost savings are far lower than for the buildings sector, so the long term cost to society is high;
- the developing region requiring greatest investment by far is Asia.

According to estimates in the World Bank report "The Cost to Developing Countries of Adapting to Climate Change: New Methods and Estimates" (2010):

- $74.6 billion annually on average will be required in developing countries for adaptation investment in the infrastructure sector between 2010-2050;
- the greatest anticipated cost is for constructing, operating and maintaining baseline levels of infrastructure services under new conditions (39%), followed by coastal zone protection (34%), water supply and riverine flood protection (18%), and agricultural infrastructure (8%);
- total infrastructure adaptation costs are greatest in Asia by a significant margin, but sub-Saharan Africa will shoulder a greater burden in proportional terms: 0.6% of GDP compared to 0.1% in Asia.

Analysis of donor funding flows

Infrastructure funding flows were analysed for approved projects from seven Climate Funds[32,33]. From these funds, $3.2 billion of direct donor funding had been raised for mitigation infrastructure up to September 2010, and $100 million (just 3% of the total) for adaptation infrastructure. Considering full project cost including co-financing leveraged, $23 billion has been raised for mitigation and $590 million (2%) for adaptation. While it is difficult to make statements about the appropriate balance between mitigation and adaptation without country-level detailed assessments of needs, these figures suggest that donor infrastructure funding flows may currently be excessively skewed towards mitigation.

Alternative sources of finance are not readily available for adaptation (unlike mitigation where carbon markets and the domestic private sector are likely to provide a significant proportion of funding), so funding not provided by donors is likely to come principally from developing country governments' budgets. The analysis here suggests that donor funding flows for adaptation infrastructure investment are inadequate by a significant

margin[34]. Scaled up donor funding, combined with new and innovative funding strategies are urgently needed to meet adaptation infrastructure funding needs.

Mitigation funding from the Climate Funds

Energy projects dominate the Climate Funds mitigation project costs, with energy production and efficiency absorbing 58% of total funds. The buildings sector is receiving just 14% of project funding provided or leveraged by the Climate Funds. It seems probable that this is lower than the optimum given the outcomes of the McKinsey and Company (2009) analysis, although it is difficult to come to any firm conclusions without an understanding of the sectoral distribution of private investment.

Many of the projects contribute to national developmental objectives as well as mitigation. For example, 95% of transport project costs are allocated to urban transportation management which will contribute to increased mobility and reduced air pollution as well as emissions reductions. This suggests that (unsurprisingly) developing country policymakers are seeking projects with developmental synergies.

Adaptation funding from the Climate Funds and NAPAs

Adaptation infrastructure funding requested under the National Adaptation Programmes of Action (NAPAs)[35] is dominated by agricultural water supply, with 75% of the total[36]. In contrast, approved funding under the Climate Funds is dominated by coastal protection, with 59%. Funding from the NAPAs programme is open to least developed countries (LDCs) only, so this is in part a reflection of the agrarian economies of most LDCs. The focus on agricultural water supply reflects policymakers' prevailing concerns and understandable desire to use Climate Funds to meet the immediate needs of their citizens, where the two objectives coincide.

The NAPAs sectoral balance is in sharp contrast to the World Bank's estimates[37], which predict that just 5% of adaptation infrastructure funding will be required for irrigation infrastructure[38], and 34% for coastal zone protection. This is at least partly attributable to the NAPAs' specific focus on meeting the "urgent and immediate needs" of LDCs. However, with only 2% of Climate Funds infrastructure project funding going to adaptation, the analysis raises concerns over how this more strategic, long-term adaptation infrastructure will be financed. The contrast in the sectoral balance between the NAPAs and the World Bank's predictions, and the relatively low-level of funding applied for compared to that required illustrate the urgent need to build policymakers' understanding of the future impacts of climate change, their ability to develop projects, and their access to high-quality predictive models.

The Clean Development Mechanism

CDM projects are dominated by energy when considering either project numbers or Certified Emission Reductions (CERs). Energy production, energy efficiency and 'energy-other' make up 79% by project number and 58% by CERs. The resources available for transportation projects under the CDM are minimal, making up just 1% of the portfolio by both project numbers and CERs. The proportion of projects or CERs for energy efficiency in buildings is lower than the McKinsey and company analysis suggests is optimal: less than 14% by project numbers or 11% by CERs. These findings illustrate the case for reforming the CDM in order to encourage the inclusion of transportation and buildings projects.

Case studies of low-carbon growth strategies in nine countries

The following are the key findings from case studies of low-carbon growth strategies in Bangladesh, Brazil, China, Ethiopia, Guyana, Mexico, Nigeria, Malawi and Rwanda:

- Provisions related to infrastructure development, particularly energy and transportation, form the backbone of many countries' climate change plans. Low-carbon growth strategies in the infrastructure sector vary considerably between country income brackets.
- Proactive plans to harness opportunities from national mitigation strategies are more evident in middle-income countries (MICs) than low-income countries (LICs).
- In the LIC documents reviewed, there is little discussion of the financial incentives or regulation with which their planned policies will be implemented, reflecting the early stage they are at in developing low carbon policies.
- The low carbon growth strategy documents show that finance is fundamental to implementation and is linked to all proposals made under countries' low carbon development plans, yet it remains scarce, particularly for LICs.
- Consultation of the private sector appears to have been limited in most countries.
- Overall, in MICs the biggest issue seems to be a lack of coordination between implementing bodies, unaligned policies and weak enforcement at the local level. In LICs, capacity represents the most significant barrier to implementation, including lack of training and expertise in climate change issues and weak enforcement and oversight.
- Therefore, key requirements for developing countries to successfully implement their plans include the need to build capacity, and enhance coordination between ministries, as

well as wider steps to provide adequate public finance and improve the investment climate and market mechanisms in order to stimulate private financing.

Recommendations and areas for further study

The recommendations given are directed towards donors, but would also be of interest to developing country policymakers, researchers and infrastructure professionals.

Recommendations for donors

Support programmes to raise awareness amongst developing country policymakers, the private sector and civil society of the urgency of taking action in the infrastructure sector in order to avoid becoming 'locked-in' to high-emissions pathways and developing infrastructure stocks that are not suited to new climatic conditions.

Support partner country governments in developing and implementing climate change policy frameworks:

- Support the development of decision making frameworks to help countries identify and prioritise mitigation and adaptation-related infrastructure investment needs, and balance these needs with developmental priorities.
- Raise awareness amongst policymakers in the developing world of the potential synergies between mitigation, adaptation and development, and support the development of tools to facilitate the identification and capture of these synergies.
- Support partner country governments in developing strategies to overcome the barriers to rapid, cost-saving emissions reductions in the buildings sector as a priority. These would include updated and better-enforced building codes, financial incentives, and education and awareness-raising.
- Assist partner country governments in preparing the infrastructure sector for climate impacts that are still uncertain. Possible approaches include: support governments in implementing cost-effective measures to climate-proof future baseline infrastructure, such as changes to building codes and climate-risk assessments at planning stage; build the capacity of infrastructure decision-makers to identify options for dedicated adaptation infrastructure that are 'no-regrets' or 'low-regrets', i.e. that are robust under most climate scenarios.
- Lead by example by adopting climate risk assessments as standard in project planning for donor supported infrastructure projects and disseminate the tools and knowledge generated[39].
- Support developing country partner governments in engaging in broad-based consultation during the development of low-carbon growth strategies, including consultation with civil society and the private sector.

Support programmes to build capacity in partner country governments, the private sector and civil society:

- Work through existing channels of development assistance to build capacity for integrating climate change into developmental decisions in the relevant government institutions.
- Develop capacity-building strategies for climate change in the infrastructure sector in partnership with partner country governments, with input from the private sector and professional institutions, and on the basis of an understanding of the existing capacity and institutional characteristics of the agencies most appropriate to take a leading role in climate-related infrastructure policy development.
- Build the capacity of developing country policymakers (particularly in lower-income countries) to develop mitigation and adaptation-related infrastructure project proposals for international funding.
- Support programmes to build the capacity of 'green workers' who could benefit from the jobs created by transition to a low-carbon economy in the labour market.

Scale-up, balance and coordinate funding flows for climate-related infrastructure:

- Scale-up donor funding flows for climate-related infrastructure investment in order to enable developing countries to achieve mitigation and adaptation goals within the timescale required.
- Scaling up funding for adaptation infrastructure investment appears to be particularly urgent as this study has found a very high proportion of donor funding for infrastructure flowing to mitigation, and there is little scope to raise adaptation funding from private sources.
- In order to make the best use of limited donor funds, exploit synergies with existing financial flows - including existing aid transfers - and improve the coordination of donor contributions across sectors, countries and regions.

Maximise the pro-poor outcomes of donor-supported adaptation infrastructure projects:

- Combine investment in physical infrastructure with programmes to enhance adaptive capacity and the resilience of livelihoods.
- Adopt community-led approaches to adaptation infrastructure projects where possible, with the aim of generating benefits including employment generation, ownership,

empowerment, and enhanced social capital.
- Develop a stakeholder engagement plan that incorporates explicit strategies to include the poorest and most vulnerable.

Support efforts to mobilise private sector support for climate-related infrastructure investment:

- Encourage private sector investment in green infrastructure in countries with challenging investment climates by providing risk mitigation in the form of guarantees, grants and loans.
- Support developing country partners in creating incentives for private investors to adapt new physical assets to climate change impacts.

Support reforms to the CDM:

- Support reforms to the CDM which would result in the allocation of a greater proportion of CDM financing to the key infrastructure sectors of transport and the built environment, and to a wider range of country income groups. One possible approach would be funding research to model the outcomes of various possible reforms, thus creating a stronger evidence base for pro-reform positions in international negotiations.

Support scaled-up technology transfer and innovation at international, regional and national level:

- Combine international initiatives to promote technology acquisition with programmes to build absorptive capacity in developing countries. Such programmes would support any or all of: the development of technical expertise, strengthening of legal frameworks to protect intellectual property rights, the creation of institutions able to promote and coordinate technology transfer.
- In addition, support national and/or regional programmes to develop technologies required specifically for developing country contexts, such as low-cost decentralised renewable energy for mitigation, and small-scale irrigation for adaptation.

Areas for Further Study (for donors or others)

Compile evidence in key areas and support the development of policy accordingly:

- Compile evidence of the developmental benefits of switching from high-emissions development to low-emissions pathways (particularly for lower-income countries), and the policy frameworks that optimise these developmental outcomes.
- Compile evidence on the potential for pro-poor green job creation in the buildings sector, and provide support in developing policy to capture these benefits.
- Research the costs associated with regulating for reduced emissions and climate robustness in the infrastructure sector. Use this to support the development of mechanisms to compensate developing country governments and private sector actors for these costs, thus providing incentives to implement and enforce climate-related regulations.
- Further research is required into the implications of the high proportion of construction activities that take place in the informal sector in developing countries for attempts to reduce emissions and prevent maladaptation through regulation, and potential approaches to reducing this barrier.
- The analysis of funding flows in this report raises several concerns and demonstrates the need for a more extensive analysis of climate-related infrastructure funding flows by sector, and by mitigation and adaptation, including – as far as is possible – donor funding flows beyond the Climate Funds and private sector flows. The analysis could be used to understand whether the very high proportion of funding flowing to mitigation found in this study still stands when a wider range of funding sources are taken into account, as well as providing valuable evidence on the allocation of infrastructure funding flows between sectors and countries. Of particular importance is further investigation into whether the buildings sector is receiving the support needed to realise the substantial and cost-effective mitigation opportunities it presents.
- Further research is required into the potential benefits of, and obstacles to, regional cooperation for adaptation and mitigation programmes in the infrastructure sector, possibly with a focus on sub-Saharan Africa. One focus area would be existing regional groupings and models of cooperation, and the extent to which these can be built upon for climate change programmes.

Areas in which research has already been carried out, but additional evidence and case studies would be valuable:

- The role of public-private partnerships in promoting green investment in, and technology transfer to, the developing world.
- Procurement strategies to encourage low-carbon, climate resilient infrastructure development.

Notes and References

[1] OECD/DAC (2006) Promoting Pro-Poor Growth: Infrastructure. Paris: OECD

[2] ICE (Institution of Civil Engineers) (2010) About Civil Engineering. [Online] Available from: http://www.ice.org.uk/About-civil-engineering [Accessed 13th August 2010]

[3] EC (European Commission) (2010) Building a post-2012 global climate regime: the EU's contribution [Online] Available from: http://ec.europa.eu/environment/climat/future_action.htm [Accessed 2nd July 2010]

[4] IPCC (2007) Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

[5] Today's high-income countries have generated about 80% of past fossil-fuel based emissions, despite having only 15% of the global population (UN-DESA (2009) Policy Brief 22: Financing mitigation and adaptation by developing countries).

[6] Burton, I., Diringer, E, Smith, J. (2006) Adaptation to Climate Change: International Policy Options. Pew Center on Global Climate Change

[7] World Bank (2010a) World Development Report 2010: Development and Climate Change. Washington D.C.: World Bank

[8] Mitchell, T., & Maxwell, S. (2010) Defining Climate Compatible Development: Climate and Development Knowledge Network Policy Brief. London: CDKN & ODI

[9] Sathaye, J., A. Najam, C. Cocklin, T. Heller, F. Lecocq, J. Llanes-Regueiro, J. Pan, G. Petschel-Held , S. Rayner, J. Robinson, R. Schaeffer, Y. Sokona, R. Swart, H. Winkler (2007): Sustainable Development and Mitigation. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[10] UN-DESA (2009) World Economic and Social Survey 2009: Promoting Development, Saving the Planet. New York: United Nations

[11] Fisher, B.S., N. Nakicenovic, K. Alfsen, J. Corfee Morlot, F. de la Chesnaye, J.-Ch. Hourcade, K. Jiang, M. Kainuma, E. LaRovere, A. Matysek, A. Rana, K. Riahi, R. Richels, S. Rose, D. van Vuuren, R. Warren (2007): Issues related to mitigation in the long term context, In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Inter-governmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge

[12] World Bank (2010b) The Economics of Adaptation to Climate Change: A Synthesis Report (Final Consultation Draft – August 2010). Washington D.C.: World Bank

[13] Levine, M., D. Ürge-Vorsatz, K. Blok, L. Geng, D. Harvey, S. Lang, G. Levermore, A. Mongameli Mehlwana, S. Mirasgedis, A. Novikova, J. Rilling, H. Yoshino (2007) Residential and commercial buildings. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[14] World Bank (2010a)

[15] World Bank (2010c) The Cost to Developing Countries of Adapting to Climate Change: New Methods and Estimates. Washington D.C.: The World Bank

[16] IPCC (2007)

[17] World Bank (2010b)

[18] McKinsey and Company (2009) Pathways to a Low Carbon Economy: Version 2 of the Global Greenhouse Gas Cost Abatement Curve. McKinsey and Company

[19] World Bank (2010c)

[20] Stern, N. (2006) Stern Review: The Economics of Climate Change. London: HM Treasury

[21] Sterk, W. & Wittneben, B. (2006) Enhancing the clean development mechanism through sectoral approaches: definitions, applications and ways forward. International Environmental Agreements: Politics, Law and Economics 6(3) 271-287

[22] World Bank (2010c)

[23] World Bank (2010a)

[24] Willems, S. & Baumert, K. (2003) Institutional Capacity and Climate Actions. France: OECD

[25] *Ibid*, pp. 5

[26] Ellis, K., Cantore, N., Keane, J., Peskett, L., Brown, D. & Willem te Velde, D. (2010) Growth in a carbon constrained global economy. London: ODI

[27] UNEP, ILO, IOE, ITUC (2008) Green Jobs: Towards decent work in a sustainable, low-carbon world. Nairobi: UNEP

[28] Wilbanks, T.J., Sathaye, J. (2007) Integrating mitigation and adaptation as responses to climate change: a synthesis. Mitigation and Adaptation Strategies for Global Change 12:957-962

[29] According to estimates in the World Bank report "The Cost to Developing Countries of Adapting to Climate Change: New Methods and Estimates" (2010) approximately 75% of adaptation investment in the developing world will be required in the infrastructure sector as defined in this report.

[30] Abatement potential is defined as the maximum potential of all technical GHG abatement measures (i.e. without a material impact on the lifestyle of consumers) below €60 ($75) per tonne, if each opportunity were pursued aggressively from 2010. McKinsey and Company estimate that this would stabilise global warming below 2°C.

[31] Disaggregated figures for the developing world are not available.

[32] Bilateral and multilateral donor funds established explicitly to fund climate change activities. They do not encompass the full range of donor funding available.

[33] A full methodology for the analysis is available in Annex B of the main report.

[34] It should be noted that this is an incomplete analysis of financial flows, which include additional bilateral and multilateral donor funding flows and private funding.

[35] The NAPAs are a special programme to support adaptive capacity in Least Developed Countries, funded by the GEF's Least Developed Countries Fund.

[36] For the Climate Funds, only funding for projects that have been *approved* is included in the analysis. Few NAPA projects have been approved to date, so the analysis has been carried out of all infrastructure projects for which funding has been *requested* under the NAPAs.

[37] World Bank (2010c)

[38] Although, at $3.4 billion annually, this is still considerably more than that applied for through the NAPAs.

[39] Some donors are already making progress in this area; see section 3.2 of the main report.

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This is the overview of a report that will be published in June 2011. The report will be available on the websites of EAP and ODI. For further details, or to be added to a mailing list, please contact Lily Ryan-Collins: l.ryancollins@engineersagainstpoverty.org

Engineers Against Poverty (EAP) is an independent NGO working in the fields of infrastructure policy, engineering practice and international development.

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