Part II

Investing in Physical Infrastructure and Dynamic Growth

High speed train in motion.

Chapter 3: Green stimulus and beyond

3.1 Introduction

In response to the financial and economic crisis of the last four years a number of countries, both industrialized and developing ones, launched fiscal stimulus packages. Altogether these were estimated to amount to US $3.1 trillion of committed spending in 2009 (UNEP 2009a). At least 15 per cent of this spending – over US $445 billion – was allocated to sectors and activities such as infrastructure, in particular, railways, electric grids, high-speed broadband networks, water and waste, energy efficiency, renewable energies and low-carbon vehicles that build on and enhance the Earth's natural capital or reduce ecological scarcities and environmental risks (Robins 2009). These sectors, in addition to other innovative and energy-efficient goods and services, can therefore broadly be considered green.

Government stimulus packages included not only committed government spending, but also tax relief and tax incentives for the private sector. An overview of specifically committed government spending in eight countries from different regions is provided in Table 1.

Table 1- Sizing Green Stimulus Packages

Country	Package	Period	Total Fund	Green Fund	Renewable	CCS* / Other	Building EE*	Lo C* Vech+	Rail	Grid	Water/ Waste
		(year)	(US$ billion)	(US$ billion)							
Asia Pacific											
China	NDRC* Stimulus Package	2009-2010	586.1	200.8	-	-	7.31	1.5	98.65	70	23.38
Indonesia	Stimulus Plan	2009	5.9	0.1	0.07	-	-	-	0.03	-	-
South Korea	Green New Deal	2009-2012	76.1	59.9	1.8	29.05	6.41	1.8	7.01	-	13.89
Africa											
South Africa	Budget 2009-2010	2009-2011	7.5	0.8	-	-	0.1	-	0.61	-	0.1
Europe											
European Union	Economic Recovery Plan-Only EU	2009-2010	38.8	24.7	0.65	12.49	2.85	3.88	-	4.85	-
Germany	Stimulus Plan	2009-2010	104.8	13.8	-	-	10.39	0.69	2.75	-	-
France	Revival Plan	2009-2010	33.7	6.1	0.87	-	0.57	-	0.39	4.13	0.19
Americas											
Mexico	Aggr for Home Economics & Emp	2009	7.7	0.8	-	-	0.75	-	-	-	-
United States	Emergency Economic Stabilization Act	10 Years	185	18.7	10.25	2.6	3.34	0.76	0.33	0.92	0.52
	American Recov and Reinvestmt Plan	10 Years	787	94.1	22.53	3.95	27.4	4	9.59	11	15.58

* NDRC = National Development and Reform Commission CCS = carbon capture and storage EE= energy efficiency LoC = low carbon

Source: Adapted from HSBC, 9 March, Delivering the Green Stimulus.

3.2 Assessing impact to date

There is indication that green stimulus spending triggered a significant expansion of economic activity in targeted green sectors. The Chinese State Grid Corporation has announced that 2009 was its highest-ever investment in grid development, in part due to an increase in railway infrastructure (Robins 2010).

In the United Sates a record high of 9.9 GW of wind installations was added in 2009. The US Department of Energy indicates that the stimulus in the renewable sector will leverage US $43 billion of private capital in 2012. Spending by the US Department of Energy has been matched by an estimated US $27 billion of private capital, totalling approximately US $65 billion in projects (approximately equivalent to 0.5 per cent of total GDP). Public-private partnerships were made possible through government grants, as well as soft and facilitated loans. As a direct result of the American Recovery and Reinvestment Plan, the State of Massachusetts in 2009 awarded funding solely for projects that move towards the development of zero net energy buildings (MNN 2009).

Infrastructure, in particular, rail infrastructure, has received the biggest boost from green stimulus packages. Investment in rail and water infrastructure, grid expansion and improved building efficiency has been particularly high, totalling 85 per cent of the allocation of green stimulus packages or US $379 billion. For example, almost half of China's US $218 billion green stimulus package has been allocated to railway infrastructure. About US $23 billion (15 per cent of the total) has been channeled to the construction of water infrastructure that benefited 14.6 million people. (Robins 2009, 2010)

In 2009 South Africa activated plans for the government and its utilities to spend US $96.7 (787 billion rand) over the next three years on building and upgrading infrastructure for power supplies (UNEP 2009b). Other investments promoted by governments include investment in informational technology infrastructure. In the US this has taken the form of a plan for improving access to high-speed broadband networks to more than 100 million households, aiming to advance national goals for education and health care (US Government 2010).

Overall, green stimulus appears to have secured green jobs at risk and created new ones around the world. In a number of countries, a large portion of the fiscal stimulus has been geared towards securing jobs and providing social safety nets, with varying degrees of success. At the same time, the injection of massive spending in specific sectors resulted in a rapid transition in labour markets within and among countries, requiring policy intervention to manage such a transition in a fair manner (ILO 2010a). Infrastructure investment is one of the main means of restarting growth and creating jobs, the reason why a significant part of fiscal spending went to construction, transportation and energy-related infrastructure. Part of this includes green infrastructure such as works for flood control, irrigation schemes, insulation of buildings and changing transport from road to rail.

The American Recovery and Reinvestment Act has saved or created some 52,000 clean-energy jobs and supported another 11,000 jobs (Robins 2010). The Republic of Korea's Green Growth Strategy is expected to create 1.47–1.18 million jobs in green industries (Korea 2010). The bulk of Indonesia`s US $5.9 billion fiscal stimulus launched in February 2009 was spent to prevent worker layoffs and improve Indonesian business competitiveness.

Nonetheless, there have been concerns about the sustainability of jobs created through stimulus packages. According to certain studies, just one in ten of the newly created green jobs became a permanent job (Álvarez and others 2009). It must be noted that very little analytical work has been devoted to this issue in the literature. Therefore, the results emanating from the few studies available should be interpreted with caution. More generally, the rising level of informality in the global economy constitutes a major challenge to all job growth, including green job growth. Spain, for example, experienced one of the highest increases in unemployment among young adults after the global financial crisis. Despite efforts to revive the economy, unemployment rates have stagnated. As a result, Spain's informal economy has grown, lowering wages and government revenue (European Employment Observatory 2010).

The effort to advance decent work and pro-poor sustainable development as a single and integrated strategy is critical to building green jobs across the developing world. One way to reduce the risks associated with green jobs would be to increase social safety nets in various countries. The Green Jobs Initiative of the ILO and its partners seek to mobilize governments, employers and workers to engage in dialogue on coherent policies and effective programmes leading to a green economy with green jobs and decent work for all.

3.3 From stimulus to long-term policy reforms towards a green economy

There is empirical evidence today that targeted government spending can start a transition to a low-carbon economy. The Green Economy Report (UNEP 2011) found that investing 2 per cent of global GDP per year in ten economic sectors between 2010 and 2050 can kick-start a transition towards a low-carbon, resource-efficient economy. Currently, 2 per cent of global GDP amounts to approximately US $1.3 trillion. In comparison, all of the green stimulus packages only amount to US $521 billion (Robins 2010).

Several countries have expanded investment in specific sectors beyond the green stimulus packages. For example, Germany announced a number of plans that can be seen as shifting the economy towards a green path, building on some of the initiatives under the stimulus package. One component is the Renewable Energy

Sources Act, which entered into force in 2009. Germany's goal is to increase the share of renewable energy in total electricity consumption to at least 30 per cent by 2020, a doubling of the current share of almost 15 per cent (Germany 2010).

Mexico is one of the first developing countries to commit to a voluntary carbon reduction target by pledging to halve GHG emissions by 2050 (WRI 2009). Mexico also plans to put in place a domestic cap-and-trade system by 2012 (Burtraw and others 2010). Among other significant measures, the government enacted the Special Program for Climate Change 2009-2012 (PECC). This programme lays out a long-term vision for combating climate change while establishing the sectoral level interventions that will result in emission reductions. It also creates a framework for monitoring improvements and establishes a blueprint for emission reduction initiatives. Through the PECC, Mexico is evaluating the vulnerability of the country to climate change and conducting an economic valuation of the priority measures for intervention (WB 2009a).

Moreover, governments have moved into macroeconomic policy reform, specifically using fiscal policy to mitigate climate change. The South African government is considering the introduction of a long-term, escalating carbon tax to help curb GHG emissions, particularly from coal-fired power plants (UNEP 2009b).

Green investments are also being integrated into medium- to long-term development plans in certain countries. This expansion of short-term countercyclical measures into spending as part of the regular budgeting process for 2010 characterized some countries. Others even developed full-fledged medium-term development plans with a significant component on themes related to promoting a green economy. The Republic of Korea adopted in July 2009 a Five-Year Green Growth Plan (2009/2013) to serve as a medium-term plan for implementing a low-carbon, green growth vision. Under the plan, US $83.6 billion, representing 2 per cent of GDP, will be spent in the area of climate change and energy, sustainable transportation and the development of green technologies. For example, around US $1.8 billion was allocated to the promotion of low-carbon vehicles in the Korean stimulus plan. This five-year plan is expected to stimulate production in the amount of US $141–160 billion. (Robins 2010, UNEP 2009b)

During the twelfth five-year plan period starting 2011, China is expected to invest US $468 billion in greening the economy with a focus on three sectors: waste recycling and reutilization; clean technologies; and renewable energy. China's environmental protection industry is expected to continue growing at an average of 15–20 per cent per year and its industrial output is expected to reach US $743 billion during the new five-year period, up from US $166 billion in 2010. The multiplier effect of this emerging sector is estimated to be 8–10 times larger than other industrial sectors (China Development Bank Corporation 2010).

The 2010 budget of the US Government outlines several green priorities under a programme for creating jobs and investing in long-term economic growth. This includes a proposal to create a Clean Energy Economy – a comprehensive energy and climate change plan to invest in clean energy, decrease dependence on oil, address the global climate crisis and create new jobs.

Recent studies on the prospects of green investments in the long run point to a possibly tripling of the market to US $2.2 trillion per annum by 2020, with an annual growth rate of 11 percent (Robins 2010). The encapsulation of short-term stimulus packages into long-term policy frameworks, targets for investment, and green economy strategies, as discussed above, appear to give reason for a significant growth of green investment in the next decade.

Some important changes could take place, both in sectors offering brighter prospects for investments and in the dynamics of markets. For example, energy efficiency in the car industry with the uptake of low-carbon vehicles such as plug-in hybrid and full electric vehicles is expected to surpass efficiency improvements in the power sector as a major investment opportunity. Similarly, the uptake of smart grids will deeply transform the relationship between energy supply and demand, especially at the household level, introducing significant reductions in GHG emissions and promoting the creation of green jobs. In general, smart grids may introduce savings of 10 to 25 per cent in electricity demand (ITU and others 2011). The low-carbon market in China would overtake the US, but not Europe.

There is, however, concern about the timing of governments' plans and targets for green investment. Despite positive economic growth, the labour market has yet to recover with unemployment figures particularly high for young adults in developed countries. As a result of the global financial crisis, many people have been left struggling to find stable employment, adding pressure on governments to address social demands related to unemployment benefits, especially in developed countries. In most OECD countries, the youth-unemployment rate increased by 4.9 per cent between 2007 and 2009, to 18.4 per cent. By the second quarter of 2010 it had risen to 19.6 per cent (Economist 2010). This coupled with budgetary constraints seem to have led to austerity even in developed countries during 2010.

Nonetheless, environmental spending appeared to be resilient in the wake of budget cuts. While governments cut spending, particularly in Europe, it is worth mentioning that green spending received relatively limited cuts despite budgetary constraints in most countries. For example, in the UK, environment spending was cut 5–8 per cent compared to an average of 20 per cent in all sectors (Robins 2010). This confirms a growing understanding that greening investments become a core part of the national strategy for longer-term economic recovery.

Rickshaws in the Old Town section of Dhaka, Bangladesh.

Chapter 4: Infrastructure in a green economy

4.1 Introduction

Despite some progress in the last decade, especially in the telecommunications sector, infrastructure needs remain enormous in developing countries. This applies to both the goal of meeting universal access needs and the goal of supporting rapid growth and job creation. Understanding the urgency of these needs as well as the budget constraints faced by developing countries in addressing them is essential when thinking about how to address the challenge of a transition to a green economy. Addressing them also requires being mindful of how human-made infrastructure ultimately relies on the supplies of a healthy ecological infrastructure, both providing public goods and services.

The case of climate change action is illustrative of the difficulty of mobilizing national economies in response to a global public good problem. The climate challenge raises fundamental issues related to energy infrastructure and efficient use of existing and cleaner sources of energy in infrastructure: the use of energy and fossil fuels in particular has ripple effects throughout the economy.

For infrastructure investments to contribute to green growth with appropriate social development impact requires careful management of possible tradeoffs that may arise between environmental, economic and social goals, between shorter- and longer-term returns, and finding optimal win-win solutions. The latter exist in, for example, the case of water and sanitation, where environmental, social and economic goals all broadly point towards similar investment choices. A win-win dynamic also characterizes urban public transport interventions that improve local air quality, reduce emissions and make cities less congested, hence more efficient and competitive. In the energy sector, however, trade-offs between economic and environmental goals (local or global) can appear significant. The higher costs of cleaner technology imply a trade-off with expansion of service. In addition, many developing countries face severe financing constraints that appear to require a choice between "building right" (which may make both economic and environmental sense) and "building more" (which may be what is required socially). This is a particularly vexing problem in the case of renewable technologies, which are characterized by substantially higher capital costs upfront and lower recurring costs.[27]

As such, investments in the transition to a green economy must be evaluated with due consideration to this developmental dilemma of apparent trade-offs between goals and time frames. This is particularly important for investment needs related to climate change adaptation and mitigation, as they are the ones most often discussed in abstraction without regard to the relevant domestic context. To date there has been remarkably little interaction between the traditional infrastructure finance community and climate finance specialists.

The two sets of debate on how to finance the enormous infrastructure investment needs of developing countries and how to address the (much smaller yet substantial) additional financing needs associated with climate change continue to occur in parallel. There is a real urgency in dealing with this issue. As developing and emerging economies build their infrastructure and cities, they may create a path dependency into a low-efficiency economy that will prevent major energy savings for decades. While the additional cost of "building right" is limited today, the cost of retrofitting this new infrastructure for environmental reasons in a few decades would be enormous.

27 It may also be the case for a number of adaptation interventions that will pay off in the future but may impose immediate additional costs.

4.2 The existing infrastructure funding gap

More than a quarter of developing-country households have no access to electricity (see Table 2). The situation is particularly dire in Africa, where nearly 70 per cent of the population is unconnected. Access to water has increased and the world is on track to meet the MDG of halving the proportion of people without access to improved water. Yet 884 million people are still without access to an improved water source. The sanitation situation is much worse, with 2.6 billion people lacking access to improved sanitation, making the achievement of the MDG sanitation goal very unlikely.[28] Connectivity also remains low, particularly in the rural population, where only 70 per cent have access to an all-weather road (33 per cent in Africa).

Table 2 - Household access to infrastructure in developing countries

	All developing countries	Africa	Non-Africa low-income countries
Percent of households with access to electricity	63	29	56
Improved water source	84	60	79
Improved sanitation facilities	52	31	48
Percent of rural population with access to an all-weather road	70	33	49
Telecom: mobile and fixed lines per 100 inhabitants	64	36	42

Source: Reproduced from Fay and others (2010).

Note: Electricity and road access figures are for 2006 or the latest year available up to that date; telecoms, water, and sanitation data are for 2008. Figures are weighted by country population. The road access indicator measures the share of rural population that lives within two kilometers of an all-season road.

The only significant infrastructure success of the last two decades has occurred in telecommunications, where 73 per cent of the population has access to a telephone today. This is a massive increase since the early 1990s when it hovered around 3 per cent. Two reasons explains this: (i) a new technology (cellular telephony), which has enabled massive leapfrogging and allows for low-cost provision even in remote, low-density areas; and (ii) the acceptability of full-cost pricing, which means it can be fully funded by users (rather than taxpayers) and can therefore be fully financed by the private sector. Information and communications technologies (ICTs) are critical to green growth, as they are key to improved management of resources through, for example, smart grids, smart transport systems, improved water resource management and early warning systems for natural disasters.[29] The relevant public intervention needs are critical but limited – provide a good regulatory and competition framework, and help structure minimal core network investments.

28 WHO-UNICEF (2010) projects that by 2015 the share of people without improved water will have fallen to 9 per cent on current trends, exceeding the target of 12 per cent. In contrast, the share of individuals without access to improved sanitation is expected to be around 36 percent, much higher than the 23 per cent target.

Very rough estimates suggest that capital investments in the order of US $1.0–$1.5 trillion are needed annually for developing countries to close the development gap and support rapid growth (Fay and others 2010). These needs represent some 6–9 per cent of developing country GDP and are not inclusive of operation and maintenance costs. Rough estimates place annual infrastructure investments in developing countries at about US $600 billion – or roughly half of what is needed.

In Africa, where estimates were carefully constructed country-by-country and sector-by-sector, infrastructure spending needs amount to some 15 per cent of the region's GDP. Only about one third of this is currently financed. (To place this in perspective, the national budget amounts to 10–20 per cent of GDP in a typical low-income country.) Efficiency gains could cover another third, but new and additional funding of some US $30 billion annually would still be needed (Foster and Briceno-Garmendia 2010).

These estimates do not include the many missing critical protective investments. Many coastal cities do not have the coastal protections that would be needed to cope with even relatively frequent storm surges (Nicholls and others 2007) or the irrigation and water storage facilities that will be needed with increasingly unpredictable precipitation patterns. These estimates are also exclusive of urban public transport systems and other large urban public works that are impossible to estimate at an aggregate level, but are obviously critical for sustainable development.

In this context of insufficient funding, many countries select least-cost technology for their infrastructure investments even when environmental impacts (from climate change to local pollution) are significant. Moreover, in the absence of adequate infrastructure, people rely on alternative service provision arrangements such as individual power generators and batteries for electricity, unregulated wells for irrigation water or open drains for sanitation and drainage. The environmental consequences of these alternative approaches are often worse than infrastructure-based provision, with higher GHG emissions and significant local air, water and soil pollution. These approaches also have important negative public health consequences, and their costs can be substantially higher (diesel generations, purchase of potable water).[30]

The economic cost of alternative service technologies is typically much higher than that of adequate infrastructure. Electricity from power generators and water from remote wells is more expensive than network-provided electricity and water. Without flood risk reduction infrastructure, the human and economic cost of disasters increases. The lack of infrastructure funding has thus both an environmental and socio-economic cost.

29 ICTs are absolutely critical for green growth as they enable green management of many infrastructure services (smart grids in electricity, smart transport and congestion management) and generally permit much more efficient management of resources (e.g., water use).

30 The implication is not, of course, that only grid provision is appropriate, but it tends to be substantially more efficient (economically and environmentally) except for isolated, low density communities or for specific uses (e.g., solar water heaters). Renewables are often the most desirable source of energy for remote communities, but they tend to require government support (financial and logistical).

4.3 Meeting the needs for local and global public goods

Aligning economic and social needs with environmental concerns is easier when dealing with the local environment, with short-term and visible impacts on welfare and economic activity. For instance, there are clear incentives to favour solutions with lower negative consequences on air and water quality and on health. Some infrastructures are even implemented with the main objective of improving local public goods. Drainage and sanitation infrastructure aims at limiting the amount of wastewater emitted into the natural environment. The welfare and economic gains are immediate and visible in terms of water treatment costs, health costs and labour productivity. In such a case, objectives associated with the three pillars of sustainable development are consistent and synergies can be exploited.

Box 1. Ecological infrastructure: Benefits and investment needs of protected areas (PAs)

Natural capital is the ecological infrastructure that provides the many goods and services that sustain all life. It is estimated that ecosystems deliver essential services worth between US $21–$72 trillion per year as compared to the 2008 World Gross National Income of US $58 trillion (Nellemann 2010). Ecosystems within protected areas provide a multitude of global benefits. Nearly 1.1 billion people worldwide depend directly on protected areas for a significant percentage of their livelihoods (UN Millennium Project 2005). Yet benefits from protection are often broadly disbursed, long-term and non-market, while the costs of protection and the earning potential from non-protection choices are often short-term and locally concentrated. Policy actions are therefore needed to address the distribution of benefits and costs and to leverage the investments needed to establish comprehensive, representative and effectively managed systems of national and regional protected areas.

The establishment of marine protected areas is a matter of particular urgency as these can play an important role in supporting the maintenance and recovery of fish stocks, as well as a wide range of other services. Financing needs and gaps for protected areas are listed below. The ecological infrastructure is also critical in cities and city-regions where the majority of humans live and the fastest growth continues to occur. The maintenance or restoration of the ecological infrastructure – including ecosystem-based adaptation and species management – should be considered an investment priority. While it is typically cheaper to maintain, conserve and sustainably use ecosystems than to restore them, it is increasingly recognized that the restoration of degraded ecosystems in urban areas or elsewhere can also bring high rates of return across a range of biomes. This is particularly the case when the value of nature's goods and services are properly accounted for.

Baseline for PA investments	Financing gap	Source
US $6.5 billion/yr	US $45 billion/yr x 30 yrs	Balmford et al. 2002
US $7 billion/yr	US $23 billion/yr x 10 yrs	Bruner et al. 2004
US $402 million/yr (Lat Am & Caribb)	US $314–700 million/yr	Bovarnick et al. 2010
US $36–38 billion/yr	US $24–135 billion/yr	Parker & Cranford 2010

Problems are more complicated when global public goods are concerned, when environmental impacts occur over the long term only, and when investment decision-making implies a trade-off between short-term costs and long-term benefits. Additional water withdrawal creates immediate economic gains for irrigation, industry or domestic use, while the negative impact on ground water availability and quality and on many ecosystems lays far in the future. In this case alternative solutions are more expensive and can only be justified using a long-term perspective, an approach difficult to apply with highly constrained resources in the immediate term. This has to be weighed against the higher longer-term costs that will follow from an eventual restoration of ecosystems (see Box 1).

This dilemma of shorter- versus longer-term returns is evident in the case of climate change mitigation. The objective of maintaining climate change below 2°C was recognized by the Major Economies Forum on Energy and Climate in L'Aquila in July 2009 (MEF 2009), was explicitly included in the Copenhagen Accord and is present in the final text adopted in Cancun in December 2010. Reaching such a goal requires global GHG emissions to decrease at least by 50 per cent below 2000 levels by 2050. By 2030, this could represent absolute emission reductions of about 30 Giga-tons carbon dioxide equivalent per year (IEA 2009).

Even if Annex I countries were to eliminate or offset their emissions by 2030, the global mitigation challenge of 30 $GtCO_2e$ per year by 2030 could not be reached. Emission reductions in developing countries are therefore essential. Studies about the still mostly under-tapped mitigation capacity in developing countries conclude that 50–70 per cent of the global mitigation potential could be located in non-Annex I countries (UNFCCC 2007). Adding the emission reduction effort of developing countries could yield up to 25 $GtCO_2e$ of reduced emissions annually.

In the case of climate change, trade-offs between immediate economic gains and long-term objectives are obvious when infrastructure decisions need to be made. Building dense cities that consume less energy and can more easily rely on public transportation requires implementing land-use regulations that are costly to enforce (both economically and politically). New land use regulations can accelerate the growth of housing costs, which are already a concern in many developing-country cities. Also, providing electricity for all is already a challenge in many countries. An increase in investment expenditure to reduce carbon emissions would translate into reduced access to energy, and potentially reduced economic growth and poverty alleviation.

Transforming the global economy will require action locally (e.g., through land use planning), at the national level (e.g., through energy-use regulations) and at the international level (e.g., through technology diffusion). Actions will have to be taken by households and individuals (e.g., investing in home insulation), businesses (e.g., change in production process), and public institutions (e.g., standards and regulation). Some of these actions will get implemented naturally, as income increases in developing countries. Other actions, however, involve difficult trade-offs, making them impossible to implement in the current situation.

Only the implementation of a set of diverse instruments – including pricing and taxation, regulation, research and development programmes and public and private investment – can make such a transition possible. In the short to medium term, developing countries are unlikely to implement economy-wide climate policy. Much can be gained, however, from early actions on investment patterns.

4.4 Climate investment needs

Reducing GHG emissions will require large investments in energy, building, transport and end-use equipment. Mitigation costs in developing countries could reach US $139–175 billion per year by 2030 with associated financing needs of US $264–563 billion (table 3). The difference between net costs and total financing needs is due to the fact that many efforts concern energy efficiency or renewable energy projects with higher upfront costs but lower operational costs that can offset at least part of the higher initial investment.

Table 3. Annual net cost and financing needs to limit warming to 2°C in 2030

	Net cost	Financing need		
		Total	Infrastructure	
	$ billion	$ billion	$ billion	%
IEA	-	565	324	57.3
IIASA	-	264	-	-
MiniCam	139	-	-	-
McKinsey & Co.	175	563	-	-
PNNL	-	384	-	-

Source: World Bank (2009b).

Table 4. Average annual incremental adaptation cost by 2050

	Total	Infrastructure	
	$ billion	$ billion	%
UNFCCC (2007)	28-67	2-41	-
Parry et al. (2009) *	-	15.9-63.2	-
World Bank (2010b) **			
NCAR scenario	90	30	33
CSIRO scenario	78	14	17

* Including housing and infrastructure. ** Delta-p only.
Source: World Bank (2010b).

An additional US $30–100 billion will be needed for adaptation (table 4). Adaptation costs are estimated as the incremental costs brought by changed climatic conditions, that is, the additional cost of bringing new investments to the new standards required by the changing climate as well as the increased maintenance and operation costs on existing assets.

Environmentally driven action on infrastructure is particularly urgent as emerging and developing countries will build the bulk of their infrastructure in the two next decades, and infrastructure is characterized by substantial inertia. Most infrastructure assets have a lifetime of more than 30 years (table 5). For transport and energy infrastructure and urbanization patterns to contribute to reduced climate vulnerability, a lower environmental footprint, as well as lower energy consumption and GHG emissions by 2050, changes in investment choices are required with no delay.

Table 5. Priority sectors, considering timescale and environmental impacts

Sector	Time scale	Sensitivity
Water infrastructure (e.g., dams, reservoirs)	30–200 yr	+ + +
Land-use planning (e.g., in flood plain or coastal areas)	>100 yr	+ + +
Coastline and flood defenses (e.g., dikes, sea walls)	>50 yr	+ + +
Building and housing (e.g., insulation, windows)	30–150 yr	+ +
Transportation infrastructure (e.g., ports, bridges)	30–200 yr	+
Urbanism (e.g., urban density, parks)	>100yr	+
Energy production (e.g., nuclear plants)	20–70 yr	+

Source: Hallegatte (2009).

China offers a striking quantitative illustration of the magnitude of the inertia issue for mitigation. Although its emissions are currently on par with those of the US, China's committed emissions (computed on the basis of its existing installed infrastructure and world infrastructure lifetime average) already account for 37 per cent of global emissions commitments (Davis and others 2010). This is due to the massive and very recent expansion in its infrastructure – the mean age of power plants in China today is 12 years as opposed to 32 for the US and 27 for the European Union – and the fact that coal accounts for most of its power generation capacity. If one takes into account the inertia in assets location and energy-services demand drivers, this only increases the amount of committed emissions in emerging countries (Guivarch and Hallegatte 2011).

A failure to start acting now may result in environmentally damaging development patterns – energy and water consuming technologies, low-density cities poorly suited to mass-transit, fossil-fuel electricity production and water-hungry ways of life – that would be difficult and costly to reverse. The stakes are high, since infrastructure directly contributes 41 per cent of GHG emissions, mostly from transport and power, without accounting for their indirect contribution. Further, delay in action will be costly: by one estimate delaying developing countries' measures to adopt green infrastructure by 10 years would result in a doubling of the estimated costs of mitigation reported in table 3 (Edmonds and others 2008).[31]

31 Modellers optimize, assuming that mitigation actions take place whenever and wherever they are cheapest.

Further, current patterns of infrastructure development increase vulnerability to natural hazards. Most economic impacts of natural disasters arise from losses of infrastructure-related services such as water and energy provision, and transportation capacity (Tierney 1997). Vulnerability to heat waves depends largely on building characteristics and urbanization patterns and pre-existing air quality issues. Droughts and reduction in water availability can be exacerbated if water infrastructure (water reservoirs, treatment plants) becomes inadequate.

Tackling environmental issues requires profound and immediate transformations in how infrastructure is planned, designed, managed and maintained. The choices made now in what is built, where and how, determine future options and vulnerabilities. There is thus a narrow window of opportunity to shift development strategies to more sustainable paths (Shalizi and Lecocq 2009) by mobilizing upfront investments in energy, building, transport and end-use equipment. This shift, however, must recognize that the funding required for infrastructure due to environmental concerns is additional to the pre-existing funding gap. Efficient climate action cannot be implemented without tackling the infrastructure challenge.

Man draws water from a pump above a mountain stream in Warduj, Afghanistan.

4.5 More effective matching of core and additional funding objectives

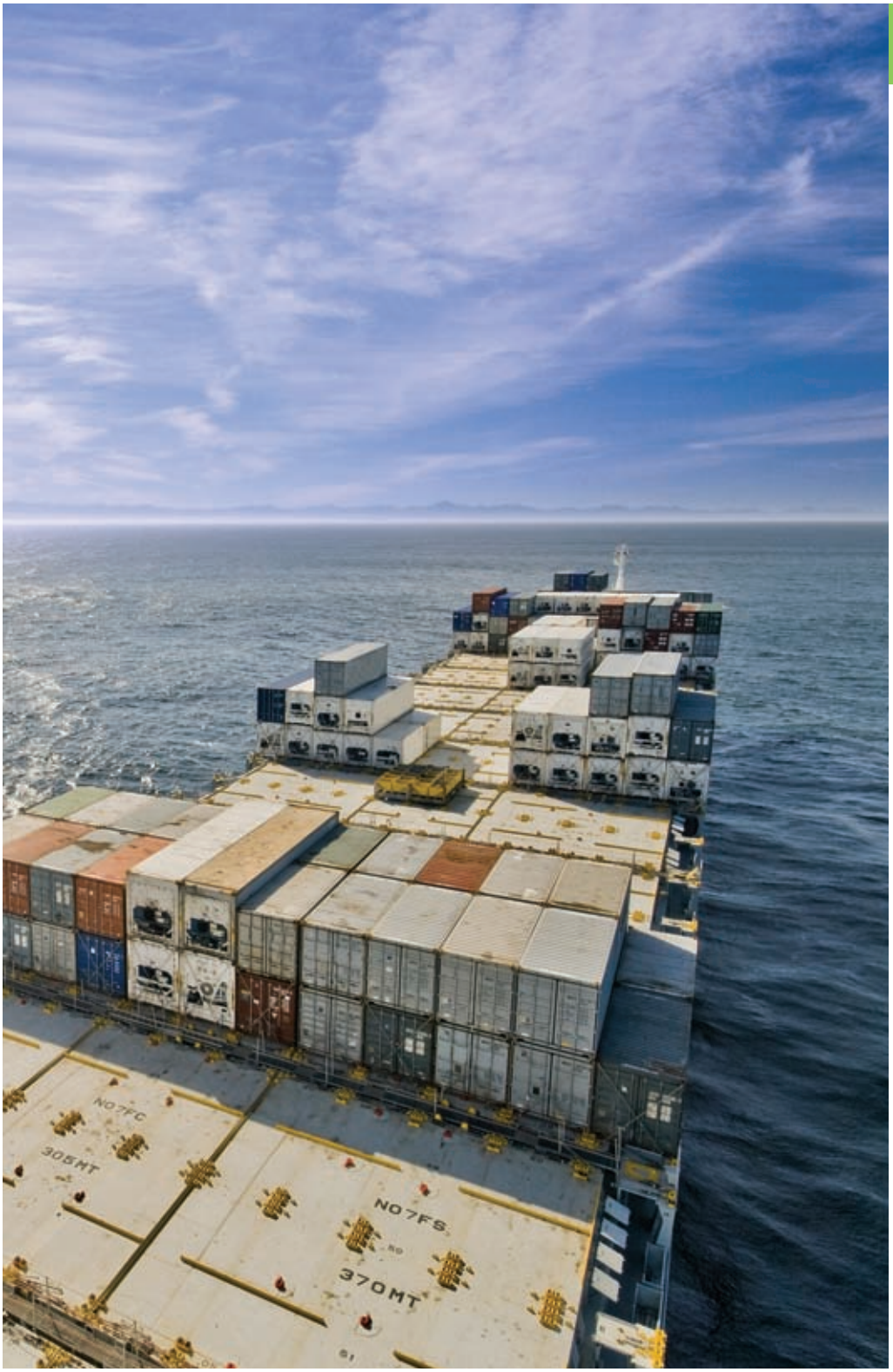
Climate-oriented financial support corresponding to the additional cost of developing infrastructure with reduced GHG emissions and increased climate resilience would not be sufficient to allow basic infrastructure to be built, unless it has a strong leverage effect. In a country where most of the population is not connected to an electricity grid and thus relies on power generators, funding only the additional cost of producing low-carbon electricity would not permit the development of the needed grid and a reduction in power-generation emissions. A poor country that cannot finance any dike system to protect its coastlines would have little use for a funding source that would pay for upgrading costs, unless this additional funding is paired with other resources.

An efficient funding scheme for mitigation and adaptation in developing countries cannot focus solely on additional cost, but must aim to leverage other sources of funding – including domestic sources, private capital and official development assistance – and thus close the financing gap for broader infrastructure needs. This calls for a rethinking of climate funding in developing countries, considering infrastructure objectives for growth and poverty alleviation. These would need to be integrated, along with a rethinking of infrastructure finance in which climate objectives are mainstreamed.

Current flows of mitigation and adaptation finance pale in comparison to the needs (World Bank 2009). Even though the resources flowing through the Clean Development Mechanism (CDM) have steadily increased since 2005, they only amounted to about US $23 billion over 2002–2008 (UNEP 2010a). With each dollar of carbon revenue leveraging on average US $4.60 in investment and possibly up to US $9.00 for some renewable energy projects, some US $95 billion in clean energy investment benefited from the CDM over 2002–2008 (World Bank 2009).

Additional funding has been made available through organizations such as the Global Environment Facility (GEF), which commits about US $250 million per year in grants for climate investments. Other donors have created climate funds that participate in the funding of infrastructure. But those fragmented initiatives are still far from closing the financing gap adding up to some US $8 billion a year, far less than what is needed. Moreover, this fragmentation is a source of inefficiency and violates the principles of the Paris Declaration on Aid Effectiveness.

The creation of a Green Fund was agreed upon in Cancun in December 2010, with the objective of mobilizing US $100 billion per year from 2020. The implementation of this fund could help close the infrastructure funding gap provided that eligibility and funding rules are designed to do so. A move away from the “additionality” criteria adopted for the CDM to a financial gap approach would also help provide developing countries with the resources needed to close their infrastructure gap, and to do it in a climate-smart way.



Container cargo ship at sea.

Chapter 5: Green and inclusive growth strategies

5.1 Introduction: Structural factors in present growth dynamics

Continuing on the path of the current energy- and material-intensive growth model which defines our global economy is no longer possible, since it is strongly correlated with increasing CO_2 emissions, overexploitation of natural resources and damage to the Earth's ecosystems, threatening the prospect of sustained economic growth at the global scale. Progress in poverty eradication has been very uneven and wealth inequalities have been widening across the globe. A new approach will have to be devised for ensuring that economic progress goes hand in hand with human development and environmental protection. Moving the global economy away from a growth path based on fossil fuels and materials consumption will necessarily involve profound changes in economic systems, in resource efficiency, in the composition of global demand, in production and consumption patterns and a major transformation in public policymaking.

Structural factors underlying the present global growth picture have translated into a persistence of large social, technological, economic and environmental asymmetries within countries and between developed and developing countries. Among the underlying structural determinants of present growth patterns that need to be taken into account by countries embracing a green and inclusive economy are the following (cf. López 2009).

World economic growth outpaced growth in commodity consumption for most commodities since 1975, but after 1992 the trend reversed in the case of metals, largely due to a steep rise in investment in industry and infrastructure in China.[32]

There has been relative decoupling of resource consumption from GDP growth since 1980 as material productivity has risen, but the strong economic growth has overwhelmed these improvements so that absolute amounts of materials and fossil energy consumption have continued to rise (cf. International Resource Panel 2010).

Since the early 1990s, the long-term trend of declining raw materials prices has been reversed, with steep rises in certain commodity prices in recent years. This reflects growing scarcities as evidenced, for example, by declining ore grades in the case of metals.

In developed countries a key feature of economic growth has been a continuous decline in the share of primary commodities and manufacturing in GDP and the rise in the share of services and human capital and technology-intensive activities. This has occurred especially over the past three decades and has meant a persistent decline in the use of material inputs in production.

In contrast to production, developed countries have not significantly reduced material consumption. This group of countries accounts for a very large share of global consumption, with the United States alone being responsible for 40 per cent and the OECD for 78 per cent of world consumption in 2009 (World Bank 2010c).

32 This has been mainly due to rapid increase in commodity-intensive manufacturing since 1993 in China. After declining for years, the commodity intensity began to rise gradually toward the beginning of the 1990s and then sharply accelerated around 1998. See World Bank (2009c).

The combination of reducing material in production and little change in material content of consumption implies that developed countries have been shifting the environmental impact associated with producing the goods they consume to other countries through international trade (Ghertner and others 2007).

A number of labour-abundant developing countries have benefited from the growing markets and increased trade in industrial goods arising from the reduction of material in production in the developed countries. In this context, the labour-rich developing countries were in a better position to gain directly from this demand than the resource-rich developing countries. The latter have supplied raw materials, until recently at low cost. In these resource-rich countries, the enclave-based expansion of commodity extraction, with weak backward and forward linkages to the rest of the economy, has in most cases been insufficient to promote economic growth based on principles of sustainable development and equity (Barbier 2005).

The incorporation of highly populated developing countries such as China and India into the global growth process is a positive phenomenon but also a challenge for a transition to a green economy. Being at an early stage of development, their consumption and production processes are still very material-intensive.[33]

Demand in emerging economies for industrial goods, notably consumer durables and agricultural products with high environmental impact, such as meat, has increased at a pace that has often exceeded growth of per capita GDP. In addition, consumption patterns linked not only to GDP growth but also to the dynamics of world population (growing from 7 billion to over 9 billion by 2050) are expected to change, particularly in South Asia and sub-Saharan Africa. In fact, projections based on world population growth and food consumption patterns indicate that agricultural production will need to increase by at least 70 percent to meet demands by 2050 (FAO 2010). Population dynamics are therefore a key variable, particularly if we expect everyone to enjoy a healthy and productive life free of poverty in the coming decades.

Furthermore, the elasticity of certain emissions, notably GHGs, in growth of these emerging industrial economies is high, which means that their continued rapid economic growth will imply increases in their emissions. More importantly, this means that world economic growth is now even more closely linked to carbon emissions than during the late twentieth century (López 2009).

Resource-rich exporting countries have benefited from rising commodity prices, but this has also increased the risk of "Dutch disease"[34] and the risk of being out-competed by the emerging industrial exporters, complicating the prospects of a transition to a green and inclusive economy for a number of the commodity exporters.

Economic growth has been fueled by, among other factors, the availability of relatively inexpensive energy. The depletion of fossil fuel resources and a soaring energy demand represent new constraints. These, combined with environmental concerns, notably related to climate change, are expected to steer energy systems towards a transition to alternative energy resources.

33 For example, from 2000 to 2007, Chinese demand accounted for 20 per cent of world export growth in metals, 11 per cent for copper, 55 per cent for iron and 58 per cent for soy. Since the crisis, while global demand for these same commodities decreased, Chinese demand for them doubled (Gallagher 2010).

34 The "Dutch disease" makes manufactured goods as well as services less competitive by raising the value of the currency.

The above underlying structural factors are at the core of the present global growth problem, and should be dealt with when identifying what kinds of dynamic growth strategies are needed for making the transition to a greener and more inclusive global economic system. Overall, there are two pressing issues that emerge from the structural factors mentioned above: (i) the need to change resource-intensive consumption patterns in developed countries; and (ii) a need to promote efficient resource-saving technological and structural changes in production systems in developing countries, so that global growth is "decoupled" from environmental impact and becomes less commodity-intensive and environmentally damaging.[35]

5.2 New engines of productive and efficient growth

As mentioned earlier, the nature of economic growth in the coming decades will have to be fundamentally different from the resource- intensive growth of the past and it will need to be assessed against the criterion of whether it satisfies demands for higher living standards for a larger global population, while adjusting to tightening environmental and natural resource constraints. This will mean much greater efficiency in resource use, stronger environmental protection and a shift in the composition of consumption away from resource-intensive goods towards less resource-intensive goods and into services. In effect, it will require a serious rethinking of lifestyles in developed countries and of the expectation that globalization will extend those lifestyles and consumption patterns to developing countries. It will require technological progress that boosts not only material and energy efficiency but also labour productivity.

The transition to a green economy will also have to consider the need to narrow two main gaps between developing and developed countries – the technological gap and the productivity gap. The technology choice of economic agents is crucial for achieving low material and low carbon intensity in the productive structures, and will have to go hand in hand with increasing labour productivity.[36] Labour productivity is key for an inclusive green transition because it reflects not only efficiency in production, but also the potential of the labour force to obtain better wages and reach higher living standards. Raising labour productivity is therefore recognized as a critical factor for increasing economic growth and reducing poverty levels, and low levels of education are among the main obstacles for reaching higher productivity in many developing countries.

The evolution of labour productivity in different groups of developing countries has varied. In Latin America, GDP per worker increased up until 1978 and has declined ever since.[37] East Asian economies have been steadily improving their labour productivity relative to the US. Strong growth in labour productivity explains in part why a number of highly populated and historically poor countries have been successful in their growth process and in narrowing the income gap with developed countries.

35 The nature of consumption is also important in developing countries, and continued structural change and technological progress is relevant in developed countries as well. It is important to make the distinction between relative and an absolute decoupling. Relative decoupling refers to a situation where resource impacts decline relative to GDP but nevertheless continue to rise. The situation in which resource impacts decline in absolute terms is called absolute decoupling. If the green economy is to tackle environmental scarcities, then absolute decoupling is needed.

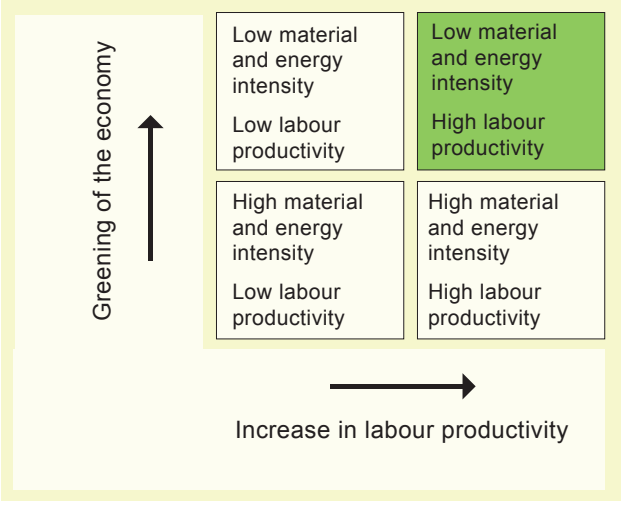
36 Labour productivity is defined as GDP per hour worked.

37 If the sectors in which productivity rises account for a small proportion of total employment, then only a few workers with more advanced skills will benefit from higher wages, while the rest will continue to be employed in sectors where wages and productivity are lower. In Latin America and the Caribbean, high-productivity sectors account for a rather small portion of all employment (8.1 per cent in 2008). See the assessment by UN-ECLAC (2010).

This can be explained in part by the transfer of large of numbers of people in Asia from low productivity rural employment to jobs in factories, a process that will eventually runs its course as it did some time ago in Latin America. Then, sustaining labour productivity growth becomes more challenging.

The argument for closing both the technology and labour productivity gaps with developed countries as basis for a green and inclusive economy is summarized in very broad terms in the following matrix (see figure 2). The green quadrant – low material and energy intensity and high labour productivity – corresponds to the twin criteria of green and inclusive. A high material and energy intense growth model characterized by low labour productivity (lower left quadrant) is not desirable from either an environmental or a social perspective and reflects the situation of many developing countries. But there are also cases of countries characterized by high labour productivity, where the economy is not sustainable (lower right quadrant).

Figure 2. Green economy matrix



Public policies will need to be used strategically to orient the process of economic growth towards such a sustainable pathway, and issues of fairness in income distribution and social investment as well as planning for long-run energy and resource efficiency need to be included in the redefined set of economic policy goals.

This approach requires a systemic shift rather than incremental improvements alone. It involves not only steering the market through the use of sound micro-economic policies, such as internalizing externalities and getting prices right, or targeting the greening of certain sectors, but it also requires major changes in economic policymaking. In fact, scaling up successful examples of best practices on greening the economy is important but insufficient for addressing the scale of environmental and equity problems that the world is facing today. The approach should therefore not be restricted to sector-level analysis, because green buildings, more efficient transportation or moving into more sustainable agricultural production systems will not, in themselves, lead us to sustainable development.

The fundamental redirection required for a green and inclusive economy cannot be achieved without a decisive reorientation of macroeconomic policy to advance the required major changes in present economic growth models and the drastic adjustments in consumption and production patterns. To encourage sustainable consumption and production requires the internalization of negative externalities through a range of instruments such as fiscal incentives and disincentives, carbon trading schemes, rules and regulations and product standards. These policies will influence consumption, investment and other relevant economic aggregates.

Redesigning macroeconomic policies is key when focusing on a new approach to economic growth. In fact, macroeconomic policies not only affect the dynamics of economic activity, income distribution, investment and employment, but they can also bring about the required structural economy-wide changes associated with a green economy transformation.

A breakdown of the major sectors of aggregate demand[38] is useful in thinking about a new economic growth path for individual countries and regions. The idea is that we should distinguish between those macroeconomic aggregates that should be strictly limited, such as resource intensive consumption, investment in energy-intensive infrastructure and transport and government spending on fossil fuel subsidies,[39] and those that could expand over time because they do not generate significant negative environmental impact. Indeed, energy-saving and natural capital investments, as well as human capital investments, are urgent from the points of view of both social well-being and environmental sustainability. The latter would include investments health care, food and nutrition security and education, as well as cultural activity and information services.[40] Investments in transforming agricultural production systems are also desirable to ensure higher productivity and food security, not only because of growing population but also because agriculture represents the biggest employer globally and the major income source especially for the poor. Growth in agriculture is often more effective than growth in industrial sectors at reducing poverty for the poorest people in society.

Naturally, however, in evaluating the environmental and resource impacts in different sectors, indirect effects through input-output linkages and the entire life cycle of the goods and services produced should be considered. For example, as food systems are becoming more globalized and complex, greening in the agriculture sector has to be achieved through the whole food chain. Excessive agrochemical production and use, water use, processing, packaging, transport, retail and waste are all major factors that make agriculture and food production one of the sectors with a significant impact on the environment and natural resources.

38 This can be expressed by balancing the well known aggregate demand equation of Y=C+I+G+X-M. For further details see Harris (2008).

39 According to the joint report prepared by OECD, IEA, World Bank and OPEC (2010) for the G20 Summit of June 2010, fossil fuel subsidies exceeded US $650 billion in 2008, in addition to the US $400 billion subsidies on agriculture in OECD countries.

40 It is of course true that the world economy as a whole cannot specialize in services and that services cannot replace essential agricultural and industrial products, but we can still imagine a transition to more service-intensive and less material-intensive consumption and production patterns.

5.3 Opportunities in agriculture, manufacturing and services

Agriculture accounts for about 14 per cent of GHG emissions (about 33 per cent when including the forestry sector), and is one of the major causes of land cover/use change, including deforestation. Sustainably managed agriculture, however, can also become a key sector in the development of a green economy, as it is able to achieve multiple benefits with relatively low capital investments, including food security, environmental sustainability, carbon sequestration and opportunities for green jobs and livelihoods.

Sustainable agriculture has the potential to enhance ecosystem services through actions such as restoring water catchment areas, reforestation and forest restoration, improving soil quality, sustainable management of animal husbandry, biodiversity conservation and creating habitats for pollinators and natural pest predators. Well-functioning ecosystem services will make production systems more resilient in the face of disruptive events, and will bring positive impacts on food security.

Investment is required in transforming both commercial and subsistence agricultural systems. In commercial systems, investments should be aimed at sustaining efficiency while reducing emissions and other negative environmental impacts. In subsistence agricultural systems, investments should be aimed at transforming smallholder agricultural systems through sound soil and nutrient management, water harvesting and efficiency in use, increasing production system resilience, conserving genetic resources, reducing post harvest losses, improving processing and reducing time to market. This in turn requires significant investments in small farmers' human capital, including investments in their food and nutrition security through social safety nets and other social protection services that enable them to make investments in the sustainable management of natural resources.

Bioenergy potentially offers developing countries many advantages: (i) it offers opportunities for enhanced energy access and increased energy security by reducing the dependence on fossil fuel imports; (ii) it potentially creates a new market for producers; (iii) it can create significant new employment; and (iv) it potentially contributes to the reduction of GHGs. Depending on the underlying feedstock, biofuel production and use can generate very different GHGs gas savings. While ethanol from sugarcane is estimated to reduce GHG emissions by 80 per cent over the production and use lifecycle, other feedstock such as sugar beets, wheat and vegetable oils offer substantially lower savings in emissions. Corn, a key feedstock for ethanol in the United States, has the lowest (<30 per cent) estimated savings (OECD 2008).

Some important concerns have been raised in relation to negative impacts of biofuels on world food security, rural development and the environment.[41] At a global or national level, the diversion of food to new markets, such as biofuels, can have ripple effects throughout food markets. The International Food Policy Research Institute and the World Bank simulations show a potential significant impact on food prices through competition for land and inputs, especially for ethanol. The rapidly increasing demand for biofuels is largely determined by the subsidies and mandates provided in many developed countries. The possible impacts of biofuels on land use, deforestation, water resources and food prices will vary with feedstock, the method and location of production and the management of the sector. Sound bioenergy policy development that reduces the competition between energy and food needs must be

41 The development of second-generation biofuels (produced from cellulosic feedstock) and third-generation biofuels (produced from algae) offer the prospect of fewer negative food and environmental impacts.

the outcome of a context-specific analysis. In the manufacturing industries, there are significant opportunities for growth and employment in renewable energy and resource-efficient technologies. A larger contribution of so-called green industry to GDP not only has positive economic and social effects, but it can also be highly beneficial for the environment in the long term and provide locally critical improvements in livelihood conditions and employment opportunities.

The development of China's solar photovoltaic industry since 2002 is a case in point. China has become one of the top global solar cell manufacturers and more than 95 per cent of domestic cell and panel production has been exported. Demand for solar cells has been driven to a great extent by the renewable energy policies of Europe, including renewable energy mandates and feed-in tariffs. Manufacturing of wind turbines is also growing rapidly, and domestic demand for wind power is growing rapidly in China. China's wind market was virtually nonexistent 20 years ago and has grown to be the fourth-largest market in the world, behind the United States, Germany and Spain.

Another case in point is the environmental goods and services (EGSs) industry. As demand for environmental services, equipment and technologies has been increasing, mainly pushed by regulatory demands in developed countries, the environmental industry has become a very dynamic growth pole in OECD countries. The EGSs market has been projected to reach US $688 billion by 2010. Developed country producers are the major participants in this global market. A number of developing countries have a significant export interest in certain environmental goods. For example, five developing economies are among the top ten exporters of the entire renewable energy category of goods: China; Hong Kong, China; Mexico; Singapore; and Thailand (WTO and others 2009).

An adequate transfer of technologies and a focus of policies on education, technical training, investment and enhancement of local skills would allow developing countries to create endogenous capacity and develop a competitive new economic sector. This goes hand in hand with environmental protection, economic growth and employment creation, while reducing knowledge and technology gaps.[42]

In the services sectors, the globalization of services with low environmental impacts provides alternative opportunities for developing countries to find markets beyond manufacturing and commodities where they can specialize, scale up and achieve high economic growth. Diversification into services can be complementary to efficiency improvements in manufacturing, displaying how intelligent use of services in both manufacturing and commodity production can result in more effective resource planning and use.

Services in information and communication technology are having a significant and continually evolving impact on economic growth. They allow for new ways of organizing production, consumption and markets, giving rise to important productivity gains across sectors. Information and communication technologies also hold high potential in the development of intelligent transport networks and smart grids, two new applications enabled by high-speed broadband networks that are expected to be future enablers of low-carbon development (GeSI 2010).

42 This was revealed by the results of assessments on market potential for environmental goods and services done by ECLAC and GTZ for Argentina, Mexico, Chile and Colombia. For more information see: www.eclac.cl/dmaah/proyectos/pymes/index.htm#

A number of modern services have become transportable, tradable and scalable and can be transacted across borders over the Internet. India is a good example, displaying rapid growth in exportable services with low environmental impact over the past two decades while generating income and facilitating growth. India is revealing strength in skill-intensive services, including software development, ICT-enabled services, product/project engineering and design, media, entertainment and healthcare (Altenburg and others 2008).

In the area of tourism, enormous growth in numbers of middle-income consumers in emerging market economies is adding significantly to the size of a global tourism business traditionally catering mostly to OECD-country consumers. This augments an already big challenge of managing tourism activities sustainably. Ecotourism innovations and the promotion of responsible business through tourism trade are as yet only a partial response to the challenge.

Pursuing all the sector-specific opportunities highlighted above will require new workforce and managerial skills that in turn require substantial investment in education and training. The important role of education as a means of increasing workforce skills and generating knowledge for innovation suggests that it should have a permanent place on growth agendas. Government policies that provide the right incentives for investing in green sectors and technologies should generate demands for the kinds of skills needed to build, manage and operate green economies and attain green growth.

Investments in human capital and more particularly in developing the skills demanded of a green economy can be seen as part of a set of mutually reinforcing investments. Deployment of new technologies in developing countries will be critical for green growth. Transfer of such technology depends on the recipient countries' absorptive capacity, which is related to infrastructure, adequate levels of human and physical capital, investment in research and development and institutional quality. All of these are important ingredients of growth. Thus, growth and greening go hand in hand (cf. OECD 2010).

5.4 Public policy and strategic positioning

Government policy plays a crucial role in determining which growth path will be followed. The transition to a green economy in the context of sustainable development will not come about without active government intervention. As mentioned before, given the scale of environmental problems that the planet is facing, public policies will need to be used strategically to orient the process of economic growth towards a sustainable pathway and to focus on the specific goals of employment and equity.

Although environmental sustainability can partly be accomplished through incentives – taxes and subsidies – aimed at internalizing environmental costs and promoting environmentally beneficial sectors, there is also a need for investment in societal and low-carbon infrastructure as well as long-term development strategies. Governments have a critical role in providing social protection as part of the investment in human capital. Fiscal policy also plays a key role, as it can shift incentives towards less environmentally damaging activities and target interventions towards particular socially and environmentally beneficial investments. Shifting the burden of taxation from economic "goods" such as income and jobs to ecological "bads" such as pollution and resource depletion should be central in the transition.

China provides a good example of combining investments and public policy incentives to encourage major advances in the development of cleaner technologies. Chinese support for domestic industry has always considered markets outside of China. The country has strategically integrated itself into world markets in order to gain access to technology and finance, following a dual track policy. The policy consists of liberalizing foreign direct investment and inflow of imported inputs to selected industries while supporting technology acquisition and absorption by domestic enterprises in those sectors to the point where they are ready to face competition with imports and even overseas (Gallagher and Porzecanski 2010).

The case of resource-rich developing countries is particularly challenging, as the motivation for a transition to a green economy is not obvious. The additional revenues generated by commodity exports, however, could be used to invest in upgrading environmental performance of technologies and adding value in existing resource-intensive sectors as well as in human, infrastructural and social capital to facilitate industrial competitiveness and diversification into new sectors. National high-speed broadband networks, which enable the uptake of green applications such as smart grids, could be promoted.[43] The effective fiscal strategy would not be to keep natural resource revenues in sovereign funds heavily invested in foreign equity markets. Rather, a more effective strategy would be to use the revenues for financing domestic or regional low-carbon infrastructure and other projects that facilitate economic development and structural change for the transition to a green economy (Lin 2009).

5.5 Private sector innovation

The transition to the green economy, like any process of structural change, is made difficult by the fact that some of the established companies, which may be among the losers, have considerable policy leverage. Yet rather than opposing or delaying structural change, leading businesses should seek to embrace and seek to benefit from first-mover advantages. This strategy is one being followed in the Republic of Korea, where government has defined green growth as a national strategy and aligned major private companies behind it.

Resource-efficient and cleaner production unleashes the potential of industries and enterprises to produce more with less, and to reduce their environmental footprint while at the same time delivering value-added goods and services and creating jobs. Eco-industrial parks, green clusters and eco-cities can be instrumental in reconfiguring traditional one-way industrial systems into circular, closed-loop systems. Resource efficiency is promoted and waste is transformed from a liability into an asset that yields economic benefits.

Further benefits can be attained by green process and product design, designing out pollution and wastes at their source. Such approaches not only enable the reduction of the use of virgin materials and waste by the design of products that are non-toxic and can be reused, repaired or recycled, but can also stimulate economic growth and create local employment opportunities and can be a driver in the establishment of sustainable communities or eco-cities. At the industry level, innovative models such as industrial symbiosis, green industrial clusters with industries from the same value chain and eco-industrial parks provide collaborative opportunities to reduce waste and

43 For further examples see ITU, UNESCO and the Broadband Commission (2011).

pollution, efficiently share resources (such as information, materials, water, energy, infrastructure and natural resources) and help achieve socio-economic gains while improving environmental quality.

What these models have in common is that they reduce costs and generate new sales for the companies involved, as well as creating significant environmental benefits such as reduced landfill, water pollution and greenhouse gases. The economic activity generated also has further social benefits with the creation of new businesses and jobs. Experience shows that eco-industrial parks, industrial symbiosis and green clusters can contribute to the critical mass needed for an increased deployment of green technology and services.

Through such green hubs, new growth drivers can be created for regions to enhance their competitiveness and revitalize economic activity. Such cooperation can also constitute a core element for the establishment of eco-cities. These are cities where urban planning, urban and peri-urban agriculture, industrial zoning, and environmental management approaches are integrated to pursue synergies in resource utilization, industrial and urban development. Urban and peri-urban agriculture can have important benefits for food security and safety by providing growers with food for their own consumption; a source of income generation; and local markets with an immediate supply of fresh and micronutrient-rich food at competitive prices. Further social benefits include better health and nutrition, increased income, employment, food security within the household and enriched community life. The success of such market gardens is attributed to the use of few external inputs, the application of agroecological principles and the reliance on locally available resources.

Other innovative approaches that could fundamentally change production and consumption systems and decouple material consumption and value creation include product service systems and Payment for Ecosystem Services. Product service systems such as Chemical Leasing offers concrete solutions for sound management of chemicals and reduction of emissions to the environment.[44] In the case of PES, experience from Uganda shows how individual farmers can be rewarded for meeting targets for establishing and maintaining woodlots. Their payments are funded by corporations eager to earn carbon credits, a diverse range of companies such as Tetra Pak, Nedbank and African Safaris.[45]

5.6 A new, dynamic growth pathway

The nature of economic growth in the coming decades will have to be fundamentally different from the resource-intensive growth of the past and it will need to be assessed against the criterion of whether it satisfies demands for higher living standards for a larger global population while adjusting to the tightening environmental constraints. A number of structural factors underlying the global growth picture need to be addressed by the international community in any proposals about a green and inclusive economy.

A breakdown of the major sectors of aggregate demand in different countries is important in defining a new economic growth path. Policymakers will need to distinguish between (i) those macroeconomic aggregates that should be strictly limited, such as resource intensive consumption, investment in energy-intensive infrastructure and transport, and (ii) those that could expand over time, such as

44 In the United Nations System, UNIDO plays the leading and coordinating role for the implementation and further development of Chemical Leasing systems.

45 See www.agriculturesnetwork.org/magazines/global/trees-and-farming/payments-rewards and Mwaloma (2011).

energy-saving and natural capital investments, as well as human capital-intensive services such as in areas of health care and education.

Public policies will have to be used strategically to orient the process of economic growth towards a green economy pathway, and issues of fairness in distribution and social investment, such as education and health, as well as planning for long-run energy and resource use need to be included in the redefined set of economic policy goals. Care has to be taken, however, that even if growth promoting policies are put in place and are successful, initial conditions of inequality in access to productive inputs, education and land, may result in the most vulnerable sectors not being able to share in the gains from green growth.

The urgency of the global environment and equity problems requires countries to share skills, best practices, technologies and methods in resource efficiency in order for poverty reduction and industrial development to be sustainable. For the private sector, the existence of an integrated framework of incentive structures, policies and regulations to encourage the development of green industries that generate green jobs will be crucial as a driver for moving the economy along a green and inclusive growth path.