Towards a GREEN economy

Pathways to Sustainable Development and Poverty Eradication

A Synthesis for Policy Makers

Citation

UNEP, 2011, *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication - A Synthesis for Policy Makers*, www.unep.org/greeneconomy

Layout and printing by:
100 Watt, St-Martin-Bellevue, France
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Acknowledgements

Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication is based on the working chapters of the Green Economy Report (GER), which were prepared by the following coordinating authors: Robert Ayres, Andrea Bassi, Paul Clements-Hunt, Holger Dalkmann, Derek Eaton, Maryanne Grieg-Gran, Hans Herren, Cornis Van Der Lugt, Prasad Modak, Lawrence Pratt, Philipp Rode, Ko Sakamoto, Rashid Sumaila, Ton van Dril, Xander van Tilburg, Peter Wooders, and Mike Young. Contributing authors and reviewers of the chapters are acknowledged accordingly in each chapter.

The synthesis report was led by Pavan Sukhdev, Special Adviser and Head, Green Economy Initiative, UNEP, and coordinated by Steven Stone, Chief, Economics and Trade Branch, UNEP under the guidance of Sylvie Lemmet, Director, Division of Technology, Industry and Economics, UNEP. Substantive contributions were received from Anna Autio, Nicolas Bertrand, Derek Eaton, Fatma Ben Fadhl, Marenglen Gjonaj, Moustapha Kamal Gueye, Leigh-Ann Hurt, Ana Lucía Iturriza, Cornis Van Der Lugt, Desta Mebratu, Robert McGowan, Asad Naqvi, Sheng Fulai, Benjamin Simmons, Niclas Svenningsen and Vera Weick.

Thanks also go to Joe Alcamo, Aniket Ghai, Peter Gilruth, Sylviane Guillaumont, Mark Halle, Marek Harsdorff, Moira O'Brien-Malone, Nick Nuttall, Peter Poschen, Kees van der Ree, Kenneth Ruffing, and Mathis Wackernagel for their important review and comments. A special thanks of appreciation go to Edward Barbier for his review and substantive inputs. Any remaining errors and omissions are the responsibility of the authoring team alone.

The Green Economy Report was produced in close partnership with the International Labour Organization (ILO). The tourism chapter was developed in partnership with the World Tourism Organization (UNWTO).

Also to be recognized are Annie Haakenstad, Kim Hyunsoo, Kim Juhern, Tilmann Liebert, François Macheras, Dominique Maingot, Dmitry Preobrazhensky, Alexandra Quandt, Pascal Rosset, and Dhanya Williams for their research assistance, and Désirée Leon, Rahila Mughal, and Fatma Pandey for administrative support.

Foreword

Nearly 20 years after the Earth Summit, nations are again on the Road to Rio, but in a world very different and very changed from that of 1992.

Then we were just glimpsing some of the challenges emerging across the planet from climate change and the loss of species to desertification and land degradation.

Today many of those seemingly far off concerns are becoming a reality with sobering implications for not only achieving the UN's Millennium Development Goals, but challenging the very opportunity for close to seven billion people – rising to nine billion by 2050 – to be able to thrive, let alone survive.

Rio 1992 did not fail the world—far from it. It provided the vision and important pieces of the multilateral machinery to achieve a sustainable future.

But this will only be possible if the environmental and social pillars of sustainable development are given equal footing with the economic one: where the often invisible engines of sustainability, from forests to freshwaters, are also given equal if not greater weight in development and economic planning.

Towards a Green Economy is among UNEP's key contributions to the Rio+20 process and the overall goal of addressing poverty and delivering a sustainable 21st century.

The report makes a compelling economic and social case for investing two per cent of global GDP in greening ten central sectors of the economy in order to shift development and unleash public and private capital flows onto a low-carbon, resource-efficient path.

Such a transition can catalyse economic activity of at least a comparable size to business as usual, but with a reduced risk of the crises and shocks increasingly inherent in the existing model.

New ideas are by their very nature disruptive, but far less disruptive than a world running low on drinking water and productive land, set against the backdrop of climate change, extreme weather events and rising natural resource scarcities.

A green economy does not favour one political perspective over another. It is relevant to all economies, be they state or more market-led. Neither is it a replacement for sustainable development. Rather, it is a way of realizing that development at the national, regional and global levels and in ways that resonate with and amplify the implementation of Agenda 21.

A transition to a green economy is already underway, a point underscored in the report and a growing wealth of companion studies by international organizations, countries, corporations and civil society. But the challenge is clearly to build on this momentum.

Rio+20 offers a real opportunity to scale-up and embed these "green shoots". In doing so, this report offers not only a roadmap to Rio but beyond 2012, where a far more intelligent management of the natural and human capital of this planet finally shapes the wealth creation and direction of this world.

Achim Steiner
UNEP Executive Director
United Nations Under-Secretary General

Introduction

From Crisis to Opportunity

The last two years have seen the idea of a "green economy" float out of its specialist moorings in environmental economics and into the mainstream of policy discourse. It is found increasingly in the words of heads of state and finance ministers, in the text of G20 communiqués, and discussed in the context of sustainable development and poverty eradication.[1]

This recent traction for a green economy concept has no doubt been aided by widespread disillusionment with our prevailing economic paradigm, a sense of fatigue emanating from the many concurrent crises and market failures experienced during the very first decade of the new millennium, including especially the financial and economic crisis of 2008. But at the same time, we have seen increasing evidence of a way forward, a new economic paradigm – one in which material wealth is not delivered perforce at the expense of growing environmental risks, ecological scarcities and social disparities.

Mounting evidence also suggests that transitioning to a green economy has sound economic and social justification. There is a strong case emerging for a redoubling of efforts by both governments as well as the private sector to engage in such an economic transformation. For governments, this would include leveling the playing field for greener products by phasing out antiquated subsidies, reforming policies and providing new incentives, strengthening market infrastructure and market-based mechanisms, redirecting public investment, and greening public procurement. For the private sector, this would involve understanding and sizing the true opportunity represented by green economy transitions across a number of key sectors, and responding to policy reforms and price signals through higher levels of financing and investment.

We argue in UNEP's forthcoming Green Economy Report, and in this extracted *Synthesis for Policy Makers,* that the rewards of greening the world's economies are tangible and considerable, that the means are at hand for both governments and the private sector, and that the time to engage the challenge is now.

An Era of Capital Misallocation

Several concurrent crises have either sprung up or accelerated during the last decade: crises in climate, biodiversity, fuel, food, water, and of late in the financial system and the economy as a whole. Accelerating climate-changing emissions indicate a mounting threat of runaway climate change, with potentially disastrous human consequences. The fuel price shock of 2008, and a related flare up in food and commodity prices, both indicate structural weaknesses and risks which remain unresolved. Rising demand, forecast by the International Energy Agency (IEA) and others, suggests an ongoing dependence on oil and other fossil fuels and much higher energy prices as the world economy struggles to recover and grow.

As regards to food security, we are seeing neither widespread understanding of the nature of the problem, nor globally collaborative solutions for how we shall feed a population of 9 billion by 2050. Freshwater scarcity is already a global problem, and forecasts suggest a growing gap[2] by 2030 between annual freshwater demand and renewable supply. The outlook for improved sanitation still looks bleak for over 2.6 billion people; 884 million people still lack access to clean drinking water.[3] Collectively, these crises are severely impacting our ability to sustain prosperity worldwide and to achieve the Millennium Development Goals (MDGs) for reducing extreme poverty. They are compounding persistent social problems from job losses, socio-economic insecurity and poverty, and threatening social stability.

Although the causes of these crises vary, at a fundamental level they all share a common feature: the gross misallocation of capital. During the last two decades, much capital was poured into property, fossil fuels and structured financial assets with embedded derivatives, but relatively little in comparison was invested in renewable energy, energy efficiency, public transportation, sustainable agriculture, ecosystem and biodiversity protection, and land and water conservation. Indeed, most economic development and growth strategies encouraged rapid accumulation of physical, financial and human capital, but at the expense of excessive depletion and degradation of natural capital, which includes our endowment of natural resources and ecosystems. By depleting the world's stock of natural wealth – often irreversibly – this pattern of development and growth has

1. The "Rio+20" agenda has adopted "green economy" as a key theme in the context of sustainable development and poverty eradication.
2. *Charting our Water Future: Economic Frameworks to Inform Decision Making.* Munich: 2030 Water Resources Group. McKinsey and Company (2009), p. iv.
3. *Progress on Sanitation and Drinking Water:* 2010 Update. WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation. World Health Organization and UNICEF (2010), pp. 6-7.

had detrimental impacts on the well-being of current generations and presents tremendous risks and challenges for future generations. The recent multiple crises are symptomatic of this pattern.

Existing policies and market incentives have contributed to this problem of capital misallocation because they allow businesses to run up significant social and environmental externalities, largely unaccounted for and unchecked. "Unfettered markets are not meant to solve social problems"[4] so there is a need for better public policies, including pricing and regulatory measures, to change the perverse market incentives that drive this capital misallocation and ignore social and environmental externalities. Increasingly too, the role of appropriate regulations, policies and public investments as enablers for bringing about changes in the pattern of private investment is being recognized and demonstrated through success stories from around the world, especially in developing countries.[5]

What is a Green Economy?

UNEP defines a green economy as one that results in *improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities.* In its simplest expression, a green economy can be thought of as one which is low carbon, resource efficient and socially inclusive. In a green economy, growth in income and employment should be driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services. These investments need to be catalysed and supported by targeted public expenditure, policy reforms and regulation changes. The development path should maintain, enhance and, where necessary, rebuild natural capital as a critical economic asset and as a source of public benefits, especially for poor people whose livelihoods and security depend on nature.

The concept of a "green economy" does not *replace* sustainable development, but there is now a growing recognition that achieving sustainability rests almost entirely on getting the economy right. Decades of creating new wealth through a "brown economy" model have not substantially addressed social marginalization and resource depletion, and we are still far from delivering to the Millennium Development Goals. Sustainability is still a vital long-term goal, but we must work on greening the economy to get us there.

To make the transition to a green economy, specific enabling conditions will be required. These enabling conditions consist of the backdrop of national regulations, policies, subsidies and incentives, and international market and legal infrastructure and trade and aid protocols. At present, enabling conditions are heavily weighted towards, and encourage, the prevailing brown economy, which, inter alia, depends excessively on fossil fuel energy.

For example, price and production subsidies for fossil fuels collectively exceeded US$ 650 billion in 2008,[6] and this high level of subsidization can adversely affect transition to the use of renewable energies. In contrast, enabling conditions for a green economy can pave the way for the success of public and private investment in greening the world's economies. At a national level, examples of such enabling conditions are: changes to fiscal policy, reform and reduction of environmentally harmful subsidies; employing new market-based instruments; targeting public investments to "green" key sectors; greening public procurement; and improving environmental rules and regulations as well as their enforcement. At an international level, there are also opportunities to add to market infrastructure, improve trade and aid flows, and foster greater international cooperation.

UNEP's Green Economy Report, entitled *Towards a Green Economy,* aims to debunk several myths and misconceptions about the economics of "greening" the global economy, and provides timely and practical guidance to policy makers on what reforms they need to unlock the productive and employment potential of a green economy.

Perhaps the most widespread myth is that there is an inescapable trade-off between environmental sustainability and economic progress. There is now substantial evidence that the "greening" of economies neither inhibits wealth creation nor employment

4. Yunus, Muhammad and Karl Weber. *Creating a World without Poverty: Social Business and the Future of Capitalism.* Public Affairs (2007), p. 5.
5. *Green Economy Developing Countries Success Stories.* United Nations Environment Programme (2010), p. 6.
6. *Analysis of the Scope of Energy Subsidies and Suggestions for the G20 Initiative.* IEA, OPEC, OECD, and World Bank joint report prepared for submission to the G20 Summit Meeting, Toronto (Canada), 26-27 June 2010, p. 4.

opportunities, and that there are many green sectors which show significant opportunities for investment and related growth in wealth and jobs. A caveat, however, is that there is a need to establish new enabling conditions to promote the transition to a green economy, and this is where urgent action is required of policy makers around the world.

A second myth is that a green economy is a luxury only wealthy countries can afford, or worse, a developed-world imposition to restrain development and perpetuate poverty in developing countries. Contrary to this perception, we find there are a plethora of examples of greening transitions taking place in various sectors in the developing world, which deserve to be emulated and replicated elsewhere. *Towards a Green Economy* brings some of these examples to light and highlights their scope for wider application.

UNEP's work on the green economy raised the visibility of this concept in 2008, particularly through our call for a Global Green New Deal (GGND). The GGND recommended a package of public investments and complementary policy and pricing reforms aimed at kick-starting a transition to a green economy while reinvigorating economies and jobs and addressing persistent poverty.[7] Designed as a timely and appropriate policy response to the economic crisis, the GGND proposal was an early output from the United Nations' Green Economy Initiative. This initiative, coordinated by UNEP, was one of the nine Joint Crisis Initiatives undertaken by the Secretary-General of the UN and his Chief Executives Board in response to the 2008 economic and financial crisis.

Towards a Green Economy – the main output of the Green Economy Initiative – demonstrates that the greening of economies is not generally a drag on growth but rather a new engine of growth; that it is a net generator of decent jobs, and that it is also a vital strategy for the elimination of persistent poverty. The report also seeks to motivate policy makers to create the enabling conditions for increased investments in a transition to a green economy in three ways.

Firstly, it makes an economic case for shifting investment, both public and private, to transform key sectors that are critical to green the global economy. It illustrates through examples how added employment through green jobs offsets job losses in the process of transitioning to a green economy.

Secondly, it shows how a green economy can reduce persistent poverty across a range of important sectors – agriculture, forestry, freshwater, fisheries and energy. Sustainable forestry and ecologically friendly farming methods help conserve soil fertility and water resources in general, and especially for subsistence farming, upon which depend the livelihoods of almost 1.3 billion people.[8]

Lastly, it provides guidance on policies to achieve this shift: by reducing or eliminating environmentally harmful or perverse subsidies, by addressing market failures created by externalities or imperfect information, through market-based incentives, through appropriate regulatory framework and green public procurement, and through stimulating investment.

How Far are we from a Green Economy?

Over the last quarter of a century, the world economy has quadrupled, benefiting hundreds of millions of people.[9] In contrast, however, 60% of the world's major ecosystem goods and services that underpin livelihoods have been degraded or used unsustainably.[10] Indeed, this is because the economic growth of recent decades has been accomplished mainly through drawing down natural resources, without allowing stocks to regenerate, and through allowing widespread ecosystem degradation and loss.

For instance, today only 20% of commercial fish stocks, mostly of low priced species, are underexploited, 52% are fully exploited with no further room for expansion, about 20% are overexploited and 8% are depleted.[11] Water is becoming scarce and water stress is projected to increase with water supply satisfying only 60% of world demand in 20 years;[12] agriculture saw increasing yields primarily due to the use of chemical fertilizers,[13] which have reduced soil quality[14] and failed to curb the growing trend of deforestation – remaining at 13 million hectares

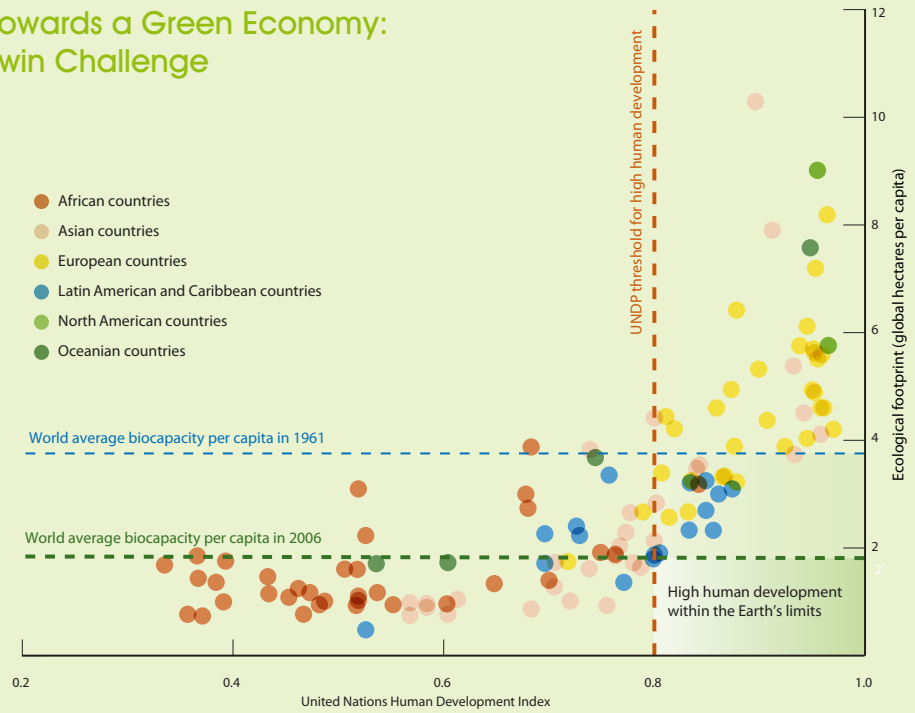
7. See Barbier, E.B. *A Global Green New Deal: Rethinking the Economic Recovery.* Cambridge University Press and UNEP (2010), Cambridge, UK.
8. *Green Jobs: Towards Decent Work in a Sustainable, Low-carbon World.* UNEP, ILO, IOE, ITUC. United Nations Environment Programme (2008), p. 11.
9. *World Economic Outlook Database,* IMF: Washington D.C. (September 2006), Available at: http://www.imf.org/external/pubs/ft/weo/2006/02/data/download.aspx.
10. *Ecosystem and Human Well-being: Synthesis.* Millennium Ecosystem Assessment (2005). p. 1.
11. *State of World Fisheries and Aquaculture 2008.* UN Food and Agricultural Organization (2009), p. 30.
12. *Charting our Water Future: Economic Frameworks to Inform Decision Making.* Munich: 2030 Water Resources Group. McKinsey and Company (2009), p. 7.
13. FAOSTAT, 2009.
14. Müller, Adrian and Joan S. Davis. *Reducing Global Warming: The Potential of Organic Agriculture.* Rodale Institute and FiBL (2009), p. 1.

of forest per year in 1990-2005.[15] Ecological scarcities are therefore seriously affecting the entire gamut of economic sectors, which are the bedrock of human food supply (fisheries, agriculture, freshwater, forestry) and a critical source of livelihoods for the poor. And ecological scarcity and social inequity are definitional signatures of an economy which is very far from being "green".

Meanwhile, for the first time in history, more than half of the world population lives in urban areas. Cities now account for 75% of energy consumption[16] and 75% of carbon emissions.[17] Rising and related problems of congestion, pollution, and poorly provisioned services affect the productivity and health of all, but fall particularly hard on the urban poor. With approximately 50% of the global population now living in emerging economies[18] that are rapidly urbanizing and will experience rising income and purchasing power over the next years – and a tremendous expansion in urban infrastructure – the need for smart city planning is paramount.

The transition to a green economy will vary considerably between nations, as it depends on the specifics of each country's natural and human capital and on its relative level of development. As demonstrated graphically below, there are many opportunities for all countries in such a transition (See Box 1). Some countries have attained high levels of human development, but often at the expense of their natural resource base, the quality of their environment, and high GHG emissions. The challenge for these countries is to reduce their per capita ecological footprint without impairing their quality of life. Other countries still maintain relatively low per capita ecological footprints, but need to deliver improved levels of services and material well-being to their citizens. Their challenge is to do this without drastically increasing their ecological footprints. As the diagram below illustrates, one of these two challenges affects almost every nation, and globally, we are very far from being a green economy.

Box 1. Towards a Green Economy: Twin Challenge



Source: *The Ecological Wealth of Nations: Earth's Biocapacity as a New Framework for International Cooperation. Global Footprint Network (2010), p. 13; Human Development Index data from Human Development Report 2009 – Overcoming Barriers: Human Mobility and Development.* UNDP (2009).

15. *Global Forest Resources Assessment 2010: Main Report.* Rome. UN Food and Agriculture Organization (2010), p. xiii.
16. *Cities and Climate Change Initiative Launch and Conference Report.* UN Habitat (March 2009), p. 8.
17. *Clinton Foundation Annual Report 2009.* Clinton Foundation (2010), p. 33. For a critique of these figures, see Satterthwaite, D (2008), "Cities' contribution to global warming: notes on the allocation of greenhouse gas emissions", *Environment and Urbanization,* Vol. 20, No 2. pp. 539-549.
18. In 2009, Brazil, China, India, Indonesia, Mexico, Russia and South Africa accounted for 3.2 billion people or nearly half of the world population. Source: World Bank, World Development Indicators, 2010.

How to Measure Progress towards a Green Economy

We cannot hope to *manage* what we do not even *measure*. Therefore, we argue that notwithstanding the complexity of an overall transition to a green economy, we must identify and use appropriate indicators at both a macroeconomic level and a sectoral level.

Conventional economic indicators, such as GDP, provide a distorted lens for economic performance particularly since such measures fail to reflect the extent to which production and consumption activities may be drawing down natural capital. By either depleting natural resources, or degrading the ability of ecosystems to deliver economic benefits, in terms of provisioning, regulating or cultural services, economic activity is often based on the depreciation of natural capital.

Ideally, changes in stocks of natural capital would be evaluated in monetary terms and incorporated into the national accounts, as is being pursued in the ongoing development of the System of Environmental and Economic Accounting (SEEA) by the UN Statistical Division, and the adjusted net national savings methods of the World Bank.[19] The wider use of such measures would provide a truer indication of the real level and viability of growth in income and employment. Green Accounting or Inclusive Wealth Accounting are available frameworks which we expect will be adopted by a few nations[20] initially and pave the way for measuring a green economy transition at the macroeconomic plane.

In this report, we explored through a macroeconomic model[21] the impacts of investments in greening the economy as against investments in "business as usual" – measuring results not only in terms of traditional GDP but also impacts on employment, resource intensity, emissions and ecological impact. We estimated, based on several studies (see Annex I), that the annual financing demand to green the global economy was in the range of US$ 1.05-2.59 trillion. To place this demand in perspective, it is less than one-tenth of the total global investment per year (as measured by global Gross Capital Formation). Taking an annual level of US$ 1.3 trillion (i.e. 2% of global GDP) as a target reallocation from "brown" investment to "green" investment, our macroeconomic model suggests that over time, investing in a green economy enhances long-run economic performance and can increase total global wealth. Significantly, it does so while enhancing stocks of renewable resources, reducing environmental risks, and rebuilding our capacity to generate future prosperity.

Towards a Green Economy

Our report, *Towards a Green Economy,* focuses on 10 key economic sectors because we see these sectors as driving the defining trends of the transition to a green economy, including increasing human well-being and social equity, and reducing environmental risks and ecological scarcities. Across many of these sectors, we have found that greening the economy can generate consistent and positive outcomes for increased wealth, growth in economic output, decent employment, and reduced poverty. These cross-cutting observations are summarized as our "key findings" in the next section.

We have also found several sector-specific investment opportunities and policy reforms to be of global importance as they appear replicable and scalable in our goal to transition to a green economy. These are largely in renewable energy and resource efficiency. Resource efficiency is a theme that has many dimensions as it cuts across energy efficiency in manufacture and habitation, materials efficiency in manufacture, and better waste management.

Finally, to transition successfully to a green economy the importance of adequate and favourable enabling conditions cannot be overemphasized. The latter includes appropriate domestic fiscal measures and policy reforms, international collaboration through trade, aid, market infrastructure, and capacity-building support. These are described and addressed, along with steps necessary to mobilize finance for a green economy transition, in the final sections of this *Synthesis for Policy Makers*.

19. *Where is the Wealth of Nations? Measuring Capital for the 21st Century.* World Bank: Washington, D.C. (2006), p. 123.
20. World Bank, together with UNEP and other partners, have recently (at Nagoya, CBD COP-10, October 2009) announced a global project on "Ecosystem Valuation and Wealth Accounting" which will enable a group of developing and developed nations to test this framework and evolve a set of pilot national accounts that are better able to reflect and measure sustainability concerns.
21. "T-21" model used in chapter on Enabling Conditions for a Green Economy.

Key Findings

Beyond an exploration of sectoral success stories, which the Green Economy Report documents in each of its chapters, there are three broad thematic conclusions which we draw, and these are documented in this section.

The first key finding is a prediction of our macroeconomic model of the transition to a green economy; that greening not only generates increases in wealth, in particular a gain in ecological commons or natural capital, but also (over a period of six years) produces a higher rate of GDP growth – a classical measure of economic performance.

Our second key finding is the inextricable link between poverty eradication and better maintenance and conservation of the ecological commons, arising from the benefit flows from natural capital that are received directly by the poor.

The third key finding is that in a transition to a green economy, new jobs are created, which over time exceed the losses in "brown economy" jobs. However, there is a period of job losses in transition, which requires investment in re-skilling and re-educating the workforce. The role of natural capital and especially "living" natural capital (the planet's ecosystems and biodiversity) cannot be overstated in the context of these key findings. Thus, we begin with some comments on natural capital and its benefit flows, especially to poor and vulnerable communities.

A Green Economy Recognizes the Value of, and Invests in, Natural Capital

Biodiversity, the living fabric of this planet, includes life at all levels: genes, species and ecosystems.[22] At each of these levels, biodiversity contributes to human well-being and provides economies with valuable resource inputs as well as regulating services towards a safe operating environment. These so-called "ecosystem services" (see Table 1) are mostly in the nature of public goods and services whose economic invisibility has thus far been a major cause of their undervaluation, mismanagement and ultimately resulting loss.

Economic values can be estimated for these ecosystem services, and the present value of these ecosystem services is a fundamental part of "natural capital." Natural assets such as forests, lakes, wetlands and river basins are essential components of natural capital at an ecosystem level. They are vital in ensuring the stability of the water cycle and its benefits to agriculture and households, the carbon cycle and its role in climate mitigation, soil fertility and its value to crop production, local microclimates for safe habitats, fisheries for proteins, and so on, which are all crucial elements of a green economy.

22. Convention on Biological Diversity, Article 2, Use of Terms, http://www.cbd.int/convention/articles/?a=cbd-02

Table 1. Natural Capital: Underlying Components and Illustrative Services and Values

Biodiversity	Ecosystem goods and services (examples)	Economic values (examples)
Ecosystems (variety & extent/area)	• Recreation • Water regulation • Carbon storage	Avoiding GHG emissions by conserving forests: US$ 3.7 trillion (NPV)[23]
Species (diversity & abundance)	• Food, fibre, fuel • Design inspiration • Pollination	Contribution of insect pollinators to agricultural output: ~US$ 190 billion/year[24]
Genes (variability & population)	• Medicinal discovery • Disease resistance • Adaptive capacity	25-50% of the US$ 640 billion pharmaceutical market is derived from genetic resources[25]

Thus a green economy transition not only recognizes and demonstrates the value of natural capital – as a provider of human well-being, as a supplier of sustenance for poor households, as a source of new and decent jobs – but it also invests in and builds up this natural capital for sustainable economic progress. In our modelling of a green investment scenario channelling capital amounting to 2% of global GDP (US$ 1,300 billion) to embark on a green economic transformation, one-quarter of this amount – 0.5% of GDP (US$ 325 billion) – is allocated to natural capital sectors: forestry, agriculture, freshwater, fisheries. Below, we discuss results and specific cases in these sectors.

Reducing deforestation and increasing reforestation make good economic sense in their own right, and also support agriculture and rural livelihoods. Forests are a key part of the "ecological infrastructure" that supports human well-being. Forest goods and services support much of the economic livelihoods of over 1 billion people.[26] Forests sustain often irreplaceable environmental services, harbouring 80% of terrestrial species, offering resilience for agriculture, health and other biology-driven sectors.[27] The current high rates of deforestation and forest degradation are driven by demand for wood products, and by pressure from other land uses, in particular agriculture and cattle ranching (see Table 2). This "frontier" approach to natural resources – as opposed to an investment approach – means that valuable forest ecosystem services and economic opportunities are being lost. Reducing deforestation can therefore be a good investment: the climate regulation benefits of halving global deforestation alone have been estimated to exceed the costs by a factor of three.[28]

Tried and tested economic mechanisms and markets exist, which can be replicated and scaled up, including from certified timber schemes, certification for rainforest products, payments for ecosystem services, benefit-sharing schemes and community-based partnerships.[29] In particular, international and national negotiations of a REDD+ regime may be the best current opportunity to facilitate the transition to a green economy for forestry. Within this context, legal and governance changes are needed to tip the balance towards sustainable forestry (which is not yet at scale) and away from unsustainable practice (which is pervasive in the global forest sector). Green economy modelling suggests that investing 0.03% of GDP between 2011 and 2050 in paying forest land holders to conserve forests, and in private investment in reforestation, could raise value added in the forest industry by more than 20% as compared to business as usual. It could also boost formal employment in this sector and substantially increase carbon stored in forests.

23. Eliasch, J. *Climate Change: Financing Global Forests.* The Eliasch Review, UK (2008), http://www.official-documents.gov.uk/document/other/9780108507632/9780108507632.pdf
24. Gallai, N., Salles, J.-M., Settele, J. and Vaissière, B.E. *Economic Valuation of the Vulnerability of World Agriculture Confronted with Pollinator Decline.* Ecological Economics (2009), Vol. 68(3): 810-21.
25. *TEEB for National and International Policy Makers. Summary: Responding to the Value of Nature.* TEEB – The Economics of Ecosystems and Biodiversity (2009), http://www.teebweb.org/LinkClick.aspx?filetick et=I4Y2nqqliCg%3d&tabid=1019&language=en-US
26. *Better Forestry, Less Poverty.* FAO (2006), p.1, ftp://ftp.fao.org/docrep/fao/009/a0645e/a0645e04.pdf
27. *Ecosystems and Human Well-Being Vol.1: Current State and Trends,* Millennium Ecosystem Assessment, (2005), pp.600-01.
28. Eliasch, J. Climate Change: Financing Global Forests. The Eliasch Review. UK (2008), http://www.official-documents.gov.uk/document/other/9780108507632/9780108507632.pdf
29. See TEEB D2, Ch. 8, for more than 50 examples of Payment for Ecosystem Services (PES) schemes in place and operational around the world, http://www.teebweb.org/Portals/25/Documents/TEEB_D2_ PartIIIb-ForUpload%5B1%5D.pdf

Table 2. Trends in Forest Cover and Deforestation

Forest Cover	1990	2010
World forest area (hectares)	4.17 billion	4.03 billion
World planted forest area (hectares)	178 million	264 million
Deforestation	**1990-2000**	**2000-2010**
Annual net forest loss (hectares/year)	8.3 million	5.2 million
Annual deforestation (hectares/year)	16 million	13 million
Annual increase in planted forest (hectares/year)	3.36 million*	5 million

Source: *Global Forest Resource Assessment 2010,* FAO; *Carle and Holmgren, 2008.

Greening agriculture offers a means to feed the world's growing population without undermining the sector's natural resource base. The challenge in agriculture is feeding 9 billion people by 2050 without damaging ecosystems and human health under the conditions of higher average global temperature. Current farming practices use over 70% of global freshwater resources[30] and contribute to over 13% of greenhouse gas (GHG) emissions.[31] They are also related to 3-5 million cases of pesticide poisoning and over 40,000 deaths every year.[32] Green agriculture is characterized by shifting both industrial and subsistence farming towards ecologically sound farming practices such as efficient use of water, extensive use of organic and natural soil nutrients, optimal tillage, and integrated pest control. Building green agriculture requires physical capital assets, financial investments, research and capacity building in five key areas: soil fertility management; more efficient and sustainable water use; crop and livestock diversification; biological plant and animal health management; and appropriate farm level mechanization.

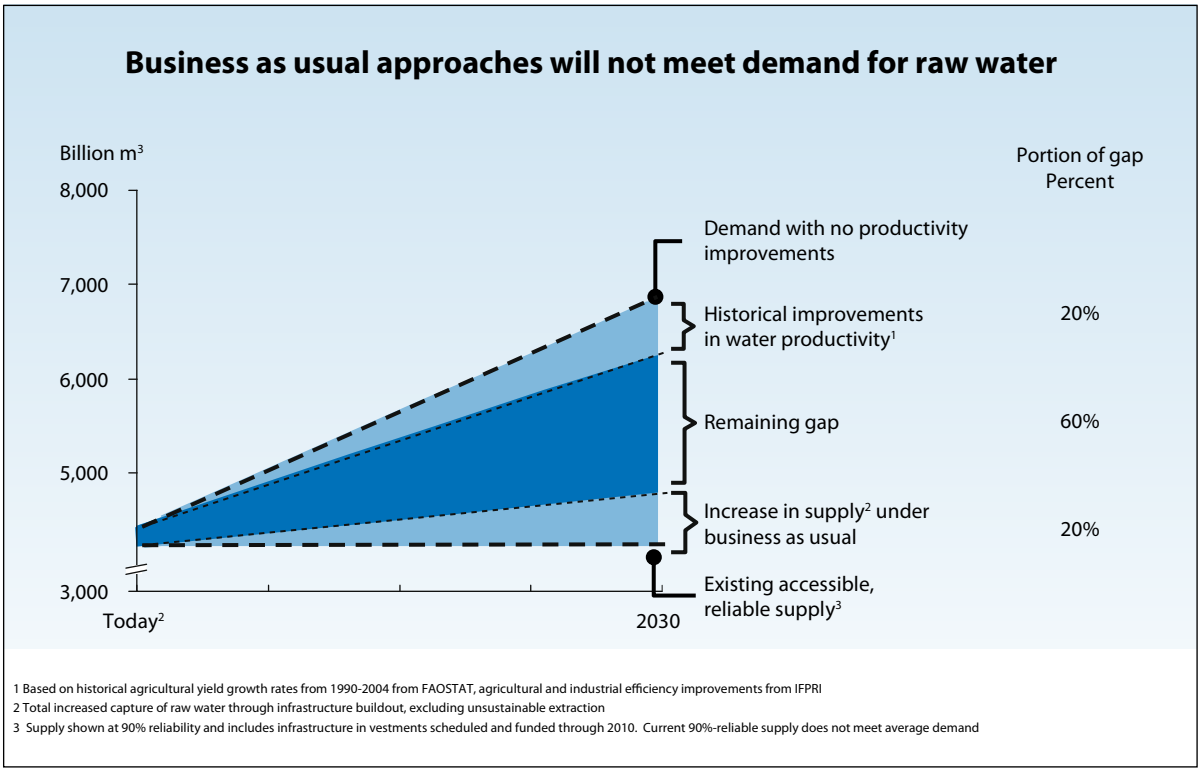
Greening agriculture also requires institutional strengthening and infrastructure development in rural areas of developing countries. Policy changes would particularly focus on the reduction and eventual removal of ecologically perverse subsidies that distort the true costs of unsustainable agricultural inputs, and on instigating pricing and regulatory reforms that account for associated environmental degradation costs in food and commodity prices. Farm-level analysis suggests that green farming practices can substantially increase yields, especially on small farms. Investments in green agriculture in the GER modelling ranging from US$ 100-300 billion per year over 2010-2050 would lead over time to rising soil quality and increasing global yields for major crops, representing an improvement of 10% above what is possible with current investment strategies. While insufficient to ensure equitable access for the hungry, such growth will be necessary to address the challenge of feeding a growing population.

30. *Securing the Food Supply, World Water Assessment Program.* UNESCO, (2001), pp. 192-93, http://www.unesco.org/water/wwap/wwdr/pdf/chap8.pdf
31. *Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Working Group III Report: Mitigation of Climate Change. IPCC (2007), p. 499, http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter8.pdf
32. Childhood Pesticide Poisoning, Information for Advocacy and Action. UNEP Chemicals (2004), p.7, http://www.chem.unep.ch/Publications/pdf/pestpoisoning.pdf

Growing water scarcity can be mitigated with policies to increase investments in improving water supply and efficiency. The provision of freshwater, of sufficient quality and quantities needed, is a basic ecosystem service. The management of, and investment in, ecosystems is therefore essential to address water security for both people and ecosystems in terms of water scarcity, the over-abundance of water (flood risk) and its quality. Business as usual is projected to lead to a large and unsustainable gap between global supply and water withdrawals (see Figure 1), which can only be addressed by investments in infrastructure and water policy reform – i.e. greening the water sector.

The latter may focus on improving institutional arrangements, entitlement and allocations systems; expanding the use of payments for ecosystem services; reducing input subsidies; and improving water charging and finance arrangements. In green investment scenarios of US$ 100-300 billion investments per year between 2010 and 2050, increased efficiency in agriculture, industrial and municipal sectors would reduce demand for water by about a fifth by 2050, as compared to projected trends, reducing pressure on groundwater and surface water in both the short and long term.

Figure 1. Projection of the global demand for water and, under a business as usual scenario, the amount that can be expected to be met from supply augmentation and improvements in technical water use efficiency (productivity).



1 Based on historical agricultural yield growth rates from 1990-2004 from FAOSTAT, agricultural and industrial efficiency improvements from IFPRI
2 Total increased capture of raw water through infrastructure buildout, excluding unsustainable extraction
3 Supply shown at 90% reliability and includes infrastructure in vestments scheduled and funded through 2010. Current 90%-reliable supply does not meet average demand

Source: 2030 Water Resources Group (2009)

Investing to achieve sustainable levels of fishing will secure a vital stream of income in the long run. The fisheries sector is essential for economic development, employment, food security and livelihood of millions of people around the world. However, subsidies in the range of US$ 27 billion per year have created excess capacity by a factor of two relative to the ability of fish to reproduce (see Table 3).

Greening the sector requires reorienting this public spending to strengthen fisheries management, and financing a reduction of excess capacity through decommissioning vessels and equitably relocating employment in the short term, all in order to rebuild overfished and depleted fish stocks. A one-time investment of US$ 100-300 billion would reduce excessive capacity, and result in an increase in fisheries catch from the current 80 M tons a year to 90 M tons in 2050, despite a drop in the next decade as stocks recover. The present value of benefits from greening the fishing sector is estimated to be about 3 to 5 times the value of the necessary investment. The alternative business as usual scenario is continued decline and contraction of the fishery sector, resulting from increased scarcity and collapse of stocks.

Table 3. Global Fisheries Subsidies[33]

Type	World total (US$ billion)
Good	7.9
Bad	16.2
Ugly	3.0
Total	27.1

Source: *Sumaila et al.* (2010).

A Green Economy is Central to Poverty Alleviation

Persistent poverty is the most visible form of social inequity, related as it is to unequal access to education, healthcare, credit availability, income opportunity and secure property rights. A key feature of a green economy is that it seeks to provide diverse opportunities for economic development and poverty alleviation without liquidating or eroding a country's natural assets. This is particularly necessary in low-income countries, where ecosystem goods and services are a large component of the livelihoods of poor rural communities and ecosystems and their services provide a safety net against natural disasters and economic shocks.[34]

Greening agriculture in developing countries, concentrating on smallholders, can reduce poverty while investing in the natural capital on which the poor depend. There are an estimated 525 million small farms in the world, 404 million of which operate on less than two hectares of land.[35] Greening the small farm sector through promotion and dissemination of sustainable practices could be the most effective way to make more food available to the poor and hungry, reduce poverty, increase carbon sequestration and access growing international markets for green products.

It has been demonstrated that even small increases in farm yields contribute directly to reducing poverty, based on data from Africa and Asia.[36] Furthermore, studies have documented that conversion of farms to sustainable practices have resulted in large productivity gains. A review of 286 "best practice" projects across 12.6 million farms in 57 developing countries found that adopting resource-conserving practices (such as integrated pest management, integrated nutrient management, low-tillage farming, agroforestry, acquaculture, water harvesting and livestock integration) resulted in average yield increases of 79%, while improving the supply of critical environmental services.[37] Our modelling indicates that adoption of sustainable farming methods also

33. Khan *et al.* (2006) classified subsidies into three categories labelled 'good', 'bad' and 'ugly', according to their potential impact on the sustainability of the fishery resource. 'Good' subsidies enhance the conservation of fish stocks through time (for example subsidies that fund effective fisheries management or marine protected areas). 'Bad' subsidies are those that lead to overcapacity and overexploitation, such as fuel subsidies. 'Ugly' subsidies can lead to either the conservation or overfishing of a given fish stock, such as buyback subsidies, which, if not properly designed, can lead to overcapacity (Clark *et al.* 2005).
34. *The Economics of Ecosystems and Biodiversity: An Interim Report.* TEEB – The Economics of Ecosystems and Biodiversity (2008), European Commission, Brussels.
35. Nagayets, O., *Small farms: Current Status and Key Trends,* Prepared for the Future of Small Farms Research Workshop, Wye College, 26–29 June 2005, p. 356, http://www.ifpri.org/sites/default/files/publications/sfproc.pdf)
36. Irz, X., L. Lin, C. Thirtle and S. Wiggins. *Agricultural Growth and Poverty Alleviation.* Development Policy Review 19 (4), (2001), pp. 449–466.
37. Pretty, J., Nobel, A.D., Bossio, D., Dixon, J., Hine, R.E., Penning De Vries, F.W.T., Morison, J.I.L. *Resource Conserving Agriculture Increases Yields in Developing Countries.* Environmental Science and Technology, 40, (2006), p. 1114.

has the potential to transform agriculture from a major emitter of greenhouse gasses to one of net neutrality and possibly a GHG sink, while reducing deforestation and freshwater use by 55% and 35% respectively.

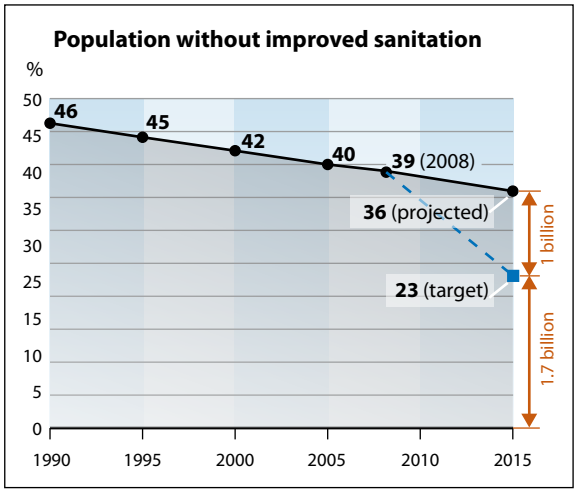
By increasing investment in natural assets that are used by the poor to earn their livelihoods, the shift towards a green economy enhances livelihoods in many low-income areas. A good example of this comes from India's National Rural Employment Guarantee Act 2006, a social protection and livelihood security scheme for the rural poor that invests in the preservation and restoration of natural capital. It takes the form of a public works programme guaranteeing at least 100 days of paid work per year to every household who wants to volunteer an adult member. The scheme has grown fourfold since its inception and investment last year amounted to over US$ 8 billion, creating 3 billion workdays and benefiting 59 million households. About 84% of this investment goes into water conservation, irrigation and land development. While there are challenges with implementation, the programme is proving to be effective, replicable and scalable.[38]

In many developing countries, one of the biggest opportunities to speed transition to a green economy is to invest in the provision of clean water and sanitation services to the poor. Water, a basic necessity for sustaining life, goes undelivered to many of the world's poor. Over 884 million people lack access to clean drinking water;[39] 2.6 billion do not have access to adequate sanitation services;[40] and 1.4 million children under the age of five die every year as a result of lack of access to clean water and adequate sanitation services[41] (see Figure 2).

When people do not have access to water, either large amounts of their disposable income have to be spent on purchasing water from vendors or large amounts of time, in particular from women and children, have to be devoted to carting it. When sanitation services are inadequate, the costs of water-borne disease are high, reaching, for instance, 2% of the combined GDP of Cambodia, Indonesia, the Philippines and Vietnam.[42]

Under a scenario of green investments of around 0.16% of global GDP/yr, water use at the global level can be kept within sustainable limits and the Millennium Development Goals for water achieved by 2015. Where there is water scarcity or large proportions of a population do not have access to adequate water supply and sanitation services, early investment in water is a necessary precondition to progress and an integral part of a green economy transition.

Figure 2. Global progress towards achieving the Millennium Development Goals' target to reduce the number of people without access to adequate sanitation services to 1.7 billion people by 2015.



Source: WHO/UNICEF, 2010.[43]

Renewable energy can play a cost-effective role in a strategy to eliminate energy poverty. The move towards a green economy aims to increase access to services and infrastructure as a means of alleviating poverty and improving overall quality of life, and addressing energy poverty is a very important part of this transition. This includes providing energy to the

38. *NREGA – A Review of Decent Work and Green Jobs.* ILO (2010).
39. *2010 Update: Progress on Sanitation and Drinking Water,* WHO/UNICEF (2010), p. 7.
40. Ibid, p. 22.
41. *The State of the World's Children 2005: Childhood under Threat.* UNICEF (2006), p. II.
42. *Economic Impacts of Sanitation in Southeast Asia: A Four-Country Study Conducted in Cambodia, Indonesia, the Philippines and Vietnam under the Economics of Sanitation Initiative (ESI).* World Bank-Water and Sanitation Programme (2008), p. 32.
43. WHO/UNICEF, Op. Cit., (2010), p. 8.

1.6 billion people who currently lack electricity.[44] In Africa, for example, the 110 million households – at the lowest income level –spend more than US$ 4 billion a year on kerosene-based lighting, which is costly, inefficient and a safety and health hazard.[45] In addition to being unsustainable, the current energy system is also highly inequitable, leaving 2.7 billion dependent on traditional biomass for cooking.[46] Moreover, indoor air pollution from using traditional biomass and coal is projected to cause more than 1.5 million premature deaths each year by 2030.[47] Ensuring access to electricity for all requires US$ 756 billion – or US$ 36 billion per year – between 2010 and 2030, according to estimates by the IEA, UNDP and UNIDO.[48] Renewable energy technologies and supportive energy policies promise to make a significant contribution to improving living standards and health in low-income areas, particularly in off-grid situations. Cost effective solutions include clean biomass and off-grid solar photovoltaics, with low operating costs and flexible, small-scale deployment options (see Box 2).

Box 2. Grameen Shakti Programme in Bangladesh

Grameen Shakti (or Grameen Energy in English) was founded in 1996 and is currently one of the fastest growing rural-based companies in the field of renewable energy in the world. Capitalizing on the microcredit network and experience of the Grameen Bank, Grameen Shakti provides soft credits through different financial packages to make solar home systems (SHSs) available and affordable to rural populations. By the end of 2009 more than 320,000 SHSs had been installed, in addition to biogas plants and improved cooking stoves. The improved cooking stoves and biogas programmes contribute to the reduction of the use of biomass and in turn decrease indoor pollution, while biogas technology further helps with sustainable waste management. Grameen Shakti aims to install over 1 million SHS by 2015, while also providing the necessary maintenance, thereby generating local employment. Grameen Shakti demonstrates the potential that can be mobilized to reduce energy poverty efficiently with innovative financing and business models that can deliver success with little or no external financial support.

Finally, tourism development when well designed can support the local economy and reduce poverty. While the growth of tourism has been accompanied by significant challenges – for instance, in terms of GHG emissions, water consumption, discharge of untreated water, waste generation, damage to local terrestrial and marine biodiversity, and threats to the survival of local cultures and traditions[49] – tourists are driving the greening of the sector, as seen by the 20% annual growth rate enjoyed by ecotourism; about six times the industry-wide rate of growth.[50]

Travel and tourism are human-resource intensive, employing 230 million people or 8% of the global workforce[51] and it is estimated that one job in the core tourism industry creates about one and a half additional or indirect jobs in the tourism-related economy.[52] The greening of the sector is expected to reinforce the employment potential of the sector with increased local hiring and sourcing. In greening the tourism sector, increasing the involvement of local community, especially the poor, in the tourism value chain is essential to developing the local economy and reducing poverty.[53]

44. *World Development Report 2010: Development and Climate Change.* World Bank (2009), p. 192.
45. *Solar Lighting for the Base of the Pyramid: Overview of an Emerging Market.* International Finance Corporation and the World Bank (2010), pp. 46-47; bottom of the pyramid households are defined as those having an income less than US $3,000 per year.
46. *Energy Poverty: How to Make Modern Energy Access Universal?* OECD/IEA (September 2010), p. 7
47. Ibid.
48. Ibid.
49. *Making Tourism More Sustainable: A Guide for Policy Makers.* UNEP and World Tourism Organization (2005), p. 12.
50. *The Economics of Ecosystems and Biodiversity for National and International Policy Makers – Summary:* Responding to the Value of Nature, TEEB (2009), p. 24.
51. *Guide for Social Dialogue in the Tourism Industry.* Sectoral Activities Programme. Working Paper 265 prepared by Dain Bolwell and Wolfgang Weinz, ILO (2008), p. 1.
52. *Human Resources Development, Employment and Globalization in the Hotel, Catering and Tourism Sector.* ILO (2001), p. 118.
53. Ibid, p. 63.

A Green Economy Creates Jobs and Enhances Social Equity

As the world economy faltered into a recession in 2008, tripped up by the banking and credit crisis and earlier price shocks, concern over job losses ratcheted up. There was already research and evidence on hand of the employment opportunities in greening the economy (UNEP/ILO/IOE/ITUC joint report on green jobs[54], the US Blue-Green Alliance" of labour unions and environmental organizations[55]) and the recession added urgency to this exploration. Several countries responded with employment-focused plans for fiscal stimulus with significant "green" components, such as the China and Republic of Korea. Countries moving towards a green economy are already seeing significant employment creation with existing policies, and the potential could be expanded with further investments into green sectors. Policies targeting small and medium size enterprises (SMEs) hold particular promise, as they account for a large share of employment and employment growth in most countries.

A shift to a green economy also means a shift in employment which, at a minimum, will create as many jobs as business as usual. The global modelling of the economy and the labour market undertaken for this report finds no significant differences in overall employment between business as usual and a green investment scenario. This is in line with earlier studies suggesting no net changes or modest overall gains in employment. In the short and medium term, and in the absence of additional measures, the net direct employment under green investment scenarios may decline somewhat due to the need to reduce excessive resource extraction in sectors such as fisheries. But between 2030 and 2050, these green investments would create employment gains to catch up with and likely exceed business as usual, in which employment growth will be further constrained by resource and energy scarcity.

Overall, however, the employment gains under green investment scenarios could be much higher. National studies show that green investments tend to be more employment intensive at least in the short to medium term. The estimates of job creation at the global level in the greening scenarios in the report are conservative, because a number of effects that have been shown to stimulate the creation of jobs in a transition to a green economy could only be partially modelled, if at all. These include: indirect and induced job creation, and the choice of policy instruments, which can significantly impact employment outcomes (eco-taxes, which raise the price of emissions and natural resource use while reducing the cost of labour have shown positive employment impacts even in carbon intensive sectors). Furthermore, negative feedback on employment from probable consequences of business as usual such as the impacts of climate-related disasters on agriculture or coastal establishments has not been included in the business as usual scenarios.

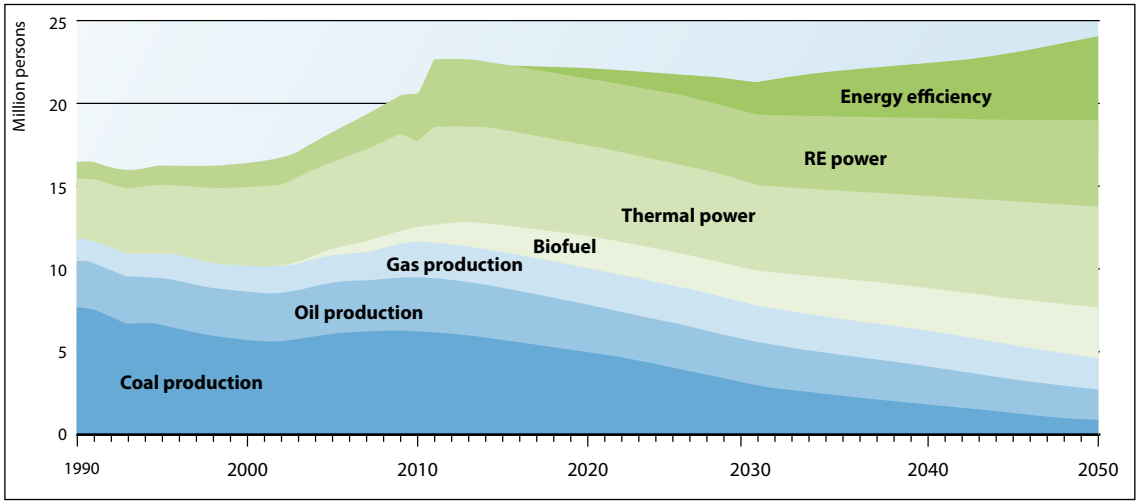
In green investment scenarios, agriculture, buildings, forestry, and transport sectors would see job growth in the short, medium, and long term exceeding their comparable business as usual scenarios. Over the next decade, global employment in agriculture could increase by as much as 4%. Investing in forest conservation and reforestation could boost formal employment alone in this sector by 20% by 2050. As far as transport is concerned, improving energy efficiency across all transport modes and shifting from private transport to public or non-motorized transport would further increase employment by about 10% above business as usual. Finally, investments in improved energy efficiency in buildings could generate an additional 2-3.5 million jobs in Europe and the United States alone. If the demand for new buildings (social housing, hospitals, schools, etc.) that exists in developing countries is considered, the potential is much higher.

Allocating a minimum of 1% of global GDP to raise energy efficiency and expand the use of renewable energy will create additional jobs, while delivering competitive energy (see Figure 3). Employment in the renewable energy sector has become quite substantial with more than 2.3 million people worldwide estimated to be working either directly or indirectly in the sector in 2006.[56] A small group of countries currently account for the majority of these jobs, especially Brazil, China, Germany, Japan and the United States.[57] There is considerable potential for further growth

54. *Green Jobs: Towards Decent Work in a Sustainable, Low-carbon World.* UNEP/ILO/IOE/ITUC (September 2008).
55. See: http://www.bluegreenalliance.org
56. UNEP/ILO/IOE/ITUC, Op. Cit. (September 2008), pp. 6-7.
57. Ibid., p. 6.

in this sector as well as from investments in energy efficiency, particularly if driven by supportive policies. In the modelling for the GER, almost half of the total investments were directed towards energy efficiency and renewable energy (including the expansion of second generation biofuels), resulting in employment that is 20% higher than business as usual by 2050, while delivering robust economic growth and reduced emissions.

Figure 3. Total employment in the energy sector and its disaggregation into fuel and power, and energy efficiency under a 2% green investment scenario.



Note: Roughly half of the investment is allocated to renewable energy and energy efficiency. See Annex I for absolute values.

Jobs in waste management and recycling will grow to handle increased waste resulting from population and income growth, although challenges in terms of decent work in this sector are considerable. Recycling in all its forms already employs 12 million people in three countries alone (Brazil, China and the United States).[58] Sorting and processing recyclables sustains 10 times more jobs than land filling or incineration on a per metric tonne basis[59]. In green investment scenarios, projected growth in jobs in the waste sector rises by 10% compared to current trends. However, even more important than the additional employment potential in waste management, reuse and recycling is the opportunity and, in fact, the need to upgrade jobs in the sector. To be truly green jobs they also need to match the requirements of decent work, including such aspects as a living wage, the elimination of child labour, occupational health and safety, social protection, and freedom of association. Upgrading is thus desirable and necessary for social and environmental reasons.

Employment from greening the water and fisheries sectors would see temporal adjustment necessitated by the need for resource conservation. In the case of water, thanks to efficiency improvements and the consequent reduction in total water consumption, jobs would be 20-25% lower than projected growth under current excessive water consumption trends in 2050 (although higher than current level). These projections do not capture new job opportunities in water efficiency infrastructure, such as water metering, and the projection of current trends is optimistic as excess water withdrawals would lead to supply problems and job declines. In the case of fisheries, greening the sector would lead to a loss

58. Ibid., p. 18.
59. Ibid, Op. Cit., (September 2008), p. 215.

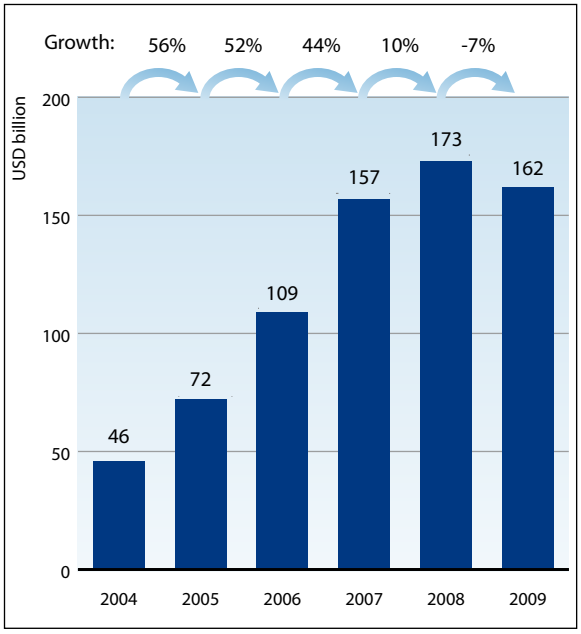
of jobs in the short and medium term due to the need to reduce fishing effort, but this can be done equitably by focusing job cuts on a small number of large-scale fishers. Additionally, a substantial number of jobs would grow back by 2050 as fish stocks are recovered. During the downward adjustments in the labour market, however, effective policies and measures need to be designed in dialogues with workers, employers, and communities to ensure a "just transition" – an issue discussed in more detail in the "enabling conditions" section.

A Green Economy Substitutes Renewable Energy and Low-carbon Technologies for Fossil Fuels

Increasing energy supply from renewable sources reduces the risks from rising and volatile prices for fossil fuels in addition to delivering mitigation benefits. The current fossil fuel-based energy system is at the root of climate change. The energy sector is responsible for two-thirds of GHG emissions, and the costs of climate change in terms of adaptation are estimated to reach US$ 50-170 billion by 2030, half of which could be borne by developing countries.[60] Many of these countries, as net oil importers, are also challenged by rising and volatile prices for fossil fuels. For example, oil accounts for 10-15% of total imports for oil-importing African countries and absorbs over 30% of their export revenue on average.[61] Some African countries, including Kenya and Senegal, devote more than half of their export earnings to energy imports, while India spends 45%. Investing in renewable sources that are available locally – in many cases abundantly – could significantly enhance energy security – and by extension, economic and financial security.[62]

Renewable energy presents major economic opportunities. The greening of the energy sector requires substituting investments in carbon-intensive energy sources with investments in clean energy as well as efficiency improvements. Many opportunities for improving energy efficiency pay for themselves, while investments in renewable energy technologies are already growing in today's market as they are becoming increasingly competitive. From 2002 until mid-2009, total investments into renewable energies exhibited a compound annual growth rate of 33%.[63] Despite the global recession, this sector is booming. For 2010, new investment in clean energy was expected to reach a record high of US$ 180-200 billion, up from US$ 162 billion in 2009 and US$ 173 billion in 2008 (see Figure 4).[64] The growth is increasingly driven by non-OECD countries, whose share of global investment in renewables rose from 29% in 2007 to 40% in 2008, with Brazil, China, and India accounting for most of it.[65] Renewable technologies are even more competitive when the societal costs of fossil fuel technologies, which are in part being delayed until the future, are taken into account. In this regard, the successful conclusion of a global agreement on carbon emissions and the resulting assurance that there will be a future carbon market and pricing is strong incentive for further business investment in renewable energy.

Figure 4. Investment in sustainable energy, 2004-2009 (US$ billion).



Source: UNEP and Bloomberg New Energy Finance, 2010.

60. *Recommendations on Future Financing Options for Enhancing the Development, Deployment, Diffusion and Transfer of Technologies under the Convention.* UNFCCC (2009), p. 33.
61. *Meeting Trade and Development Challenges in an Era of High and Volatile Energy Prices: Oil and Gas in LDCs and African Countries.* UNCTAD (2006), p. 4.
62. *Policy Brief: Achieving Energy Security in Developing Countries.* GNESD (2010), p. 4.
63. *Global Trends in Sustainable Energy Investment 2010: Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency.* UNEP/SEFI (Paris, 2010), p. 13.
64. Ibid., p. 5.
65. Ibid., p. 45.

Government policy has an essential role to play in enhancing incentives for investing in renewable energy. Time-bound incentives, notably feed-in tariffs, direct subsidies and tax credits can make the risk/revenue profile of renewable energy investments more attractive (see Box 3). Such incentives can be enhanced with emissions trading schemes or taxes that help capture the full social costs of fossil fuel use. Various studies from the IEA demonstrate how a concerted package of policy-driven investments, in the general range of 1-2% of global GDP, can shift the global economy to a low-carbon growth path.[66] To put this figure in perspective, this additional investment is comparable to the level of fossil fuel subsidies, which in 2008 was roughly equivalent to 1% of GDP. The results of these studies are reinforced by modelling for the GER, which finds that substituting investments in carbon-intensive energy sources with investments in clean energy would almost triple the penetration rate of renewables in power generation from 16% to 45% by 2050. For the entire energy mix, renewables could double to provide more than 25% of total supply.

Box 3. Feed-in Tariffs: An Example from Kenya

Feed-in tariffs, much like preferential pricing, guarantee payment of a fixed amount per unit of electricity produced from renewable sources, or a premium on top of market electricity prices. Feed-in tariffs have been implemented in more than 30 developed countries and in 17 developing countries.[67] Kenya, for example, introduced a feed-in tariff on electricity from wind, biomass and small hydropower in 2008, and extended the policy in 2010 to include geothermal, biogas and solar energy resource-generated electricity. This could stimulate an estimated 1300 MW of electricity generation capacity in the coming years or nearly double installed capacity. As with any kind of positive support, the design of feed-in tariffs is crucial for determining their success, depending on issues such as time periods for support, graduated tariff decreases over time, minimum or maximum capacity limits.

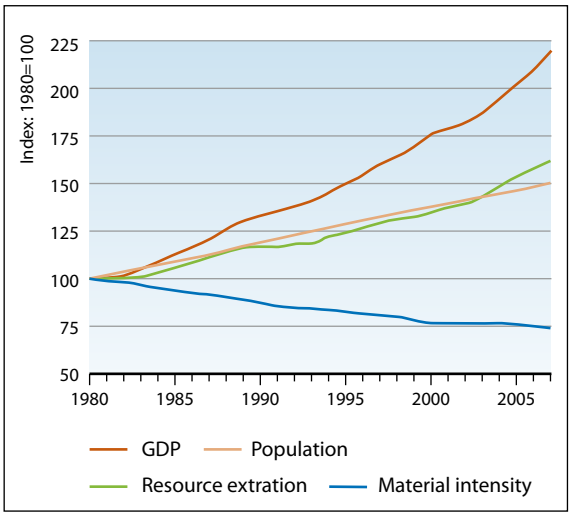
A Green Economy Promotes Enhanced Resource and Energy Efficiency

The cost of using natural resources inefficiently has generally not been a critical limiting factor for human civilization historically because an exploitative "frontier" mentality in a largely unpopulated world allowed for the discovery of new resources.[68] The habit of stewardship has been hard to form, and harder still to reconcile with prevailing business models. Therefore, in this sub-section, we explore the issue of resource scarcities and externalized costs as constraints which need to be managed profitably and for the benefit of society as a whole. That takes us to the complex and vast arena of resource efficiency and its economic benefits. Much of what we describe here relates to resource efficiency in production, however, we also explore sustainable consumption as the demand side of the equation, especially in so far as it relates to food.

A key concept for framing the challenges we face in making the transition to a more resource efficient economy is decoupling. As global economic growth bumps into planetary boundaries, decoupling the creation of economic value from natural resource use and environmental impacts becomes more urgent.[69] Recent trends indicate a moderate tendency of relative decoupling over time as a response to scarcity and rising input prices (see Figure 5). The central challenge, however, as we transition to a resource and carbon-constrained world, is to decouple growth absolutely from material and energy intensity. To do so, this section looks at scope for efficiency gains in the most material parts of the economy.

66. *World Energy Outlook 2009: Executive Summary.* International Energy Agency (2009), p. 5.
67. Renewables 2010 *Global Status Report.* REN21 (2010), pp. 38-9.
68. Barbier, E. *Scarcity & Frontiers: How Economies have Developed through Natural Resource Exploitation,* Cambridge University Press (2010), p. 34.
69. *Decoupling the Use of Natural Resources and Environmental Impacts from Economic Activity: Scoping the Challenges.* The International Resource Panel, UNEP (2011).

Figure 5. Global relative decoupling trends (1980-2007).



Source: Sustainable European Research Institute (SERI), 2010. [70]
*Note: This figure illustrates global trends in resource extraction, GDP, population and material intensity in indexed form (1980 equals a value of 100).

Manufacturing faces multiple challenges and opportunities for enhanced resource efficiency. Currently accounting for 23% of global employment, manufacturing represents a key stage in the lifecycle of material use, which begins with natural resource extraction and ends with final disposal.[71] In terms of resource use, the sector is responsible for around 35% of global electricity use,[72] over 20% of world CO_2 emissions, and over a quarter of primary resource extraction.[73] Manufacturing is currently responsible for about 10% of global water demand and this is expected to grow to over 20% by 2030, thereby competing with agriculture and urban uses.[74] As manufacturing expands in developing markets, risks associated with the use of hazardous substances are increasing. Toxicity challenges include the dying and tanning of products, paper bleaching processes, and high temperature processes where the formation of by-products or emissions of metals pose problems. In addition, manufacturing industries account for 17% of air pollution-related health damages, and air pollution damages are equivalent to 1-5% of global GDP[75] – far outweighing the costs of embarking on a green economy transition.

There is abundant evidence that the global economy still has untapped opportunities to produce wealth using less material and energy resources. Greening the manufacturing sector implies extending the useful life of manufactured goods by means of greater emphasis on redesign, remanufacturing and recycling, which constitute the core of closed-loop manufacturing. Redesigning production systems would involve the redesigning of products to extend their useful life by making them easy to repair, recondition, remanufacture and recycle, thereby providing the basis for closed cycle manufacturing. Remanufacturing operations processes, which are based on reprocessing of used products and parts through take-back systems, currently save about 10.7 million barrels of oil each year.[76] Recycling supports the use of byproducts of the production process while also providing alternatives for substitution of inputs in manufacturing. Recycling of materials such as aluminum, for instance, requires only 5% of the energy for primary production. An important and underexploited, near-term opportunity is recycling high temperature waste heat from processes such as coke ovens, blast furnaces, electric furnaces and cement kilns, especially for electric power generation using combined heat and power (CHP).

At a broader level, the development of eco-industrial parks provides a basis for the effective implementation of closed-loop manufacturing at a higher level. All of the industries under the manufacturing sector have significant potential for energy efficiency improvements albeit in varying degree and with varying investment requirements. Looking forward, modelling results indicate that green investments in energy efficiency over the next four decades could reduce industrial energy consumption by almost one half compared to business as usual.

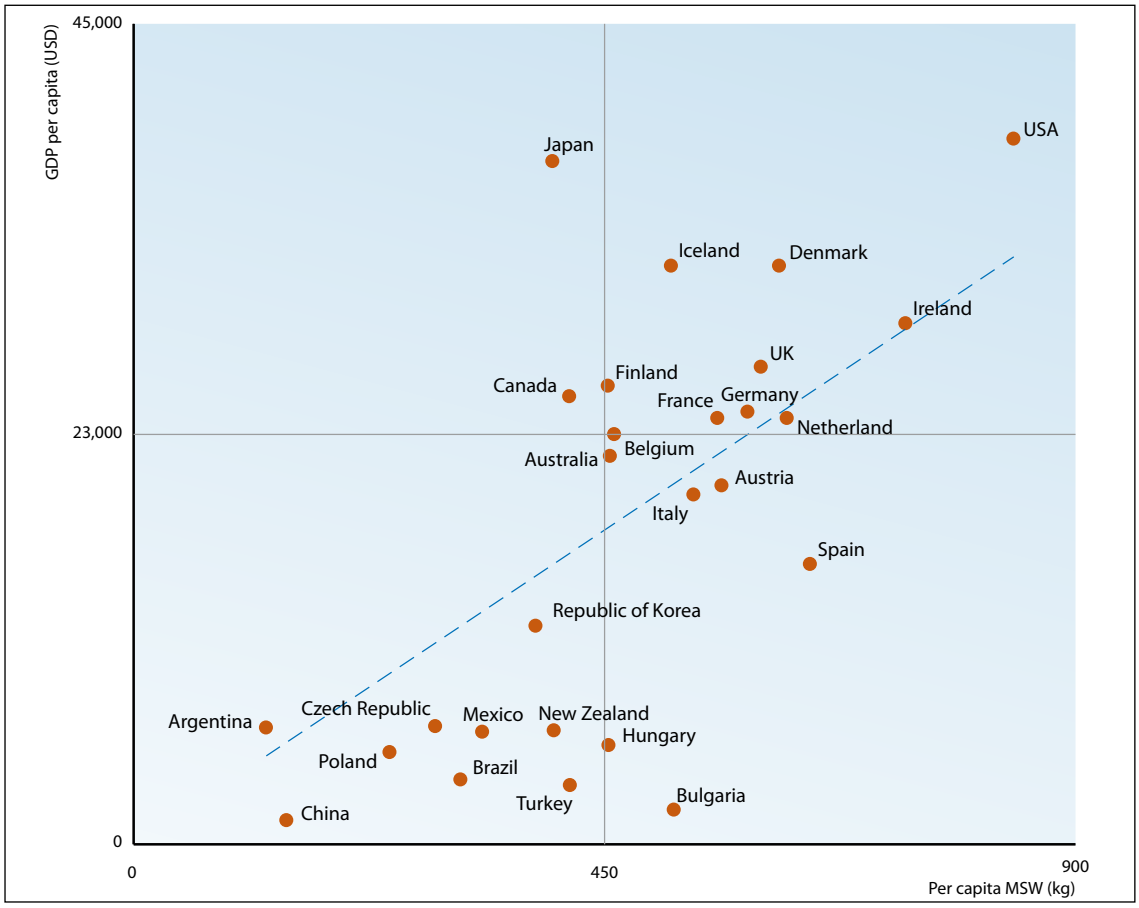
Decoupling waste from economic growth and rising living standards is central to resource efficiency. Current levels of waste are highly correlated with income (see Figure 6). As living standards and incomes rise, the world is expected to generate over 13.1 billion tons of waste in 2050, about 20% higher

70. *Trends in Global Resource Extraction, GDP and Material Intensity 1980-2007.* Sustainable European Research Institute (SERI) (2010), (http://www.materialflows.net/index.php?option=com_content&task=view&id=32&Itemid=48)
71. *World Development Indicators.* World Bank for Reconstruction and Development (WBRD) (2009).
72. *Slicing the Pie: Sector-based Approaches to International Climate Agreements.* World Resources Institute (2007).
73. *Energy Technology Perspectives.* International Energy Agency (IEA). (2008, 2010).
74. *Charting Our Water Future.* Water Resources Group, McKinsey & Company (2009).
75. *World Development Indicators.* World Bank for Reconstruction and Development (WBRD) (2008).
76. Steinhilper R, *Remanufacturing: The Ultimate Form of Recycling.* Stuttgart: Fraunhofer IBC Verlag (1998).

than the amount in 2009. Greater resource efficiency and resource recovery, enabled through smart public policy, can reduce waste flows associated with rising living standards, and avoid future liabilities. Indeed, the scope for recovering waste is large, as currently only 25% of all the waste is recovered or recycled, while the world market for waste, from collection to recycling, is worth an estimated US$ 410 billion a year.[77]

Government regulation and pricing policies play an important role to guide industries and consumers on a more resource-efficient path (see Boxes 4 and 5). Of all the waste streams, waste from electrical and electronic equipment (e-waste) containing new and complex hazardous substances presents the fastest growing challenge in both developed and developing countries. Improvements possible through a green economy would result in near full recycling of e-waste, from a current estimated level of 15%. On a global scale, under the green investment scenario, the recycling rate in 2050 would be more than three times the level projected under business as usual, and the amount of waste destined for landfills would be reduced by more than 85%. In terms of climate benefits, between 20-30% of the landfill methane emissions projected for 2030 could be reduced at negative costs, and 30-50% at costs of less than US$ 20/tCO_2-eq/yr.[79]

Figure 6. GDP per capita vs. municipal solid waste per capita.[78]



Sources: US EPA 2007; Borzino 2002; Kumar and Gaikwad 2004; Methanetomarkets 2005; World Bank 2005; OECD 2008; Yatsu 2010 and GHK 2006.
*Note: US$ 23,000 represents the median point in the GDP data.

77. Chalmin P. and Gaillochet C. *From Waste to Resource: An Abstract of World Waste Survey.* Cyclope, Veolia Environmental Services, Edition Economica (2009). p. 25
78. This figure was generated by using latest available data from 27 countries including developed and developing countries from specified sources (using the GDP and population data for the year for which the latest waste data is available). Population data sourced from http://esa.un.org/unpp/ and GDP data sourced from the World Bank.
79. IPCC (2007). Climate Change 2007: Mitigation of Climate Change AR4, Chapter 10 Waste Management, http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter10.pdf

Box 4. Resource Efficiency and Waste: Examples of Regulation and Pricing Policies

In the Republic of Korea, a policy of Extended Producer Responsibility (EPR) has been enforced on packaging (paper, glass, iron, aluminum and plastic) and specific products (battery, tire, lubricating oil and fluorescent lamp) since 2003. This initiative resulted in recycling of 6 million metric tonnes of waste between 2003 and 2007, increasing the recycling rate by 14% and creating an economic benefit equivalent to US$ 1.6 billion.[80]

In 2003, South Africa introduced a plastic bag levy to reduce unwanted litter. By 2009, in his budget review, the finance minister announced an increase in the levy on plastic bags and the introduction of a levy on incandescent light bulbs at the manufacturing level and on imports. The plastic bag levy was expected to generate US$ 2.2 million in budget revenue while the incandescent light bulb levy was expected to generate an additional US$ 3 million. The South African policy is seen to have inspired other countries such as Botswana to adopt similar regulations.[81]

Box 5. Recycling and Waste: An Example from Brazil

Brazil has a tradition of recycling with recovery levels for many materials matching or exceeding those in industrialized countries. Some 95% of all aluminum cans[82] and 55% of all polyethylene bottles are recycled.[83] About half of all paper and glass is recovered. Recycling in Brazil generates a value of almost US$ 2 billion[84] and avoids 10 million tons of greenhouse gas emissions.[85] In spite of this achievement recyclable material worth about US$ 5 billion goes to landfill.[86] Full recycling would be worth 0.3% of GDP.[87]

Waste management and recycling employ well over 500,000 people in Brazil, mostly as individual waste pickers in informal jobs with low and very unstable incomes and poor working conditions.[88] At the initiative of local governments, some 60,000 recycling workers have been organized into cooperatives or associations and work in formal employment and service contracts.[89] Their income is more than two times higher than that of individual waste pickers, lifting families out of poverty.[90] The National Solid Waste Policy (PNRS) – established by law on 2 August 2010 – aims to build on this potential. It provides for the collection, final disposal and treatment of urban, hazardous and industrial waste in Brazil. The PNRS is the result of a broad consensus based on social dialogue involving the government, the production sector, stakeholders in waste management and academia.

Recycling and energy recovery from waste are becoming more profitable and should continue to do so as waste materials become more valuable resources. Waste can be turned into marketable products, as in the case of the waste-to-energy (WtE) market, which was already estimated at US$ 20 billion in 2008 and is projected to grow by 30% already by 2014.[91] Agricultural residue generated primarily in rural areas amount to 140 billion metric tonnes globally and have an energy potential equivalent to 50 billion metric tonnes of oil.[92] In a green economy scenario, by 2050 all

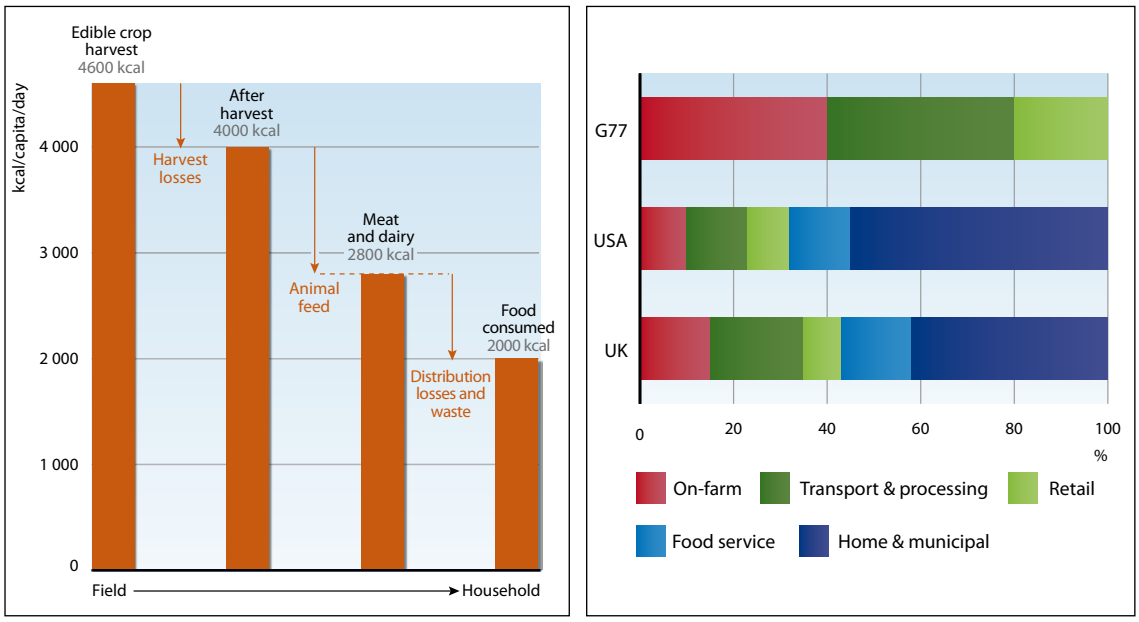
80. Ministry of Environment, Republic of Korea, http://eng.me.go.kr/content.do?method=moveContent&menuCode=pol_rec_pol_rec_sys_responsibility
81. Nahma, Anton. *Food Packaging in South Africa: Reducing, Re-using and Recycling.* Government Digest (February 2010); Hasson, R., Leiman, A. and Visser. M. T*he Economics of Plastic Bag Legislation in South Africa.* South African Journal of Economics (2007), Volume 75, Issue 1, pp. 66-83.
82. *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World,* UNEP (2008), p. 214.
83. Nascimento, Luis Felipe, Marcelo Trevisan, Paola Schmitt Figueiró, and Marilia Bonzanini Bossle. *PET Bottle Recycling Chain: Opportunities for the Generation of Employment and Income.* Greener Management International Issue, 56, No. 56 (2010), p. 44.
84. Oliveira, L., and L. Rosa. *Brazilian Waste Potential: Energy, Environmental, Social and Economic Benefits.* Energy Policy 31, No. 14 (November, 2003), 1481-1491, p. 1486.
85. Ibid., p. 1490.
86. *National Solid Waste Policy – Now it's the Law.* Compromisso Empresarial para Reciclagem (CEMPRE) (2010).
87. Oliveira, L, and L Rosa. *Brazilian Waste Potential: Energy, Environmental, Social and Economic Benefits.* Energy Policy 31, No. 14 (November 2003): 1481-1491, p. 1490.
88. *Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World,* UNEP (2008), p. 17
89. Ibid. p. 215
90. Samson, Melanie. "Formal Integration into Municipal Waste Management Systems." In *Refusing to be Cast Aside: Waste Pickers Organising around the World.* Cambridge, USA: Women in Informal Employment: Globalizing and Organizing (WIEGO) (2009), p. 52.
91. Argus Research Company, Independent International Investment Research Plc and Pipal Research Group 2010.
92. Nakamura T. *Waste Agriculture Biomass Convention,* IETC, The 6th Biomass Asia Workshop in Hiroshima, 18-20 November 2009, http://www.biomass-asia-workshop.jp/biomassws/06workshop/presentation/25_Nakamura.pdf

biomass waste would be composted or recovered for energy.

Reducing waste and increasing efficiency in agricultural and food systems can contribute to securing global food security now and in the future. There is more than enough food produced to feed a healthy global population, but food losses translate the current production of 4,600 kcal per person per day into the availability of 2,000 kcal per person per day for consumption.[93] In the United States, for example, 40% of food worth US$ 48.3 billion is wasted every year, together with embedded 350 million barrels of oil and 40 trillion litres of water per year.[94] Low-income countries tend to suffer significant losses from a lack of storage facilities, on-farm pest infestations, poor food handling and inadequate transportation infrastructure (see Figure 7).

An important and underemphasized strategy to confront the challenge of feeding a growing world population without increasing the environmental burden of production is reducing food waste. Researchers estimate that with the magnitude of losses and the potential gains, a reduction by 50% of losses and wastage in the entire food chain – including agricultural and post-harvest practices – is realistic.[95]

Figure 7. The make-up of total food waste.[96]



*Note: Retail, food service and home and municipal are aggregated for LICs.

93. Adapted from Chalmin P. and Gaillochet C. *From Waste to Resource: An Abstract of World Waste Survey,* Cyclope, Veolia Environmental Services, Edition Economica (2009).
94. *The Environmental Food Crisis.* UNEP (2009), http://www.grida.no/_res/site/file/publications/FoodCrisis_lores.pdf
95. Lundqvist, J., C. de Fraiture and D. Molden. *Saving Water: From Field to Fork – Curbing Losses and Wastage in the Food Chain.* SIWI Policy Brief. Stockholm International Water Institute (2008).
96. The Environmental Food Crisis. UNEP (2009), http://www.grida.no/_res/site/file/publications/FoodCrisis_lores.pdf, p. 30, based on: Lundqvist et al., *Saving Water: From Field to Fork,* (2008), p. 5. Godfray et al., *Food Security: The Challenge of Feeding 9 Billion People* (2010), Science, Vol. 327, No. 5967, pp. 812-818, based on: Cabinet Office, *Food Matters: Towards a Strategy for the 21st Century* (Cabinet Office Strategy Unit, London, 2008); Waste and Resources Action Programme (WRAP), *The Food We Waste* (WRAP, Banbury, UK, 2008); T. Stuart, *Uncovering the Global Food Scandal* (Penguin, London, 2009).

A Green Economy Delivers More Sustainable Urban Living and Low-carbon Mobility

Today's urban areas are home to 50% of the world's population[97] but account for 60-80% of energy consumption and 75% of carbon emissions.[98] Rapid urbanization is exerting pressure on fresh water supply, sewage systems and public health, and often results in poor infrastructure delivery, declining environmental performance and significant costs to public health. Against this backdrop, unique opportunities exist for cities to increase energy efficiency and productivity, reduce emissions in buildings as well as waste, and promote access to key services through innovative, low-carbon transportation modalities – saving money while enhancing productivity and social inclusion.

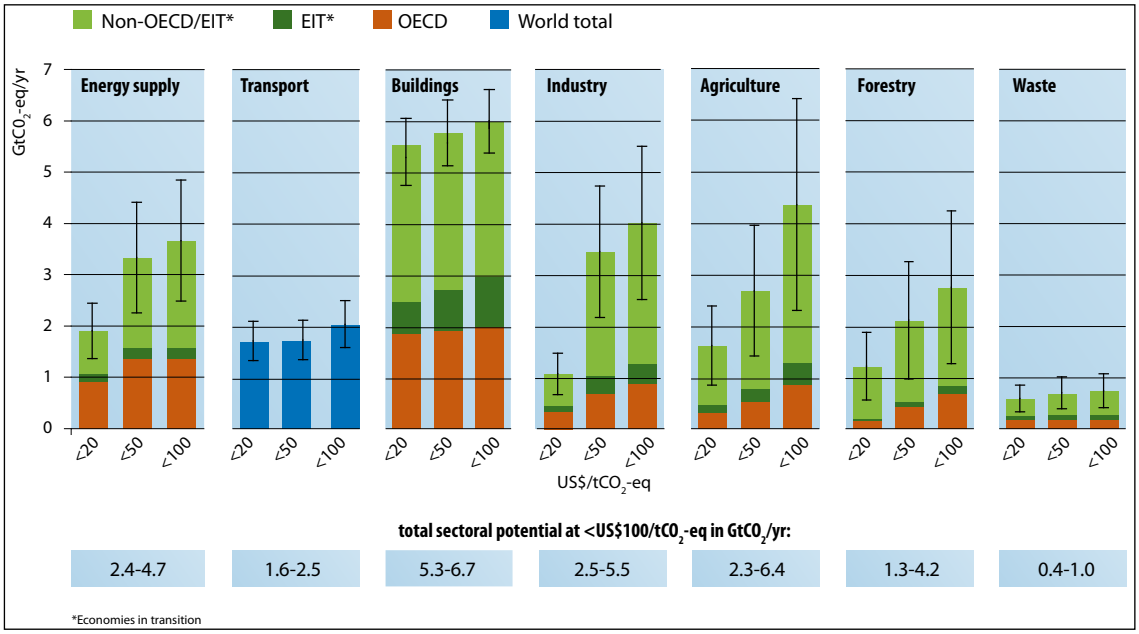
Promoting green cities raises efficiency and productivity. Eco-cities or green cities are typically characterized by higher density of population, housing, employment, commerce, and entertainment facilities, subject to thresholds to avoid congestion. Well connected and designed neighbourhoods of 100 to 1,000 persons per hectare (up to 3,000, depending on culture and geography) allow for effective provision of public transport and are seen as a starting point for green cities.[99] Doubling the employment density of an urban area – and respecting decent work conditions – typically raises labour productivity by around 6%.[100] Infrastructure, including streets, railways, water and sewage systems as well as other utilities comes at a considerably lower cost per person the higher the urban density. A recent study of Tianjin in China concluded that infrastructure cost savings as a result of compact and densely clustered urban development reach 55% compared to a dispersed scenario.[101] As such, there are significant opportunities to capture the potential synergies and efficiencies by integrating sustainability considerations in urban planning processes. Such processes should consider social coherence and urban health issues, which most often are best addressed in the context of green communities/neighbourhoods. To enable cities to capture the green economy potential, it is also important that they are assigned responsibility and develop capacity as implementing agents for national legislation at local levels, with the mandate to enforce stricter conditions than required at national levels if needed.

Cities will see a rapid expansion and increasing investment over the next decades, particularly in emerging economies. For example, India's urban population grew from 290 million in 2001 to 340 million in 2008 and it is projected to reach 590 million in 2030.[102] As a result, India will have to build 700-900 million square metres of residential and commercial space a year to accommodate this growth, requiring an investment US$1.2 trillion to build 350-400 kilometres of subway and up to 25,000 kilometres of new roads per year. Similarly, China's urban population is expected to increase from 636 million in 2010 to 905 million by 2030.[103] It is predicted that by 2050 the country will need to invest 800-900 billion RMB per year to improve its urban infrastructure, about one-tenth of China's total GDP in 2001.[104] How this investment takes place – in transportation networks, access to services, buildings, water and energy systems – will make a crucial difference in avoiding or "locking in" high-carbon infrastructure for the next generation.

As part of the effort to green cities, the impact of buildings is key. The building sector is the single largest contributor to global greenhouse gas emissions (8.6 billion tons CO_2 eqv.), mostly explained by the fact that one-third of global energy end use takes place within buildings.[105] The potential for significant low-cost emission reductions with existing technologies has been confirmed for this sector, as was also reflected in the IPCC AR4 report (see Figure 8). Further, the construction sector is responsible for more than a third of global material resource consumption, including 12% of all fresh water use, and significantly contributes to the generation of solid waste (estimated at 40%). The IPCC high-growth scenario projects the climate footprint of the buildings sector to almost double to 15.6 billion tones CO_2 eqv by 2030 (approximately 30% of total energy related CO_2).[106]

97. Kamal-Chaoui, L. and Robert, A. *Competitive Cities and Climate Change.* OECD Regional Development Working Papers 2009/2. OECD, Public Governance and Territorial Development Directorate.
98. *World Urbanisation Prospects: The 2005 Revision. Executive Summary, Fact Sheets, Data Tables.* UN Department of Economic and Social Affairs, UN Population Division (2006).
99. Hasan, A., Sadiq, A. and Ahmed, S. *Planning for High Density in Low-income Settlements: Four Case Studies from Karachi.* Human Settlements Working Paper Series. Urbanization and Emerging Population Issues 3. IIED and UNFPA (2010), p. 7.
100. Melo, P., Graham, D. and Noland, R.B. *A Meta-Analysis of Estimates of Urban Agglomeration Economies.* Regional Science and Urban Economics (2009), 39:3, pp. 332-342.
101. Webster, D., Bertaud, A., Jianming, C. and Zhenshan, Y. *Toward Efficient Urban Form in China.* Working Paper No. 2010/97. World Institute for Development Economics Research (WIDER). UNU-WIDER (2010), p. 12.
102. *India's Urban Awakening: Building Inclusive Cities, Sustaining Economic Growth.* McKinsey Global Institute (2010).
103. *World Urbanisation Prospects: The 2009 Revision.* UN Population Division, UN Department of Economic and Social Affairs (2010).
104. Chen, H., Jia, B. and Lau, S.S.Y. *Sustainable Urban Form for Chinese Compact Cities: Challenges of a Rapid Urbanized Economy.* Habitat International (2008), 32, 1, pp. 28-40.
105. *Sustainable Building Construction Initiative.* UNEP (2009), http://www.unep.org/sbci/pdfs/UNEPSBCI-GlobalCompactBrochure-Final.pdf [accessed 11 January 2011], p. 1.
106. *IPCC (2007). Climate change 2007: Mitigation of climate change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge; New York.*

Figure 8. IPCC projections of CO_2 mitigation potential in 2030.



Source: IPCC (2007).[107]

Constructing new green buildings and retrofitting existing energy- and resource-intensive buildings stock can achieve significant savings. McKinsey has shown that a reduction of 3.5 gigatons (Gt) of CO_2 emissions can be done at an average abatement cost of negative US$ 35 per ton, applying existing technology and benefitting from the evolution of renewable energy supply.[108] When scaling up these efforts to a global level, various projections, including those by IEA and the modelling done for this report, indicate that investments ranging from US$ 300-1,000 billion (depending on assumptions used) per year up to 2050 can achieve energy savings of about one-third in the buildings sector worldwide compared to projections under business as usual.[109] To realize these benefits, government policy is critical.

The UNEP Sustainable Building & Construction Initiative (SBCI) and partners have demonstrated that among a range of potential policy instruments, the most cost-effective and efficient policies rely on enforcement of sustainable building standards, often supported with economic and fiscal incentives as well as capacity building efforts. Although such instruments come with an additional upfront investment cost for buildings, they normally generate lifecycle savings, through reduced energy use, strengthened household economies and improved environmental health. And apart from energy savings, greening the building sector can also contribute to increased efficiency in the use of materials, land and water, and a reduction of waste and risks associated with hazardous substances. Particularly for developing countries, the sector holds a huge potential to reduce indoor air pollution associated with 11% of human deaths globally each year. For developed economies, a major retrofit programme could boost employment significantly.

With regard to transportation, current modalities based primarily on private motorized vehicles are a major contributor to climate change, pollution, and health hazards. Across and beyond the urban sphere,

107. *Climate Change 2007: Synthesis Report.* IPCC (2007), p. 59.
108. *Averting the Next Energy Crisis: The Demand Challenge.* McKinsey Global Institute (2009).
109. International Energy Agency and Millennium Institute.

transport accounts for more than half of the world's consumption of liquid fossil fuels and nearly a quarter of the global energy-related CO_2 emissions. Studies indicate that the environmental and social costs, in terms of local air pollutants, traffic accidents and congestion, can add up to nearly or over 10% of a region or country's GDP[110]– well beyond the amounts needed to jump start a green economy transition. Policies for greening transport follow three interlinked principles: 1) avoiding or reducing trips through integration of land use and transportation planning, and localized production and consumption; 2) shifting to more environmentally efficient modes such as public and non-motorized transport for passengers and to rail and water transport for freight; and 3) improving vehicle and fuel technology to reduce the negative social and environmental effects from each kilometre travelled. Policies required include land-use planning to promote compact or mass transit corridor-based cities, the regulation of fuel and vehicles, and the provision of information to aid decisions by consumers and industry. Strong economic incentives such as taxes, charges and subsidy reform can also support an increase in cleaner private vehicles as well as a shift to public and non-motorized transport (see Box 6).

Box 6. Examples of Green Transport Policies in Action

Municipalities across the world have employed a range of instruments and policies to enhance the efficiency of their transportation systems and improve their quality of life. In central London, a "congestion charge" reduced daily vehicle journeys by 70,000[111] and CO_2 emissions by 20%.[112] Singapore's Electronic Road Pricing and Vehicle Quota System slowed increasing car use and motorization.[113] Bogota's bus rapid transit system (BRT) is contributing to a 14% drop in emissions per passenger,[114] and as a product of its success BRT has been replicated across the globe in Lagos, Ahmadabad, Guangzhou and Johannesburg. In Europe, cities are following Zurich's example of investing in a tram system as the backbone of urban transport in preference to an expensive underground system.[115] Emissions standards and car-sharing schemes have reduced car dependency[116] while low-emission zones and timed delivery permits have helped reduce congestion and pollution,[117] bringing enhanced productivity and well-being to urban dwellers.

Improving energy efficiency in the transport sector, adopting clean fuel and shifting from private to public and non-motorized transport can deliver significant economic and health benefits. In Europe, analysis indicates that public transport investments yield economic benefits at the regional level more than twice their cost. In Sub-Saharan Africa (SSA), reducing the sulfur content of fuels used for transport could save up to US$ 980 million per year in health and related economic costs.[118] The now well-known example of Curitiba in Brazil, where for example, fuel usage is 30% lower than in the country's other major cities, is inspiring many other city-level initiatives. Taking a global perspective, modelling for the GER indicates that investing 0.34% of global GDP per year over 2010-2050 (starting at about US$ 195 billion) in the transport sector can contribute to reducing oil-based fuel usage as much as 80% below business as usual, while increasing employment by 10%.

A Green Economy Grows Faster than a Brown Economy over Time, while Maintaining and Restoring Natural Capital

One of the key questions in economics focuses on the apparent trade-off between development and

110. Creutzig F & He D. *Climate Change Mitigation and Co-benefits of Feasible Transport Demand Policies in Beijing.* Transportation Research Part D: Transport and Environment. Volume 14, Issue 2 (March 2009), pp. 120-131.
111. *Congestion Charging Central London: Impacts Monitoring.* Second Annual Report. Transport for London (2004).
112. Beevers, S. and Carslaw, D. *The Impact of Congestion Charging on Vehicle Emissions in London.* Atmospheric Environment, 39 (2005), pp. 1-5.
113. Goh, M. *Congestion Management and Electronic Road Pricing in Singapore.* Journal of Transport Geography, 10: 1 (2002), pp. 29-38.
114. Rogat, J., Hinostroza, M. and Ernest, K. *Promoting Sustainable Transport in Latin America through Mass Transit Technologies.* Colloque international Environnement et transports dans des contextes différents, Ghardaïa, Algerie, 16-18 February 2009. Actes, ENP ed., Alger, p. 83-92.
115. EcoPlan (2000). *The Famous Zurich U-Bahn.* [online] (Updated 20 March 2000), http://www.ecoplan.org/politics/general/zurich.htm [accessed 10 December 2010].
116. Nobis, C. *Car Sharing as Key Contribution to Multimodal and Sustainable Mobility Behavior: Carsharing in Germany.* Transportation Research Record: Journal of the Transportation Research Board, 1986 (2006), pp. 89-97.
117. Geroliminis, N. and Daganzo, C. F. *A Review of Green Logistics Schemes Used in Cities Around the World.* UC Berkeley Center for Future Urban Transport: A Volvo Center of Excellence. Institute of Transportation Studies, UC Berkeley (2005).
118. *Sub-Saharan Africa Refinery Project – Final Report.* ICF International (2009), http://www.unep.org/pcfv/PDF/Final_Executive_Summary_6-08-09.pdf

environmental quality. In this section, we look at the opportunities for investing in the transformation of key sectors of the economy to decrease carbon intensity and to improve resource efficiency. It explores the alternatives for a new development pathway, characterized by greater complementarities between, physical, human and natural capital.

To examine the global effects of greening the world economy, the modelling undertaken for the GER analyses the potential macroeconomic impacts of investing 2% of global GDP on an annual basis over the coming decades into both business as usual and green economy scenarios. About half of this green investment is allocated to energy efficiency, particularly buildings, industry and transport, as well as the development of renewable energy sources, given the large potential cost savings and reflecting the international policy priority given to addressing climate change. The remainder is devoted to improved waste management, public transport infrastructure and a range of natural capital-based sectors, such as agriculture, fisheries, forestry and water supply.

The green investment scenario amounts to about US$ 1.3 trillion per year and the breakdown among sectors is presented in detail in Annex I. This also shows how the allocation is comparable to various assessments of investment needs for achieving relevant policy targets, such as halving worldwide energy-related CO_2 emissions by 2050, or reducing deforestation by 50% by 2030.

This green investment scenario is compared to business as usual projections using a global version of the Threshold 21 (T21) simulation model. This model, generally applied at the national level to analyse national development and poverty reduction strategies, directly incorporates the dependence of economic production on natural resources (See Annex II for more details). This characteristic helps to illuminate the medium and long-term implications the stewardship of such resources has for economic and social well-being, and the generation of future wealth and prosperity.

The findings are as follows:

A green investment scenario of 2% of global GDP delivers long-term growth over 2011-2050 that is at least as high as an optimistic business as usual case, while avoiding considerable downside risks such as the effects of climate change, greater water scarcity, and the loss of ecosystem services. Without taking into account the potential negative impacts of climate change or major loss of ecosystem services, global economic growth under business as usual will nonetheless be constrained by increasing scarcity of energy and natural resources. Even with conservative assumptions, a green investment scenario achieves higher annual growth rates within 5-10 years (see Figure 9) and an increase in renewable resource stocks that contribute to global wealth (see Figure 10 and Box 7). By promoting investment in key ecosystem services and low-carbon development, this economic growth is characterized by a significant decoupling from environmental impacts, also illustrated by a considerable decline in the global ecological footprint (see Figure 10 and Annex III). With respect to energy, primary demand returns to current levels by 2050, which is about 40% less than what is expected under business as usual. The combination of demand and supply side measures would reduce energy prices below business as usual in the coming decades, reducing the vulnerability of the global economy to potential energy price shocks, and contributing to stable economic growth. Savings on capital and fuel costs in power generation under the green economy scenario are projected to average about US$ 760 billion per year between 2010 and 2050.

Figure 9. Projected trends in annual GDP growth rate.

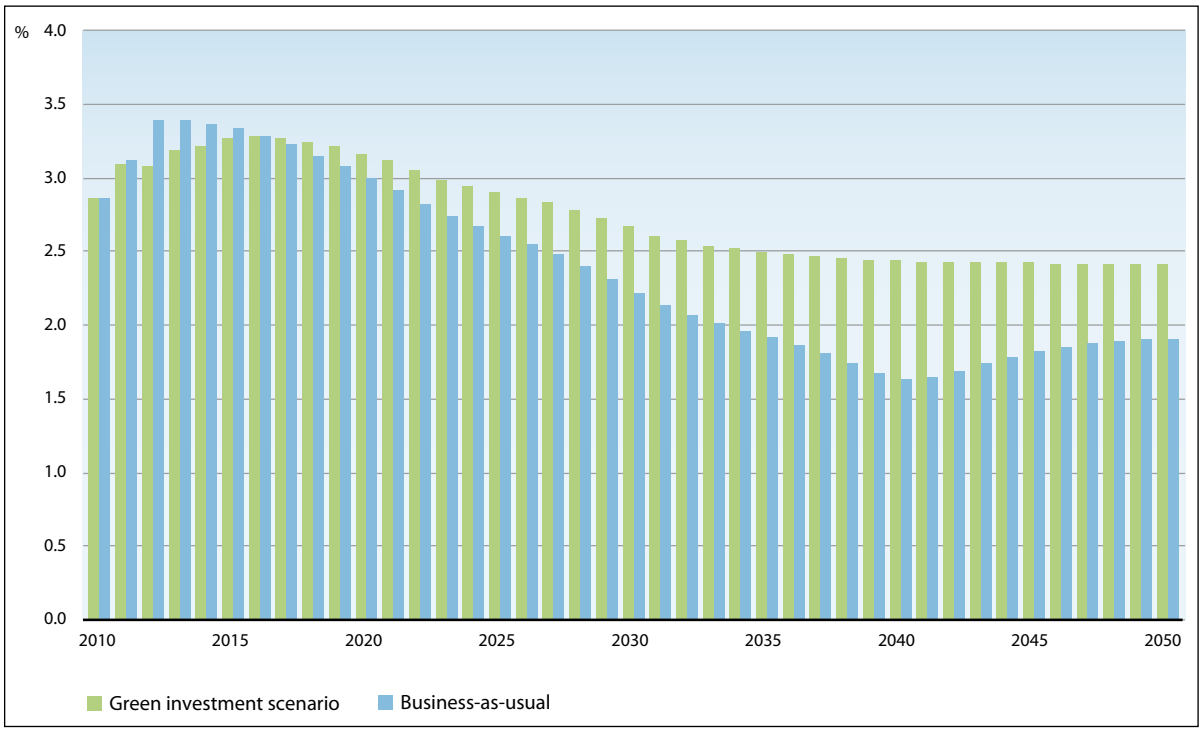
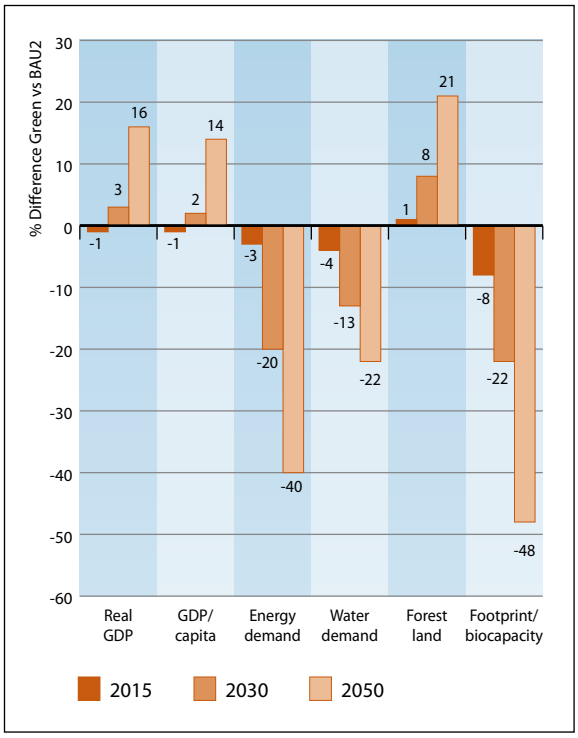


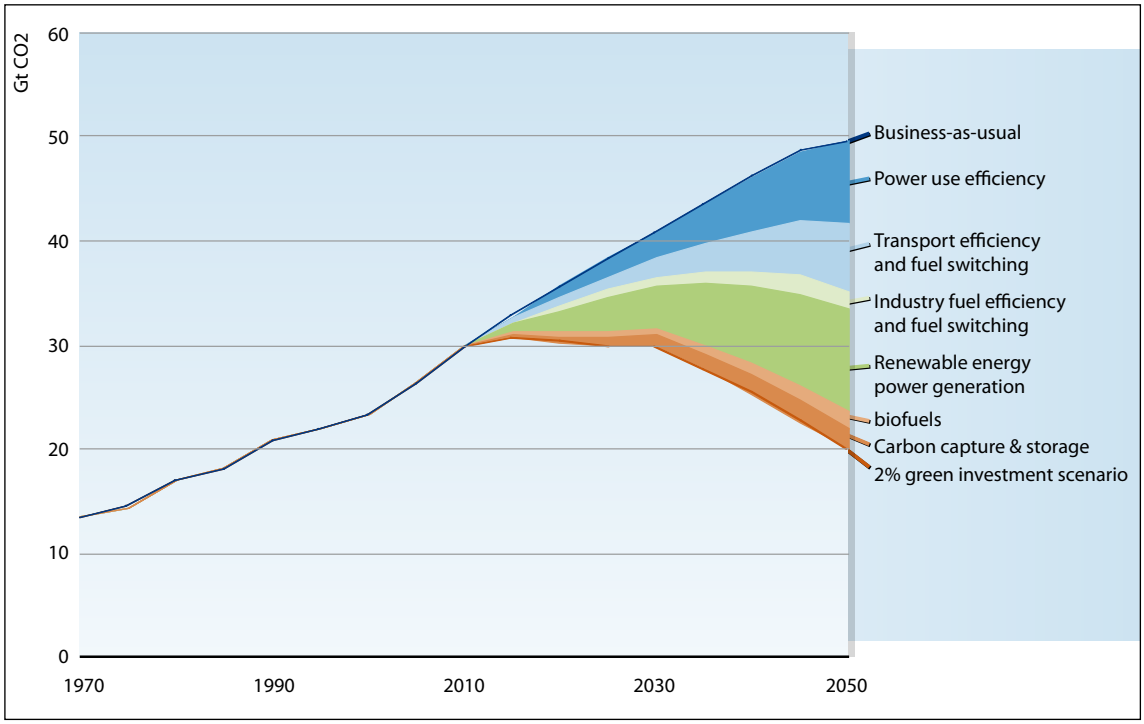
Figure 10. Impacts of the green investment scenario relative to business as usual for selected variables (per cent + / -).



The greening of most economic sectors would reduce GHG emissions significantly. With more than half of the green investment scenario allocated to raising energy efficiency across sectors and expanding renewable energy, including second generation biofuels, global energy intensity would be reduced by about 40% by 2030, and annual volume of energy-related CO_2 emissions would decline to 20 Gt in 2050 from a current level of about 30 Gt (see Figure 11). Together with the potential carbon sequestration of green agriculture, a green investment scenario is expected to reduce the concentration of emissions to 450 ppm by 2050, a level essential for having a reasonable likelihood of limiting global warming to the threshold of 2˚C.

A strategic policy agenda that integrates greening of a range of key economic sectors takes advantage of synergies and promotes long-term growth by mitigating scarcities. Policies that focus only on individual sectors will not benefit from linkages between them. Energy and GHG emissions reduction is a strong example where increasing the use of renewable energy on the supply side is reinforced by energy efficiency measures in key sectors, such as buildings, transport and manufacturing. Additional forestland can positively affect agriculture production and rural livelihoods by improving soil quality and increasing water retention. Integrating recycling and remanufacturing operations can reduce the need for expanding waste management, allowing investments in that sector to concentrate on areas such as waste to energy. Water demand is highly linked to energy use, and the reverse is also true.

Figure 11. Energy-related CO_2 emissions – breakdown of reductions achieved in a 2% green investment scenario relative to baseline business as usual projections.



Box 7. Accounting for Inclusive Wealth

The use of conventional economic indicators, such as GDP and other macroeconomic aggregates, can lead to a distorted picture of economic performance, particularly since such measures do not reflect the extent to which production and consumption activities may be drawing down natural capital. By either depleting natural resources, or degrading the ability of ecosystems to deliver economic benefits, in terms of provisioning, regulating or cultural services, economic activity may be based on the depreciation of natural capital. Future growth may be compromised if alternative investments are insufficient, or if critical thresholds of natural capital are reached, undermining economically important or vital ecosystem services.

Changes in stocks can be evaluated in monetary terms and incorporated into the national accounts, as being pursued in the ongoing development of the System of Environmental and Economic Accounting (SEEA) by the UN Statistical Division, and the adjusted net national savings methods of the World Bank.[119] The wider use of such complementary measures, including net domestic product and genuine savings rates would provide a more accurate and realistic indication of the level of economic output and total inclusive wealth, including stocks of physical, human and natural capital.

The green economy scenario is characterized by investment in and recovery of stocks of renewable natural capital stocks, including fish, forests and soil. Stocks of non-renewable resources, in particular fossil fuels, are drawn down at a slower rate due to efficiency improvements and the development of renewable substitutes, providing a basis for sustained income gains over the medium to longer term. The GER modelling chapter makes some initial attempts to calculate the net genuine savings rate, demonstrating how both stocks of natural capital grow as physical capital also increases under a green investment scenario and breaking with past history.

119. *Where is the Wealth of Nations? Measuring Capital for the 21st Century,* World Bank (2006).

Enabling Conditions

The preceding section outlined the key benefits of moving towards a green economy, in terms of wealth creation, employment, poverty eradication and long-term economic prosperity. In many cases, concrete steps taken by countries to achieve these results were outlined as examples that could be replicated on a wider basis.

The following section takes a broader perspective and suggests a few powerful ideas that have emerged from a review of the policies and actions that have proven successful in promoting a green economic transition. Although a green economic transition will involve many actors, the following points are made with national governments and their policy makers specifically in mind. These key enabling conditions include:

- establishing sound regulatory frameworks;
- prioritizing government investment and spending in areas that stimulate the greening of economic sectors;
- limiting spending in areas that deplete natural capital;
- employing taxes and market-based instruments to shift consumer preference and promote green investment and innovation;
- investing in capacity building and training; and
- strengthening international governance.

The message from these recommendations is clear: concrete policy options for transitioning to a green economy not only exist, they are being implemented by many countries throughout the world. The governments that act early to establish green economy enabling conditions will not only support the transition but will also ensure they are in the best place to take advantage of it. The section closes with a special reference to those policies and conditions required to ensure a "just transition" for all.

Establish Sound Regulatory Frameworks

A well-designed regulatory framework can define rights and create incentives that drive green economic activity as well as remove barriers to green investments. A regulatory framework can regulate the most harmful forms of unsustainable behaviour, either by creating minimum standards or prohibiting certain activities entirely. Moreover, an adequate regulatory framework reduces regulatory and business risks, and increases the confidence of investors and markets. It is often better for businesses to work with clear and effectively enforced standards, and not have to deal with uncertainty or face unfair competition from non-

compliance.[120] Industry self-regulation and voluntary agreements between a government and a business can be a useful complement to government rules and regulations as they take away some of the burden of information and administrative costs from government authorities.

Command and control measures may offer the lowest-cost solution in some cases. While market-based instruments have a well-deserved reputation for efficiency, in some situations command and control measures may offer the lowest-cost solution. For example, there may be no market instrument that can efficiently ensure the elimination of bottom-trawling in fisheries, and the cost-effectiveness of regulation may be preferable where there are opportunities to regulate an industry upstream – such as oil extraction and refining – that can have knock-on effects throughout the supply chain. Depending on the situation, command and control measures can be administratively easier to implement and may pose fewer political challenges. In the short term, for example, it may be easier to establish new energy-efficiency standards and remove obstacles in the planning-permission process of renewable energy projects than to establish a carbon market and eliminate fossil-fuel subsidies.

Standards can be effective tools for achieving environmental objectives and enabling markets in sustainable goods and services. Technical standards (i.e. requirements on products and/or processes and production methods) are mainly developed and implemented at the national level, although for instance standards that aim at enhancing energy efficiency and that set targets for emission reductions, such as those associated with the Clean Development Mechanism under the Kyoto Protocol, are also developed internationally. The requirements may be based on the design or the particular characteristics required, such as many biofuel standards, or they may be performance-based, as is the case with many energy efficiency standards.[121] Mandatory standards in particular can be very effective in achieving a desired outcome. However, it may be difficult to promote action and improvements beyond what the standard requires unlike many market-based instruments, which can be designed to provide a continued incentive to improve. The enforcement of standards can also be an issue if institutions are too weak.

Sustainable public procurement can help create and strengthen markets in sustainable goods and services. Government procurement represents a large proportion of total public spending in both developed and developing countries. In South Africa and Brazil, for instance, the percentages are 35 and 47 of GDP, respectively.[122] By using sustainable public procurement practices, governments can create high-volume and long-term demand for green goods and services. This sends signals that allow firms to make longer term investments in innovation and producers to realize economies of scale, lowering costs. In turn, this can lead to the wider commercialization of green goods and services, promoting sustainable consumption. For example, sustainable public procurement programmes in Austria, Denmark, Finland, Germany, the Netherlands, Sweden and the United Kingdom reduced the CO_2 footprint of procurement by an average of 25%.[123] Public procurement has also helped launch markets in Europe for organic food and drink, fuel-efficient vehicles and sustainable timber products.

Prioritize Government Investment and Spending in Areas that Stimulate the Greening of Economic Sectors

Subsidies that have public-good characteristics or positive externalities can be a powerful enabler for a transition to a green economy. Green subsidies, such as price support measures, tax incentives, direct grants and loan support, may be used for a number of reasons: (a) to act quickly in order to avoid locking in unsustainable assets and systems, or of losing valuable natural capital that people depend on for their livelihoods; (b) to ensure the realization of green infrastructure and technologies, especially those with substantial non-financial benefits or financial benefits that are difficult for private actors to capture; and (c) to foster green infant industries, as part of a strategy to build comparative advantage and drive long-term employment and growth.

Tax incentives can help promote investment in a green economy and mobilize private

120. *The Contribution of Good Environmental Regulation to Competitiveness.* Network of Heads of European Environment Protection Agencies, (November 2005), p. 2.
121. *Trade and Climate Change.* WTO-UNEP (2009), p. 119.
122. *Building Accountability and Transparency in Public Procurement.* IISD (2008), p. 1.
123. *Collection of Statistical Information on Green Public Procurement in the EU: Report on Data Collection Results.* Pricewaterhouse Coopers, Significant and Ecofys (2009), pp. 5-7.

finance. Such incentives can target either the consumption or the production of goods or services. A number of municipalities in India, for instance, have established a rebate in the property tax for users of solar water heaters. In some cases this rebate is 6-10% of the property tax.[124] Accelerated depreciation, another type of tax reduction, is often used to encourage the production of energy from renewable sources. It allows an investor to depreciate the value of eligible fixed assets at a higher rate, which reduces the investor's taxable income. In Mexico, investors in environmentally sound infrastructure have benefited from accelerated depreciation since 2005.[125]

Price support measures and net metering have been successfully used to promote renewable energy technologies. Price support, usually in the form of a subsidy or price control, guarantees the market price of a particular good or service and provides the long-term security required by private sector investors. The most common and high profile of these, as highlighted in the key findings, is the use of feed-in tariffs to promote the deployment and development of renewable energy technologies. Many governments are also using "net metering" to provide incentives to small-scale renewable power generation. Under a net metering system, if the amount of power that a consumer's renewable energy equipment supplies to the national electricity grid is greater than the amount the consumer takes from the grid, the consumer receives a credit for that amount on future energy bills. Net metering is common within the United States and has also been adopted in Mexico and Thailand.[126]

Government spending should be time-bound. Once they have been created, subsidies can be difficult to remove as recipients have a vested interest to lobby for their continuation. In general, governments can try to keep expenses to a minimum by designing subsidies with cost control in mind. For example, depending on the support mechanism, this might include regular programme reviews, with agreed conditions for adjustment, as well as caps on total spending and clear sunset mechanisms.[127] IEA analysis of subsidies for renewable energy suggests that, where countries aim to stimulate private investment in a sector, it is important that the support is stable and predictable, gives certainty to investors, and is phased out over time in order to motivate innovation.[128]

Limit Government Spending in Areas that Deplete Natural Capital

Many subsidies represent a significant economic and environmental cost to countries. Artificially lowering the price of goods through subsidization encourages inefficiency, waste and over use, leading to the premature scarcity of valuable finite resources or the degradation of renewable resources and ecosystems. For instance, global subsidies to fisheries have been estimated at US$ 27 billion annually,[129] at least 60% of which have been identified as harmful, and are thought to be one of the key factors driving over-fishing. It is estimated that depleted fisheries result in lost economic benefit in the order of US$ 50 billion per year, more than half the value of global seafood trade.[130]

Subsidies reduce the profitability of green investments. When subsidization makes unsustainable activity artificially cheap or low risk, it biases the market against investment in green alternatives. Fossil fuel consumption subsidies were an estimated US$ 557 billion worldwide in 2008 and production subsidies accounted for an additional US$ 100 billion.[131] By artificially lowering the cost of using fossil fuels, such subsidies deter consumers and firms from adopting energy efficiency measures that would otherwise be cost effective in the absence of any subsidies. There is consensus that these subsidies pose a significant barrier to the development of renewable energy technologies.[132] It is estimated that phasing out all fossil fuel consumption and production subsidies by 2020 could result in a 5.8% reduction in global

124. *Annual Report 2009-10.* Ministry of New and Renewable Energy of India, para. 5.17.
125. *Accelerated Depreciation for Environmental Investment* (Depreciación acelerada para inversiones que reportan beneficios ambientales). OECD-IEA, Climate Change Database.
126. *Trade and Climate Change.* WTO-UNEP (2009), p. 115.
127. Victor, D. *The Politics of Fossil-Fuel Subsidies.* IISD and GSI (2009), p. 27.
128. *Deploying Renewables: Principles for Effective Policies.* OECD-IEA (2008), p. 23.
129. Sumaila, U.R., Khan, A.S., Dyck, A.J., Watson, R., Munro, G., Tyedmers, P., and Pauly, D. *A Bottom-Up Re-estimation of Global Fisheries Subsidies.* Journal of Bioeconomics 12: 201-225 (2010), pp. 213, 201-202.
130. *The Sunken Billions – The Economic Justification for Fisheries Reform.* World Bank-FAO (2009), p. xvii.
131. *Analysis of the Scope of Energy Subsidies and Suggestions for the G20 Initiative.* IEA, OPEC, OECD and World Bank (2001), p. 4.
132. *Reforming Energy Subsidies: Opportunities to Contribute to the Climate Change Agenda.* UNEP (2008), p. 32.; *International Trade and Climate Change: Economic, Legal and Institutional Perspectives.* World Bank (2008), p. 12.; el Sobki, M, Wooders, P., & Sherif, Y. *Clean Energy Investment in Developing Countries: Wind Power in Egypt.* IISD (2009), p. 8.

primary energy demand and a 6.9% fall in greenhouse gas emissions.[133]

Subsidy reform is possible if done with careful attention to the poorest communities. Removing subsidies is challenging given the vested interests in their maintenance, but there are numerous examples of countries that have undertaken reform processes (see Box 8). Subsidies are sometimes justified with the argument that they benefit low-income households, but unless the aid is targeted, the majority of the spending often flows to higher-income households.[134] That said, subsidy reform will often lead to increases in the prices of subsidized goods. Although low-income groups typically benefit from only a small share of subsidies, they spend a larger proportion of their income on basic goods, including food, water and energy, and can be disproportionately affected if subsidies for these goods are removed.[135] Given this, a gradual reform strategy with short-term support measures is required. Such a reform strategy could include, among other things, the use of targeted consumption subsidies to poor households or the redirection of funds into high-priority areas for public spending, such as health care or education.[136]

Box 8. Energy Subsidy Reform: Some Examples

Cash transfers. When Indonesia reduced its energy subsidies and raised fuel prices in October 2005, the government established a year-long programme to transfer unconditional quarterly payments of US$ 30 to 15.5 million poor households.[137] Considering its quick implementation, the programme is considered to have operated well.[138] The same move was taken when fuel prices were raised in May 2008, with US$ 1.52 billion being allocated to cash transfers to low-income households.[139] The proxy means testing method that was used to identify poor households when reforming subsidies was subsequently used in the government's design and trial of an ongoing conditional cash transfer programme – the Hopeful Family Program (Program Keluarga Harapan), intended to increase the education and health of poor communities.[140] Payments are made to female household heads through post offices on the condition that they meet requirements to use health and education services.[141]

Microfinance. In Gabon, the impact of subsidy reform was offset by using liberated revenue to help fund microcredit programmes for disadvantaged women in rural areas.[142]

Basic services. When Ghana reformed its fuel subsidies, fees for attending primary and junior secondary schools were eliminated and the government made extra funds available for primary health care programmes concentrated in the poorest areas (IMF, 2008).[143]

Employ Taxes and Market-based Instruments to Promote Green Investment and Innovation

Taxes and market-based instruments can be an efficient means of stimulating investments. Significant price distortion exists that can discourage green investments or contribute to the failure to scale up such investments. In a number of economic sectors, such as transportation, negative externalities such as pollution, health impacts or loss of productivity, are typically not reflected in costs, thereby reducing the incentive to shift to more sustainable goods and services. The situation for waste is similar, where the full cost associated with the handling and disposal of waste is usually not reflected in the price of a product or waste disposal service. A solution to this problem is to incorporate the cost of the externality in the price of a good or service via a corrective tax, charge or levy or, in some cases, by using other market-based instruments, such as tradable permit schemes (see Box 9).

133. *Analysis of the Scope of Energy Subsidies and Suggestions for the G20 Initiative.* IEA, OPEC, OECD and World Bank (2010), p. 4.
134. *Reforming Energy Subsidies: Opportunities to Contribute to the Climate Change Agenda.* UNEP (2008), p. 17.
135. *Fuel and Food Price Subsidies: Issues and Reform Options.* IMF (2008), p. 25.
136. Ibid., p. 30.
137. Bacon, R. and Kojima, M. *Coping with Higher Oil Prices,* ESMAP (2006), p. 93.
138. Ibid.
139. *Lessons Learned from Indonesia's Attempts to Reform Fossil-Fuel Subsidies.* IISD (2010), p. 10.
140. Ibid., p. 24.
141. Hutagalung, S., Arif, S., & Suharyo, W., *Problems and Challenges for the Indonesian Conditional-Cash Transfer Programme – Program Keluarga Harapan (PKH),* (2009), p. 6.; Bloom, K., *Conditional Cash Transfers: Lessons from Indonesia's Program Keluarga Harapan.* Asian Development Bank presentation (2009), p. 8.
142. *Fuel and Food Price Subsidies: Issues and Reform Options.* IMF (2008), p. 30.
143. Ibid.

Taxes often provide clear incentives to reduce emissions, use natural resources more efficiently and stimulate innovation. Environmentally related taxes can be broadly broken down into two categories: "polluter pays" focused on charging producers or consumers at the point that they are responsible for the creation of a pollutant; and "user pays", which focuses on charging for the extraction or use of natural resources. Singapore, for instance, introduced the world's first road charging scheme in the 1980s and is now in the forefront of using pricing tools to deal with waste and water issues. Placing a price on pollution has also been found to stimulate innovation and use of new technologies as firms seek out cleaner alternatives. For instance, in Sweden the introduction of a tax on NOx emissions led to a dramatic increase in the adoption of existing abatement technology – from 7% of the firms adopting the technology prior to the tax to 62% the following year.[144]

Box 9. Eco-taxes: A Double Dividend for Jobs and the Environment

Eco-taxes are designed to put a price on the pollution and the use of scarce natural resources and to stimulate employment creation by reducing the cost of labour in the form of taxes and social security contributions. An ILO study analysed the impact of an eco-tax on the global labour market. It found that imposing a price on carbon emissions and using the revenue to cut labour costs by lowering social security contributions would create 14.3 million net new jobs over a period of five years, which is equivalent to a 0.5% rise of world employment.[145]

In 1999, the German government increased taxes for engine fuels, electricity, oil and gas in small foreseeable steps up to 2003. The revenue was directly used to reduce non-wage labour costs by lowering the social partner's contribution to the pension fund. An impact study by the German Institute for Economic Research finds that if the modest eco-tax had not been introduced, the contribution to the pension fund would be 1.7% higher.[146] The effect of reduced non-wage labour costs is estimated to have created an additional 250,000 full time equivalent jobs[147] and reduced CO_2 emissions by 3% in 2010.[148]

Opportunities offered by environmentally related taxes are accessible to all countries. Many developing countries are increasingly focusing on implementing levies on natural resource extraction, including charges on forest resources, license-based fees for fisheries, and taxes on extracting mineral and petroleum resources. Environmentally related taxation on some level has been used successfully by countries around the world since the 1970s and 1980s, including China, Malaysia, the Philippines, Tanzania and Thailand.[149]

Market-based instruments, such as tradable permits, are powerful tools for managing the "economic invisibility of nature" and are being increasingly used to address a range of environmental issues. As opposed to taxes, which fix a price for pollution and then allow the market to determine the level of pollution, tradable permits schemes, including cap-and-trade systems, first establish an overall level of pollution allowed and then let the open market determine the price. The Kyoto Protocol, for instance, provides countries with the ability of trading emissions reduction credits. In total, 8.7 billion tonnes of carbon was traded in 2009 with a value of US$ 144 billion.[150]

Markets establishing "payments" for providing ecosystem services can influence land-use decisions by enabling landholders to capture more of the value of these environmental services. It has been estimated that hundreds of millions of dollars are currently being invested in payments for ecosystem services schemes (PES) – such as carbon sequestration, watershed protection, biodiversity benefits and landscape beauty – that range from the local level to national and even global schemes.[151] As the contribution of deforestation and forest degradation to greenhouse

144. *Taxation, Innovation and the Environment: Executive Summary.* OECD (2010), p. 6.
145. *World of Work Report 2009: The Global Jobs Crisis and Beyond.* ILO (2009), p. x.
146. Knigge, M. & Görlach, B. *Effects of Germany's Ecological Tax Reforms on the Environment, Employment and Technological Innovation.* Ecologic Institute for International and European Environmental Policy, (2005), p. 5.
147. Ibid., p. 8.
148. Kohlhaas, M., *Gesamtwirtschaftliche Effekte der ökologischen Steuerreform.* DIW Berlin (2005), pp. 13-14.
149. Bluffstone, R., *Environmental Taxes in Developing and Transition Economies.* Public Finance and Management, 2 (1), 143-175, (2003), pp. 11-14.
150. *State and Trends of the Carbon Market 2010.* World Bank (2010), p. 1.
151. *Global Green New Deal: Policy Brief.* UNEP (2009), p. 24.

gas emissions has become better understood, the potential to create an international PES scheme related to forests and carbon has become a key focus of international climate negotiations. The scheme, referred to as REDD (reducing emissions from deforestation and degradation) and more recently as REDD+, which adds conservation, sustainable management of forests and enhancement of forest carbon stocks to the list of eligible activities, represents a multi-layer PES scheme with transfers of finance between industrialized countries and developing countries in exchange for emission reductions, and further transfers from the national level to forest landowners and communities.[152] Scaling up this financing option is explored further in the following section.

Invest in Capacity Building, Training and Education

The capacity to seize green economic opportunities and implement supporting policies varies from one country to another, and national circumstances often influence the readiness and resilience of an economy and population to cope with change. A shift towards a green economy could require the strengthening of government capacity to analyse challenges, identify opportunities, prioritize interventions, mobilize resources, implement policies and evaluate progress. For instance, environmentally related taxes have been used with success by a number of developing countries. Nevertheless, the implementation and administration of such taxes may present challenges, and enhancing the administrative capacity of a country may be required. To sustain the momentum of a green economy transformation, governments also need to be able to measure the progress being achieved. This would require the capacity to develop indicators, collect data, and analyse and interpret results for guiding policy development.

Training and skill enhancement programmes are needed to prepare the workforce for a green economy transition. A shift to a green economy by definition entails some degree of economic restructuring, and measures may be required to ensure a just transition for affected workers. In some sectors, support will be needed to shift workers to new jobs. In the fisheries sector, for example, fishermen may need to be trained for alternative livelihoods, which could include participation in a rebuilding of fisheries stocks. Investing in the re-skilling of the workforce may also be necessary. In Germany, for example, the renewable energy industry has been experiencing a shortage of skilled workers. In fact, almost all energy sub-sectors lack skilled workers with the most pronounced shortage found in the hydro, biogas and biomass sectors. The shortage is also pressing for manufacturing in the renewable energy industry, particularly for engineers, operation and maintenance staff and site management.

Inter-governmental organizations, international financial institutions, non-governmental organizations, the private sector and the international community as a whole can play a critical role in providing technical and financial assistance in developing countries. Enabling a smooth transition to a green economy will require a sustained international effort by a variety of actors. In this regard, current levels of overseas development assistance may be insufficient and need to be re-evaluated in light of the scale of transformation required. Additionally, the United Nations and its partners will need to mobilize around its long history of supporting national capacity building and training activities, and utilize this expertise to support national green economy efforts. South-South cooperation is likely to be important: many developing country experiences and successes in achieving a green economy can provide valuable impetus, ideas and means for other developing countries to address similar concerns – particularly given the impressive gains and leadership that have been demonstrated in practice.[153] South-South cooperation can thus increase the flow of information, expertise and technology at a reduced cost. More broadly, as countries take steps towards a green economy, formal and informal global exchanges of experiences and lessons learned can prove a valuable way to build capacity.

Strengthen International Governance

International environmental agreements can facilitate and stimulate a transition to a green economy. For instance, multilateral environmental

152. See http://www.un-redd.org/AboutREDD/tabid/582/Default.aspx and related links.
153. *Green Economy Success Stories from Developing Countries.* UNEP (2010), p. 6.

agreements (MEAs), which establish the legal and institutional frameworks for addressing global environmental challenges, can play a significant role promoting green economic activity. The Montreal Protocol on the Substances that Deplete the Ozone Layer, which is widely considered to be one of the most successful MEAs, is a case in point. The Protocol led to the development of an entire industry focused on the replacement and phase out of ozone-depleting substances. Of course, the MEA with the most potential to influence the transition to a green economy is the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC's Kyoto Protocol has already stimulated growth in a number of economic sectors, such as renewable energy generation and energy efficient technologies, in order to address greenhouse gas emissions. At a global level, the renewal of a post-Kyoto framework for carbon will be the single most significant factor in determining the speed and scale of the transition to a green economy.

An active role by governments in international processes can promote coherence and collaboration in the transition to a green economy. The United Nations Conference on Sustainable Development (Rio +20) summit in 2012 will provide an invaluable opportunity for the international community to promote green economy action given that one of the two themes for the summit is "a green economy in the context of sustainable development and poverty eradication."[154] The commitment and action by governments, business, international organizations and other stakeholders over the next two years will determine whether the summit provides the impetus and direction required for driving the transition. In preparation for accelerating national-level green economy action, the United Nations Environmental Management Group is coordinating with 32 international organizations to develop an inter-agency assessment on how the expertise of the different UN agencies, funds and programmes can contribute directly to supporting countries in the transition to a green low-carbon economy.[155]

The international trading system can have significant influence on green economic activity, enabling or obstructing the flow of green goods, technologies and investments. If environmental resources are properly priced at the national level, then the international trading regime allows countries to sustainably exploit their comparative advantage in natural resources that benefits both the exporting and importing country. Water-scarce regions, for instance, can relieve pressure on local supplies by importing water-intensive products from water-abundant regions. As noted previously, trade-related measures, such as standards, can also play an important role in driving growth in a number of sectors in a green economy. However, such measures could also be perceived by countries as a challenge to market access or a form of trade protectionism. It is therefore crucial for countries to combine and balance environmental protection with safeguarding market access.

The current World Trade Organization Doha Round negotiations offer the opportunity to promote a green economy. A successful conclusion of these negotiations could contribute to a green economic transition. For example, negotiations are currently focused on the removal of fisheries subsidies, which often contribute directly to overfishing. Another opportunity exists with respect to the current negotiations aimed at reducing tariff and non-tariff barriers on environmental goods and services. A World Bank study found that trade liberalization could result in a 7-13% increase in trade volumes in these goods.[156] Finally, the ongoing negotiations to liberalize trade in agriculture are expected to lead to a reduction in agricultural subsidies in some developed countries that should stimulate more efficient and sustainable agricultural production in developing countries. It is essential, nonetheless, that developing countries are supported through capacity building to fully exploit the potential gains from trade liberalization, particularly in the context of a transition to a green economy.

154. A/RES/64/236, para. 20(a).
155. *Terms of Reference for the Issue Management Group on a Green Economy.* Environment Management Group, 12 February 2010, para. 6.
156. *Warming Up to Trade: Harnessing International Trade to Support Climate Change Objectives.* World Bank (2007), pp. 69, 94.

Financing the Green Economy Transition

While the scale of financing required for a green economy transition is substantial, it can be mobilized by smart public policy and innovative financing mechanisms. The rapid growth of capital markets, the growing green orientation of these markets, the evolution of emerging market instruments such as carbon finance and microfinance, and the green stimulus funds established in response to the economic slowdown of recent years, are opening up the space for large-scale financing for a global green economic transformation. But these flows are still small compared to total volumes, and urgently need to be scaled up if the transition to a green economy is to happen in the near term. Concentrated pools of assets, such as those controlled by long-term investors, such as public financial institutions, development banks, sovereign wealth funds as well as some pension funds and insurance funds, whose liabilities are not due for payment on a short-term basis, will be needed to transform our economy. This final section examines the most promising mechanisms for mobilizing finance at scale to drive the green economy transition in the coming decades.

There is no complete estimate of funds needed to green the entire global economy, but the amounts involved are substantial. Existing estimates focus on what is needed for achieving CO_2 emission reduction targets, such as the IEA's Blue Map scenario of halving worldwide energy-related CO_2 emissions by 2050.[157] It requires investments of US$ 46 trillion higher than what is required in the baseline scenario, or approximately US$ 750 billion per year from 2010 to 2030 and US$ 1.6 trillion per year from 2030 to 2050. The World Economic Forum and Bloomberg New Energy Finance, on the other hand, calculate that clean energy investment needs to rise to US$ 500 billion per year by 2020 to restrict global warming to less than 2°C, while HSBC estimates that transition to a low-carbon energy market will require US$ 10 trillion between 2010 and 2020.

These indicative amounts correspond, on average, to the scenarios modelled for the Green Economy Report. An assessment made by the Green Economy team at UNEP, based on key sectoral investment requirements to achieve both the IEA's Blue Map scenario as well as the MDGs, came to a range US$ 1.05 trillion to US$ 2.59 trillion annually at the outset (see Annex I). On average, these additional investments amounted to 2% of global GDP per year over 2010-2050, across a range of sectors to build capacity, adopt new technologies and management techniques, and scale up green infrastructure. For the sectors covered, the estimate for the lower range of annual investment (2011-2050) stands at US$ 1.3 trillion a year and rises as global GDP increases. This additional investment is substantial, but an order of magnitude smaller than global gross capital formation, which stood at 22% of global GDP in 2009.[158]

The financial services and investment sectors control trillions of dollars and are positioned to provide the bulk of financing for a green economy transition. Long-term institutional investors such as pension funds and insurance companies are increasingly seeing the potential for minimizing environmental, social and governance (ESG) risks by building up "green" portfolios (see Box 10) – a move that can be supported by defining a regulatory framework that encourages long term investment as well as integrated and sustainability reporting on progress in applying ESG criteria.[159] Similarly, commercial and retail banks are increasingly bringing ESG considerations into lending policies and in designing "green" financial products. In the renewable energy sub-sector, for example, around US$ 627 billion of private capital had already been invested between 2007 and mid-2010. This market saw a three-fold increase in investment from US$ 46 billion in 2004 to US$ 173 billion annually in 2008.[160]

157. The International Energy Agency's Blue Map scenario is described in *Energy Technology Perspectives 2010: Scenarios & Strategies to 2050.*
158. World Development Indicators (2010), p. 256.
159. See: www.globalreporting.org and www.integratedreporting.org
160. *Global Trends in Sustainable Energy Investment 2010: Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency.* UNEP/Bloomberg New Energy Finance (2010), p. 5.

Box 10. An Example of Long-term Investing: The Norwegian Pension Fund Global

The Norwegian Pension Fund Global, one of the largest sovereign wealth funds in the world, has a broad ownership in more than 8,400 companies worldwide. The pension fund is largely passively invested and holds an average ownership share of 1% in each company it is invested in. As a universal owner, the fund seeks to ensure that good corporate governance and environmental and social issues are duly taken into account. Fiduciary responsibility for the pension fund includes safeguarding widely shared ethical values. In the area of environmental issues, including climate change mitigation and adaptation, the Norwegian Finance Ministry has established a new investment programme for the fund, which will focus on environmental investment opportunities, such as climate-friendly energy, improving energy efficiency, carbon capture and storage, water technology, and the management of waste and pollution.[161] The investments will have a clear financial objective. At the end of 2009, over NOK 7 billion had been invested under this programme, a faster escalation than originally assumed.[162]

Public financing, however, is essential for jump-starting a green economic transformation. The important role of public finance in supporting a green economy was demonstrated by the green components of the massive fiscal stimulus packages launched by G20 countries in responding to the financial and economic crisis, which broke out in 2008.[163] Out of the estimated US$ 3.3 trillion in stimulus funds, almost 16%, or US$ 522 billion, was initially allocated towards green investments.[164] These investments are not confined to short-term responses to the financial and economic crisis, however, and new thought is being given beyond the recovery to ensuring a lasting transition. For example, during the 12th five-year plan period starting 2011, the Chinese government will invest US$ 468 billion in green sectors compared to US$ 211 billion over the last five years, with a focus on three sectors: waste recycling and reutilization; clean technologies; and renewable energy. With this amount of public investment, China's environmental protection industry is expected to continue growing at an average of 15-20% 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.[165]

In countries where public financing based on tax revenues and governments' ability to borrow from capital markets are constrained, reform of subsidies and taxation policies can be used to open fiscal space for green investments. Subsidies in the areas of energy, water, fisheries and agriculture, for example, reduce the prices and encourage excessive use of the related natural capital. At the same time, they impose a recurrent burden on the public budget. Phasing out such subsidies and introducing taxes on the use of energy and natural resources can enhance efficiency while strengthening public finance and freeing up resources for green investments. Removing subsidies in these four sectors alone, for example, would save between 1-2 % of global GDP every year.

At the global level, the emergence of major green funding mechanisms is needed. At the Climate Conference in Cancun in December 2010, a process was established to design a Green Climate Fund. This is a welcome first step in devising an international mechanism to fund a low-carbon, green economy transition. The conference decisions included US$ 30 billion in fast start finance from developed countries to developing countries for climate action up to 2012, and the plan to jointly raise US$ 100 billion per year by 2020.[166] These resources are urgently needed and can form the nucleus of an international fund to support a green economy transition in low-income countries. But countries must begin to deliver on their promises.

Additional financing mechanisms will be needed to maintain global natural capital. Apart from climate financing, the UN-REDD Programme – an initiative launched in September 2008 by FAO,

161. *GPFG Responsible Investment*, Norwegian Ministry of Finance (2010), http://www.regjeringen.no/upload/FIN/brosjyre/2010/spu/english_2010/index.htm
162. "The National Budget for 2011", Norwegian Ministry of Finance (2010), http://www.regjeringen.no/upload/FIN/brosjyre/2010/spu/english_2010/index.htm
163. Barbier, Edward. *A Global Green New Deal: Rethinking the Economic Recovery.* University Press, Cambridge, UK (2010).
164. Barbier, Edward. *Green Stimulus, Green Recovery and Global Imbalances.* World Economics (2010) 11(2):149-175.
165. *Annual Report 2009.* Beijing: China Development Bank Corporation (2010), p. 55.
166. UNFCCC press release, 12 December 2010, http://unfccc.int/files/press/news_room/press_releases_and_advisories/application/pdf/pr_20101211_cop16_closing.pdf; World Bank Green Bonds, http://treasury.worldbank.org/cmd/htm/WorldBankGreenBonds.html

UNDP and UNEP in support of national efforts to reduce deforestation and forest degradation and enhance forest carbon stocks – along with other REDD+ mechanisms can provide an important vehicle to drive the green economy transition. Donor pledges to REDD+, including the UN-REDD Programme, REDD+ Partnership, Forest Carbon Partnership Facility, the GEF and the Forest Investment Programme among others, currently amount to US$ 5 billion through 2012.[167] As part of ongoing pilots for REDD+, there is mounting evidence that such "payment for environmental services" holds wider promise not only for climate regulation and biodiversity conservation services, but also to scale up significant resources to communities who are stewards at the landscape level. The Global Environment Facility (GEF) is another important financing vehicle for the green economy that needs to be scaled up and strengthened.

In addition to these mechanisms, development finance institutions at international and national levels will play a key role in supporting the green economy. These institutions include multilateral development banks such as the World Bank and regional/sub-regional development banks, bilateral development assistance agencies such as KFW of Germany and Caisse des Depots and AFD of France, and national development banks such as BNDES from Brazil, DBSA from South Africa and CDB from China. In 2009, multilateral development finance institutions committed US$ 168 billion in development assistance, whereas national development banks and bilateral agencies provided over US$ 350 billion in 2008.[168]

The role of these institutions in supporting a green economy transformation could be strengthened further. They could, for instance, adopt the goal of supporting green economy development and link it to specific targets such as CO_2 emissions reduction, access to water and sanitation, biodiversity promotion, on top of poverty alleviation. They could also measure the net contribution of their activities to climate change, biodiversity loss and the green economy at large. Policies can be designed to improve the "green efficiency" of their portfolio, examining for example the carbon and ecological «footprint» of their investments. In addition, these institutions also influence the nature of investments and public financing through loans agreements and due diligence in their lending procedures. They can jointly define protocols for green due diligence and standards and goals for sectors in which they have major influence such as municipal finance, transport, and energy. Domestic development banks can also play a major role in developing and sharing new ways of addressing the green role of municipalities as well as greening the housing sector.

Finally, stable and resilient capital markets, supported by productive processes of investment and financial intermediation, will have a pivotal role in the provision of capital at sufficient scale for the delivery of a green economy. It is clear that across banking, investment and insurance – the core activities of the financial system – significant changes in philosophy, culture, strategy and approach, notably the overwhelming dominance of short-termism, will be required if capital and finance is to be reallocated to accelerate the emergence of a green economy. At the same time, fundamental aspects of international accounting systems and capital market disciplines, as well as our understanding of fiduciary responsibility in investment policy-making and investment decision-making, will need to evolve to fully integrate a broader range of ESG factors than takes place at present. Without these changes, the pricing signals and incentives that would support the transition to a green economy will remain weak.

167. http://www.un-redd.org/NewsCentre/COP16_Press_Release_en/tabid/6595/Default.aspx
168. Figures on multilateral funding are based on World Development Indicators 2010, World Bank; figures on bilateral funding are based the websites of the bilateral agencies covered. They include:
http://www.afd.fr/jahia/Jahia/site/afd/lang/en/pid/11118,
http://www.bndes.gov.br/SiteBNDES/bndes/bndes_en/Institucional/The_BNDES_in_Numbers/Annual_Report/,
http://www.caissedesdepots.fr/en/the-group/who-are-we/key-figures.html,
http://www.cdb.com.cn/english/Column.asp?ColumnId=91,
http://www.dbsa.org/(S(4ilhomm44linm35501iztz45))/InvestorRelations/Pages/default.aspx,
http://www.eib.org/about/publications/annual-report-2009-activity.htm,
http://www.halkbank.com.tr/channels/10.asp?id=385,
http://www.jica.go.jp/english/publications/reports/annual/2009/index.html,
http://www.kfw-entwicklungsbank.de/EN_Home/KfW_Entwicklungsbank/Our_bank/Key_figures.jsp

Conclusions

Moving towards a green economy has the potential to achieve sustainable development and poverty eradication on a scale and at a speed not seen before. This potential derives, essentially, from a changed playing field: our world, and the risks we face, have materially changed, and require a fundamental rethinking of our approach to the economy.

As this report has argued, a reallocation of public and private investments – spurred through appropriate policy reforms and enabling conditions – is needed to build up or enhance natural capital such as forests, water, soil and fish stocks, which are particularly important for the rural poor. These "green" investments will also enhance new sectors and technologies that will be the main sources of economic development and growth of the future: renewable energy technologies, resource and energy efficient buildings and equipment, low-carbon public transport systems, infrastructure for fuel efficient and clean energy vehicles, and waste management and recycling facilities. Complementary investments are required in human capital, including greening-related knowledge, management, and technical skills to ensure a smooth transition to a more sustainable development pathway.

One of the major findings of this report is that a green economy supports growth, income and jobs, and that the so-called "trade-off" between economic progress and environmental sustainability is a myth, especially if one measures wealth inclusive of natural assets, and not just narrowly as produced output. The results of the report indicate that while in the short term economic growth under a "green" scenario may be less than under business as usual, in the longer term (2020 and beyond), moving towards a green economy would outperform business as usual by both traditional measures and more holistic measures.

The report also finds that in a number of important sectors, such as agriculture, buildings, forestry and transport, a green economy delivers more jobs throughout the short, medium, and long terms than business as usual. In sectors whose capital is severely depleted, such as fisheries, greening will necessitate the loss of income and jobs in the short and medium term to replenish natural stocks, but this is to prevent the permanent loss of income and jobs in these same sectors. In such cases, transitional arrangements are needed to protect workers from negative impacts on their livelihoods.

Although the bulk of the investments required for the green transformation will come from the private sector, public policy will also have a leading role to play in overcoming distortions introduced by perverse subsidies and externalized costs. And public investment will be required to jump-start an effective transition to a green economy.

While private capital is many times more than the financial resources available from the public sector, many developing countries have limited access to it. A large part of the funds needed for green investments at scale in the initial stages of the transition towards a green economy, therefore, need to come from new innovative financing mechanisms. In this regard, the new Green Climate Fund and nascent REDD+ funding mechanisms offer significant hope for achieving the finance required at scale for an effective green economy transition. Where national budgetary conditions are limited, multilateral development banks are ideally positioned to offer financial assistance to enable these countries to embark on a green development trajectory.

In summary, a green economy values and invests in natural capital. Ecosystem services are better conserved, leading to improved safety nets and household incomes for poor rural communities. Ecologically friendly farming methods improve yields significantly for subsistence farmers. And improvements in freshwater access and sanitation, and innovations for non-grid energy (solar electricity, biomass stoves, etc) add to the suite of green economy strategies, which can help alleviate poverty.

A green economy substitutes clean energy and low-carbon technologies for fossil fuels, addressing climate change but also creating decent jobs and reducing import dependencies. New technologies promoting energy and resource efficiency provide growth opportunity in new directions, offsetting "brown economy" job losses. Resource efficiency becomes a driving proposition – both energy and materials use – be it in better waste management, more public transportation, green buildings or less waste along the food chain.

Regulations, standards and targets are important to provide direction. However, developing countries must be allowed to move at their own speed, respecting their development objectives, circumstances and constraints. Developed nations have a key role to play in building skills and capacity in developing countries, and in creating international market and legal infrastructure for a green economy.

Enabling conditions have to be managed and adequate finance provided for successful transitioning

to a green economy, but both are eminently achievable. Environmentally and socially harmful subsidies are a deterrent, and they should be phased out. In select circumstances and over defined periods however, rational use of subsidies can facilitate the transition to a green economy. Taxes and other market-based instruments can be used to stimulate the necessary investment and innovation for funding the transition. And while the scale of financing required for a green economy transition is large, it can be mobilized by smart public policy and innovative financing mechanisms.

A green economy can generate as much growth and employment as a brown economy, and outperforms the latter in the medium and long run, while yielding significantly more environmental and social benefits. Of course, there are many risks and challenges along the way. Moving towards a green economy will require world leaders, civil society and leading businesses to engage in this transition collaboratively. It will require a sustained effort on the part of policy makers and their constituents to rethink and redefine traditional measures of wealth, prosperity and well-being. However, the biggest risk of all may be remaining with the status quo.

Annex I: Annual Green Economy Investment (by sector)

SECTOR	GER INVESTMENT ALLOCATION 2011 (US$ bn/yr; see Note 1)	INVESTMENT NEEDS ASSESSMENT (US$ bn/yr; see Note 1)	DETAILS
Agriculture	108		Target: increase nutrition levels to 2800-3000 Kcal/person by 2030 (and maintain)
Buildings	134		Target: increase energy efficiency to reach energy consumption and emissions targets set in IEA's Blue Map scenario
		308	IEA ETP 2010 Blue Map scenario, additional (see Notes 3 and 4)
Energy (supply)	362		Target: increase penetration of renewables in power generation and primary energy consumption to at least reach targets set in IEA's Blue Map scenario
		233	IEA ETP 2010 Blue Map scenario, additional (see Notes 3 and 4)
		500	New Energy Finance and World Economic Forum (2010) estimate of annual spending on clean energy that is necessary by 2020 to restrict the increase in global average temperatures to 2°C
		611	EREC and Greenpeace Energy [R]evolution (2010) Advanced Revolution scenario estimate of average global investment in renewable energy to 2007-2030 (see Note 5)
		460-–1,500	HSBC (2010) estimate of total investments in low-carbon energy generation (supply) and energy efficiency and management (demand) required to build a low-carbon energy market by 2020 (see Note 6)
Fisheries	108		Achieve maximum sustainable yield by an aggregate world cut in fishing effort of 50% by decommission of vessels, reallocation of labour force and fisheries management
		90–280	Same (from GER fisheries chapter analysis)
Forestry	15		Target: 50% reduction in deforestation by 2030 as well as increase planted forests to sustain forestry production
		37	Effective management of the existing network of protected forests and 15% of land area in each region (Balmford et al 2002) – adjusted for inflation
		2–30	REDD+ (more an assessment of potential flow of funds)
Industry	76		Target: increase energy efficiency to reach energy consumption and emissions targets set in IEA's Blue Map scenario
		50–63	IEA ETP 2010 Blue Map scenario, additional (see Notes 3 and 4)
Tourism	134		
Transport	194		Target: increase energy efficiency to reach energy consumption and emissions targets set in IEA's Blue Map scenario, and expand public transport
		325	IEA ETP 2010 Blue Map scenario, additional (see Notes 3 and 4)
Waste	108		Target: reduce the amount of waste going to landfills by at least 70%
Water	108		Target: meet MDG to halve the number of people without access to water and sanitation by 2015, plus reduce water intensity (without quantitative target)
		18	Meet MDG to halve the number of people without access to water and sanitation by 2015 (Hutton and Bartram 2008)
		50	Meet world's water needs (2030 Water Resources Group, McKinsey)
Total	**1,347**	**1,053–2,593**	**(see Note 2)**

Notes:
1. All amounts are annual investment figures; GER investment allocation in 2010 US dollars; IEA investment needs are in 2007 US dollars (difference should be considered negligible relative to imprecision of estimates). The GER investment portfolio allocates investments totalling 2% of global GDP across the range of given sectors, with a number of specific sectoral targets, which are described in the details column. These will rise over the period 2011-2050 as economic growth proceeds to reach US$ 3.9 trillion in 2050 (in constant 2010 US dollars). Investment needs are assessments generally taken from other sources, but many of which have influenced the allocation of the GER investment portfolio, especially the IEA.

2. For the investment assessment under the right-hand column, the range of total investments corresponds to the sums of low and high estimates per sector.

3. Most IEA figures are simple average of estimated total investment over 2010-2050; it appears though that lower investments are projected for earlier years, and higher figures for later years.

4. The figures for the IEA Energy Technology Perspectives (2010) Blue Map Scenario represent only the additional investment, totalling an average of US$ 1.15 trillion per year, and do not include the projected investments for the reference scenario, which involves investments to meet increased energy demand through a continuation of existing investment trends.

5. The European Renewable Energy Council and Greenpeace's Advanced [R]evolution scenario has a key target for the reduction of CO_2 emissions down to a level of around 10 Gt per year by 2050, and a second objective of phasing out of nuclear energy. The [R]evolution scenario has similar targets, but assumes a technical lifetime of 40 years for coal-fired power plants, instead of 20 years; the estimated average global investment needed for this scenario is US$ 450 billion.[169]

6. These estimates are for HSBC's Conviction scenario, which projects «the most likely pathway to 2020».It sees the EU meeting renewable targets but not energy efficiency targets, limited growth in clean energy in the US, and China exceeding current clean energy targets. This scenario does not correspond to any specific climate policy target. In addition to supply of low-carbon energy, this estimate also includes energy efficiency investments that would be undertaken in transport, buildings and industry sectors. In terms of the breakdown, HSBC estimates that US$ 2.9 trillion will be required between 2010 and 2020 in total for low-carbon energy supply and US$ 6.9 trillion for energy efficiency and management.

169. *Energy [R]evolution: A Sustainable World Energy Outlook, 3rd Edition*, European Renewable Energy Council and Greenpeace (2010).

Annex II: The Threshold 21 (T21) Model[170]

The T21 model was developed to analyse strategies for medium to long-term development and poverty reduction, most often at the national level, complementing other tools for analysing short-term impacts of policies and programmes. The model is particularly suited to analysing the impacts of investment plans, covering both public and private commitments. The global version of T21 used for purposes of the GER models the world economy as a whole to capture the key relationships between production and key natural resource stocks at an aggregate level.

The T21 model reflects the dependence of economic production on the "traditional" inputs of labour and physical capital, as well as stocks of natural capital in the form of resources, such as energy, forest land, soil, fish and water. Growth is thus driven by the accumulation of capital – whether physical, human or natural – through investment, also taking into account depreciation or depletion of capital stocks. The model is calibrated to reproduce the past 40-year period of 1970-2010, and simulations are conducted over the next 40-year period, 2010-2050. Business as usual projections are verified against standard projections from other organizations, such as the United Nations Population Division, World Bank, OECD, IEA, and FAO.

The inclusion of natural resources as a factor of production distinguishes T21 from essentially all other global macroeconomic models.[171] Examples of the direct dependence of output (GDP) on natural resources are the availability of fish and forest stocks for the fisheries and forestry sectors, as well as the availability of fossil fuels to power the capital needed to catch fish and harvest timber, among others. Other natural resources and resource efficiency factors affecting GDP include water stress, waste recycle and reuse, and energy prices.

In purposely ignoring issues such as trade and sources of investment financing (public vs private, or domestic vs foreign), the analysis with T21 of the potential impacts of a green investment scenario at a global level are not intended to represent the possibilities for any specific country or region. Instead, the simulations are meant to stimulate further consideration and more detailed analysis by governments and other stakeholders of a shift to a green economy.

170. This section draws from the modelling chapter authored by Andrea Bassi of the Millennium Institute.
171. A recent review of macroeconomic models by Cambridge Econometrics (2010) highlights this general deficiency. Pollitt, et al. *A Scoping Study on the Macroeconomic View of Sustainability.* Final report for the European Commission, DG Environment, Cambridge Econometrics and Sustainable Europe Research Institute (July 2010), http://ec.europa.eu/environment/enveco/studies_modelling/pdf/sustainability_macroeconomic.pdf.

Annex III: Impacts of Allocating an Additional 2% of GDP towards Greening the Global Economy Relative to 2% in Business as usual

	2011	2015		2020		2030		2050	
		BAU2	Green (%)	BAU2	Green (%)	BAU2	Green (%)	BAU2	Green (%)
GDP (US$, real)	69,344	79,306	-0.8	92,583	-0.4	119,307	2.7	172,049	15.7
GDP per capita	9,992	10,959	-0.8	12,205	-0.4	14,577	2.4	19,476	13.9
Total employment (millions)	3,187	3,419	0.6	3,722	-0.6	4,204	-1.5	4,836	0.6
Calories per capita	2,787	2,857	0.3	2,946	0.3	3,050	1.4	3,273	3.4
Forest land (Bn ha)	3.94	3.92	1.4	3.89	3.2	3.83	7.9	3.71	21.0
Water demand (km3/Yr)	4,864	5,275	-3.7	5,792	-7.2	6,784	-13.2	8,434	-21.6
Total landfill (Bn tons)	7.88	8.40	-4.9	9.02	-15.1	10.23	-38.3	12.29	-87.2
Footprint/biocapacity ratio	1.51	1.60	-7.5	1.68	-12.5	1.84	-21.5	2.23	-47.9
Primary energy demand (Mtoe/Yr)	12,549	13,674	-3.1	15,086	-9.1	17,755	-19.6	21,687	-39.8
Renewable energy share of primary demand (%)	*13*	*13*	*15*	*13*	*17*	*12*	*19*	*12*	*27*

Notes: All dollar figures are in constant 2010 US dollars. "Green" column represents the percent difference (+/-) of the green investment scenario relative to business as usual projections, in which an additional 2% of global GDP is allocated to extend existing investment trends, except for rows where the units are in percentage terms. In this case the "green" column refers to the percentage value under the green investment scenario. For a full explanation of the business as usual and green investment scenarios, see the GER modelling chapter.

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