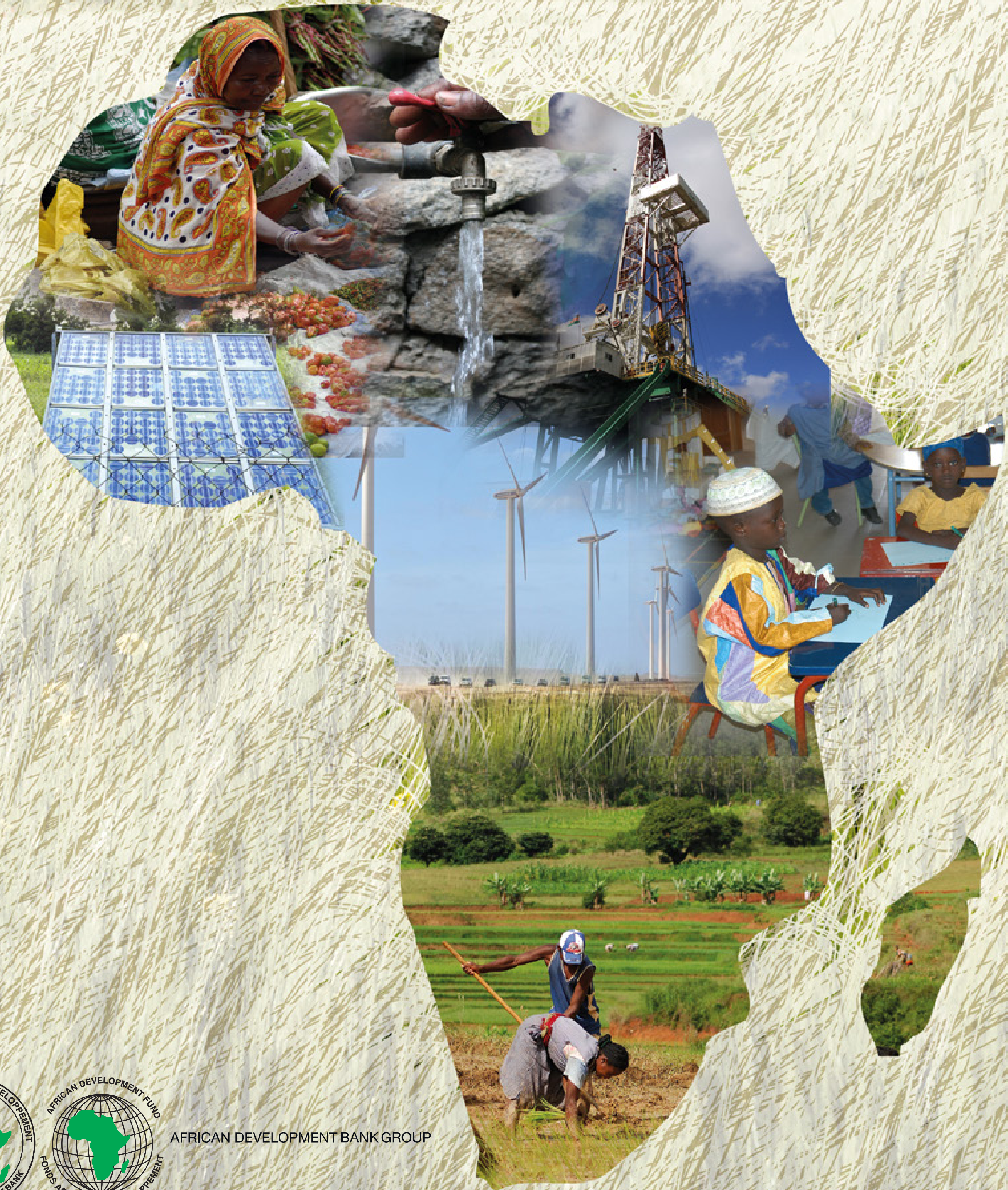
African Development Report 2012

Towards Green Growth in Africa



AFRICAN DEVELOPMENT BANK GROUP

African Development Report 2012

Towards Green Growth in Africa

Temporary Relocation Agency (TRA)
Angle de l'Avenue du Ghana et des rues Pierre de Coubertin et Hédi Nouira
B.P. 323-1002 Tunis-Belvedere, Tunisia
Tel: (216) 7110-2876
Fax: (216) 7183-5705
Email: economic-research@afdb.org / afdb@afdb.org
Website: www.afdb.org

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Foreword

Africa's robust economic growth, averaging five percent a year over the last ten years, has placed the continent among the fastest growing regions in the world. During the past decade, poverty rates on the continent have declined and the attainment of other MDG targets is within sight.

Although headcount poverty rates have decreased, Africa is still a poor continent and rapid economic growth has not reduced inequality. Hunger remains widespread on the continent, especially in sub-Saharan Africa, while access to energy is inadequate. Environmental and socioeconomic changes present further challenges for Africa. Notably, climate change, global population growth and shifting consumption patterns are putting additional pressure on Africa's natural resources.

Viable solutions to these and future challenges are anchored on growth pathways that encourage efficient and sustainable management of natural assets; are less carbon-intensive than conventional pathways; and ensure that the benefits of growth are shared equitably to ensure poverty reduction, reduce income inequalities, and improve livelihoods.

The African Development Bank has placed inclusive growth and the transition to green growth at the center of its new Ten-Year Strategy (2013-2022). The transition to green growth is part of a broader push for quality of growth and is focused on empowering African countries to reach their development objectives in a more resource efficient, sustainable and resilient manner. The Report underpins the Bank's emphasis on strengthening the robustness, sustainability and inclusiveness of growth on the continent in a time of rapid change. It provides innovative analytical perspectives and critical inputs into the discussion of what green growth means for Africa's development.

Donald Kaberuka
President,
African Development Bank Group

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Abbreviations

ADB	Asian Development Bank
AERC	African Economic Research Consortium
AfDB	African Development Bank
AICD	Africa Infrastructure Country Diagnosis
AR4	Fourth Assessment Report of the Intergovernmental Panel on Climate Change
ASTI	Agricultural Science and Technology Indicators
ASSA	Allied Social Science Associations
AU	African Union
AU/NEPAD	African Union's New Partnership for Africa's Development
AWF	Africa Water Facility
AWDR	African Water Development Report
BAU	Business as Usual
BBLS	Billion Barrels
BCM	Billion Cubic Meters
BP	British Petroleum
BRICs	Brazil, Russia, India and China
CAADP	Comprehensive Africa Agriculture Development Program
CAR	Central African Republic
CBFM	Community-based Forest Management
CCS	Carbon Capture and Storage
CDE	Center for Development and Environment
CDM	Clean Development Mechanism
CFLs	Compact Fluorescent Lamps
CGIAR	Consultative Group on International Agricultural Research
CHP	Combined Heat and Power
CIC	Climate Innovation Center
CIF	Climate Investment Fund
CIFOR	Center for International Forestry Research
CO_2	Carbon Dioxide
CO_2eq	Carbon Dioxide Equivalent
COPD	Chronic Obstructive Pulmonary Disease
CPV	Concentrating Potovoltaic
CSP	Concentrating Solar Thermal Power
CSPs	Country Strategic Papers
CSTM	Center for Studies in Technology and Sustainable Development
DALYs	Disability-Adjusted Life Year
DEWA	Division of Early Warning and Assessment
DFID	Department for International Development
DRC	Democratic Republic of Congo
DWAF	Department of Water Affairs and Forestry
ECN	Energy Research Center of the Netherlands
ECOWAS	Economic Community of West African States
EE	Energy Efficiency
EEZ	Exclusive Economic Zone
EGS	Engineered Geothermal Systems
EI	Energy Institute
EITI	Executive Industries Transparency Initiative
EMBO	European Molecular Biology Organization
ENERGIA	International Network on Gender and Sustainable Energy
EPO	European Patent Office
EPOPA	Export Promotion of Organic Products from Africa
ESW	Economic Sector Works
FAC	Future Agricultures Consortium
FAO	Food and Agriculture Organization
FCO	Foreign and Commonwealth Office
FDI	Foreign Direct Investment
FIFA	Fédération Internationale de Football Association
FIG	Fédération Internationale des Géomètres (International Federation of Surveyors)
FISP	Farm Input Subsidy Program
FITs	Feed-In Tariffs
FPAN	Forests Philanthropy Action Network
FTE	Full-Time Equivalent
GCMs	General Circulation Models
GDP	Gross Domestic Product

GEA	Global Energy Assessment
GEF	Global Environment Facility
GGGI	Global Green Growth Institute
GGKP	Green Growth Knowledge Platform
GHG	Greenhouse Gas
GHI	Global Hunger Index
GHP	Geothermal Heat Pumps
GIGA	German Institute of Global and Area Studies
GIZ	Gesellschaft für Internationale Zusammenarbeit (German Agency for International Coorporation)
GLASOD	Global Assessment of Soil Degradation
GMOs	Genetically Modified Organisms
GoE	Government of Ethiopia
GSI	Global Subsidy Initiative
GTZ	Deutche Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation)
GVEP	Global Village Energy Partnership
GW	Gigawatt
GWP	Global Water Partnership
HEDON	Household Energy Network
IAASTD	International Assessment of Agricultural Knowledge, Science and Technology for Development
IAHS	International Association of Hydrological Sciences
ICLEI	International Council for Local Environmental Initiatives
ICROFS	International Center for Research in Organic Food Systems
ICTSD	International Center for Trade and Sustainable Development
IDS	Institute of Development Studies
IAAE	International Association of Agricultural Economists
IEA	International Energy Agency
IEG	Independent Evaluation Group-World Bank
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IFPRI	International Food Policy Research Institute
IFRI	Institut Français des Relations Internationales
IISD	International Institute for Sustainable Development
IIT	Indian Institute of Technology
IMF	International Monetary Fund
IMT	Irrigation Management Transfer
IPCC	Intergovernmental Panel on Climate Change
IPRs	Intellectual Property Rights
IREDA	Indian Renewable Energy Development Agency
IRENA	International Renewable Energy Agency
ITF	International Transport Forum
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resource Management
KfW	Kreditanstalt für Wiederaufbau
kW	kilowatt
LDCs	Least Developed Countries
LED	Light Emitting Diode
Lm/W	Lumens per Watt
LPG	Liquefied Propane Gas
LPI	Logistics Performance Index
MDG	Millennium Development Goals
MEA	Millennium Ecosystem Assessment
MFIs	Micro-finance Institutions
MLD	Mean Log Deviation
MOFED	Ministry of Finance and Economic Development Ethiopia
MVP	Millennium Villages Project
MW	Megawatt
MWh	Megawatt per hour
NBER	National Bureau of Economic Research
NEPAD	New Partnership for Africa's Development
NGO	Non-governmental Organization
NPA	New Petroleum Authority
NRW	Non-Revenue Water
NTFPs	Non-timber Forest Products
O&M	Operations and Maintenance
ODA	Official Development Assistance
ODI	Overseas Development Institute
OECD	Organisation for Economic Cooperation and Development
ONEC	Environment and Climate Change Department
OWAS	Water and Sanitation Department
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PES	Payment for Ecosystem Services

PFM	Participatory Forest Management
PIDA	Program for Infrastructure Development in Africa
POST	Parliamentary Office of Science and Technology
PPM	Parts per Million
PPP	Public-Private Partnerships
PRSP	Poverty Reduction Strategy Paper
PV	Photovoltaic
PVMTI	Photovoltaic Market Transformation Initiative
R&D	Research and Development
RECs	Regional Economic Communities
REDD	Reducing Emissions from Deforestation and Forest Degradation
REEEP	Renewable Energy and Energy Efficiency Partnership
RET	Renewable Energy Technology
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture
RWH	Rainwater Harvesting
SADC	Southern African Development Community
SEA	Strategic Environmental Assessment
SEEP	The Small Enterprise Education and Promotion
SEFA	Sustainable Energy Fund for Africa
SEI	Stockholm Environment Institute
SHSs	Solar Home Systems
SIDS	Small Island Developing States
SME	Small- And Medium- Enterprise
SPRU	Science and Technology Policy Research,University of Sussex
SREP	Scaling-Up Renewable Energy Program
SSA	Sub-Saharan Africa
SSA_SDM	Sub-Saharan Africa Summary for Decision Makers
STEPS	Social, Technological and Environmental Pathways to Sustainability
STP	Sao Tome and Principe
TCF	Trillion Barrels of Cubic Feet
TERI	The Energy and Resources Institute
TFCG	Tanzania Forest Conservation Group
TNA	Technology Needs Assessment
TRIPS	Trade Related Aspects of Intellectual Property Rights
TSAs	Tourism Satellite Accounts
TT	Technology Transfer
TWh	Terawatt per Hour
UNCSD	United Nations Conference on Sustainable Development
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Program
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Program
UNEP/SEI	United Nations Environment Program/ Stockholm Environment Institute
UNEP-WCMC	United Nations Environment Program-World Conversation Monitoring centre
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UN-HABITAT	United Nations Human Settlements Program
UNIDO	United Nations Industrial Development Organization
UNU-WIDER	United Nations University- World Institute for Development Economics Research
VERs	Voluntary Emission Reduction
WAEMU	West Africa Economic and Monetary Union
WAMU	West African Monetary Union
WCMC	World Conversation Monitoring Centre
WC/WDM	Water Conservation and Water Demand Management
WDI	World Development Indicators
WDM	Water Demand Management
WHO	World Health Organization
WTO	World Trade Organization
WUA	Water Users' Associations
WWAP	World Water Assessment Program
WWF	World Wildlife Fund

Executive Summary

Towards Green Growth

Green growth in Africa encompasses the achievement of critical development objectives while seeking to maximize efficient use of natural resources, minimize waste and pollution, and enhance the resilience of livelihoods. In this regard, the main objective of the African Development Report 2012 is to explore the rationale for green growth in Africa's development process.

The 21st century presents a number of challenges for Africa. These include climate change, population growth, and the combined influence of these factors on energy transformation and agricultural markets. In particular, climate change poses a threat to Africa's economic growth by compounding existing effects of natural and human actions, and by introducing new risks. The effects of climate change are already evident and it is now well established that human activities are the predominant cause. Africa emits less than 4 percent of global greenhouse gases (GHGs) but due to its high climate sensitivity and relatively low adaptive capacity, it is widely viewed as the most vulnerable to the resulting increase in temperature. Managing the risk associated with climate change could therefore significantly improve Africa's resilience and accelerate the pace of development.

Africa's population is growing, creating both opportunities and challenges. With a large population, Africa can harness and build on the expanded work force to spur economic growth. However, this is conditional on Africa articulating right education policies and creating employment opportunities. On the other hand, a rapidly growing population exerts pressure on limited natural resources at a time when such resources are dwindling.

Green Growth in Africa's Development Process

The majority of the poor in Africa depend on natural resources for their livelihoods. For instance, the agriculture sector employs about 60 percent of Africa's total population and contributes a third of Africa's GDP. Furthermore, an estimated 70 percent of African households rely on wood fuels for cooking and heating. Thus, continued use of natural resources to satisfy these needs inevitably requires that resources are managed sustainably.

Greening agricultural practices through agroforestry and organic farming practices deliver short and long-term development benefits. There is ample evidence which suggests that sustainable land management practices can improve resilience and adaptive capacity while also increasing average agricultural output. Increasing agricultural production in Africa on a sustainable basis requires a diverse toolkit, including green and conventional practices, with the clear target of preserving the natural systems upon which food security depends.

Forestry provides an example where there are considerable synergies and trade-offs between local and global environmental and development objectives. The clearing of forests and harvesting of forest products serves as an important source of energy and food security, especially for Africa's rural poor. Africa's forests also provide services beyond the boundaries of the continent. Forests sequester carbon dioxide and are an important resource for biodiversity. Yet, green practices that enhance forest stocks and reduce loss of forest biomass do not often directly create any income. Thus, it makes policy sense to compensate farmers or landowners who adopt green practices that generate the environmental benefits.

International initiatives such as Reducing Emissions from Deforestation and Degradation (REDD+) provide performance based payments and hence incentives for the conservation of natural resources. This could potentially offer new revenue streams which facilitate the transition to greener development trajectories, if natural resource management efforts are linked to improving the livelihoods of local population.

Energy security is essential for Africa's development, yet only 42 percent of the African population had access to electricity in 2008. Although this is projected to increase to 66 percent by 2040, the majority of Africa's rural poor will continue to depend on wood fuel as a source of energy. Fulfilling this energy demand will require development of fossil fuels which however produce unavoidable "subsistence emissions". Although this may be justified in principle due to Africa's pressing energy needs, in contrast to the more "luxury emissions" by developed countries, the continents' exposure and vulnerability to climate change dictates that energy development is undertaken through low-carbon pathways. This can be achieved by reforming fossil fuel subsidies, adoption and deployment of low-carbon technologies such as renewable energy, improving energy efficiency, promoting sustainable modes of transport, and developing smart cities.

Africa is well endowed with abundant sources of renewable energy such as solar, hydro and wind resources. While renewable energy technologies (RETs) are in general still more expensive than fossil energy technologies, unit costs have been falling overtime while costs for fossil energy technologies are increasing. Investing now in RETs could avoid investments in technologies and systems that would lock African countries into high carbon pathways for decades into the future. RETs have the potential to create jobs in the service end of the supply chain, including distribution and sales, installation and maintenance.

Emerging Technology Transfer and Financing Options

Access to green technologies can increase productivity and efficiency in various sectors. For agriculture, green technologies can increase land productivity by reducing water input, fertilizer and pesticide use, energy and other inputs, while increasing yields per hectare. Green technologies can also increase the efficiency of energy consumption (e.g., energy efficient vehicles, boilers, light bulbs and other electrical goods).

To accelerate appropriate diffusion and adoption of efficient technologies, domestic innovation capacities should be built and supported by building the knowledge, expertise and experience for generating and managing technical change. Africa must therefore begin to assess its technological needs as well as developing innovation capacities through knowledge flows. Nationally located Climate Innovation Centers (CICs), building on in-depth, stakeholder led assessments in each country and region, can be the right instrument to build and support these innovation capacities.

Without adequate financing, green policies and strategies will not be able to bridge the gap between green practices and technologies and their conventional counterparts. At the global scale, the estimated annual financing demand for a green transition is estimated to be between US$1.05 trillion and US$2.59 trillion between 2011 and 2050. However, estimates suggest that the cost of inaction is ultimately higher than the costs of a green transition, at least in the medium to long term. For example, in the context of climate change, global estimates suggest that the cost of continuing with "business as usual" (BAU) may be between 5 to 20 times higher than the cost of action associated with limiting to about 2˚C.

The amount required for a green transition underlines the need to explore several financing options. Focusing on financing strategies that depend largely on donor funds with few or no cost-sharing measures will generate very modest financial resources for green growth. Instead, green growth should be financed by a combination of self-financing coupled with donor support. Strategies for African countries can adopt to finance green growth include (i) optimizing resource efficiency and productivity gains by greening value chains; (ii) reducing the fiscal cost of subsidies through realignment; (iii) leveraging global financing options for green growth, (iv) building targeted public-private partnerships, and (v) harnessing other fiscal and environmental policy tools.

Creating an Enabling Environment for Green Growth

There are several levers for promoting green growth and enabling the transition toward greener economies in Africa. The most strategic of these is the progressive mainstreaming of green growth into upstream development planning and ensuring that the right institutional enabling environment is put in place. Key entry points for mainstreaming green growth are the national development planning cycles, where the role that green growth approaches can play in meeting development objectives could have a more prominent role. Smaller levers for green growth are further downstream and focus on integrating principles of resource use efficiency, sustainability and resilience into the design of development programs and projects.

Strengthened planning requires a broader integration of sectors, and the need for high-level political commitment cannot be overemphasized in charting long-term development visions. Improved diagnostic, information and monitoring capabilities are especially important to adequately capture a country´s natural resource wealth, assess risks to sustainability and monitor progress. Only if development progress is defined and monitored along appropriate economic, social and environmental criteria will it be possible to assess the quality of growth from a green growth perspective.

Green growth strategies need to provide concrete policy frameworks for how economic development and environmental sustainability can reinforce each other and create a win-win synergy. Associated green policies, as discussed above, include subsidy reforms, environmental fiscal reform and promotion of technology transfer and diffusion as well as appropriate land reforms and policies, targeted public investments and strengthening transparency and good governance.

The African Development Bank, along with other multi-lateral and bilateral organizations, can facilitate the transition to green growth in Africa. This can be achieved by facilitating awareness, knowledge sharing, and upstream technical support, as well as providing guidance and resources for programmatic and project-specific interventions. While there may be efficiency gains and cost savings associated with green growth, there are likely to be upfront investment costs, which could constrain the transition. Through its operational experience, the African Development Bank also already possesses many building blocks for promoting green growth and can be a partner to its member countries in the transition toward more sustainable development pathways. However, this is the starting point of a journey, which requires adjustments over time and mutual learning by development partners and client countries. Yet in light of the local and global development and environmental challenges, the time for action on green growth is now to ensure efficient, sustainable and robust development progress in Africa.

Introduction

Chapter 1

1 Introduction

After several decades of economic stagnation, most African countries have experienced sustained economic growth in the last 15 years. This has placed a number of these countries among the fastest growing economies in the world. However, the poverty impact of this impressive growth has been modest. Neither has it been adequate and inclusive to lower income inequalities. Moreover, the environmental basis for growth and further poverty reduction is progressively being eroded.

The vast majority of the population in Africa derives their livelihoods from the use of natural resources. For instance, the agriculture sector employs about 60 percent of Africa's total population and contributes at least one-third to the region's GDP. Despite this, African growth is currently consuming natural resources (i.e., forests, topsoil, and fish stocks), sometimes at alarming rates. Thus, under the current growth patterns, compounded by further challenges such as climate change and population growth, it has become imperative that Africa pursues a new model of growth, namely green growth.

A range of context and region specific definitions for green growth and the related concept of "Green Economy" have emerged (See Table 1.1)[1]. Nonetheless, all these definitions place economic, social and environmental concerns on equal footing. Building on this, the rationale for promoting green growth in Africa is to enable the achievement of critical development objectives and growth targets essential for human welfare while seeking

1 Throughout the Report, green growth and green economy are used interchangeably.

Table 1.1: Selected Alternative Definitions of Green Growth and Green Economy

Definitions by other international organizations	Source
Green Growth: "means fostering economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies."	OECD, 2011
Green Growth: "… economic progress that fosters environmentally sustainable, low carbon and socially inclusive development."	UN-ESCAP et al., 2010
Green Growth is a "growth that is efficient in its use of natural resources, clean in that it minimizes pollution and environmental impacts, and resilient in that it accounts for natural hazards and the role of environmental management and natural capital in preventing physical disasters."	World Bank, 2012b
Green Economy	
Green Economy: "An economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities."	UNEP, 2011

Source: Compiled by the AfDB Green Growth team.

to improve the efficiency of natural resource use, minimize waste and pollution, and enhance the resilience of livelihoods and economic sectors. Throughout this Report, the African Development Bank's (AfDB) definition of green growth is used, that is, *"the promotion and maximization of opportunities from economic growth through building resilience and managing natural assets efficiently and sustainably, including enhancing agriculture productivity, and promoting sustainable infrastructure."*

Green growth is closely linked to the broader concept of sustainable development anchored on three pillars of social equity, economic prosperity and ecological sustainability. Green growth or green economy is therefore consistent with sustainable development and the two are complementary (UNCSD, 2012; UNEP, 2011; World Bank, 2012b).

Sustainable development represents a paradigm linking the economy, society and the environment. However, it does not provide concrete guidance on "how to." In this regard, green growth can fill this lacuna by providing concrete policy frameworks on how economic development and environmental sustainability can reinforce each other and create a win-win synergy to achieve the three pillars of sustainable development (Girouard, 2011). Green growth as a framework for achieving sustainable development has been recognized by various international organizations (see Table 1.2). Thus, in Africa, green growth is about enabling sustainable development pathways in the face of global and local changes.

This Report makes a case for pursuing green growth pathways that use natural capital and ecological systems efficiently and sustainably; that are low-carbon; and that share the benefits of growth in order to reduce poverty and inequality and improve livelihoods. The purpose of the Report is therefore to offer analytical perspectives and critical input into the discussion of what green growth means within the development contexts of Africa.

The rest of the Report is divided as follows. Chapter 2 sets out the basis for green growth by analyzing the impact of Africa's economic performance on important socioeconomic indicators, notably poverty and inequality, as well as on natural resources. The Chapter notes that growth has not been decisively inclusive and environmentally sustainable.

Chapter 3 highlights the key challenges of the 21st century, including climate change, population growth, and the influence of these factors on energy transformation and agricultural markets.

Chapter 4 is devoted to a discussion on the optimal management of Africa's renewable resources, consisting of agricultural land, water resources, forest stocks, fisheries and biodiversity. Chapter 5 looks at issues related to energy security, fossil fuels and the opportunities for low carbon development. The discussion in Chapters 4 and 5 shows that green growth pathways offer an opportunity

Table 1.2: Selected Descriptions of the Relationship between Green Growth/Green Economy and Sustainable Development

Description of Relationships by international organizations	Source
Green Growth: "Inclusive green growth is the pathway to sustainable development."	World Bank, 201 2b
Green Economy: "We consider green economy in the context of sustainable development and poverty eradication as one of the important tools available for achieving sustainable development."	UNCSD, 2012
Green Economy: "Sustainability is still a vital long-term goal, but we must work on greening the economy to get us there."	UNEP, 2011

Source: Compiled by the African Development Report 2012 team.

for Africa to expand its development frontier along the lines of environmental sustainability and inclusion.

An analysis of actions required to facilitate green growth in Africa is the subject of Chapters 6, 7 and 8. In Chapter 6, the role of technology transfer (TT) necessary for green growth in Africa is discussed, while Chapter 7 outlines the opportunities and challenges of financing green growth in Africa. Chapter 8 looks at the enabling institutional and policy environment to foster green growth on the continent.

Finally, Chapter 9 is the conclusion, reflecting entry points for green growth in Africa and the potential role of the African Development Bank and other organizations in making this a reality.

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Main Drivers of Africa's Economic Performance

2

Chapter

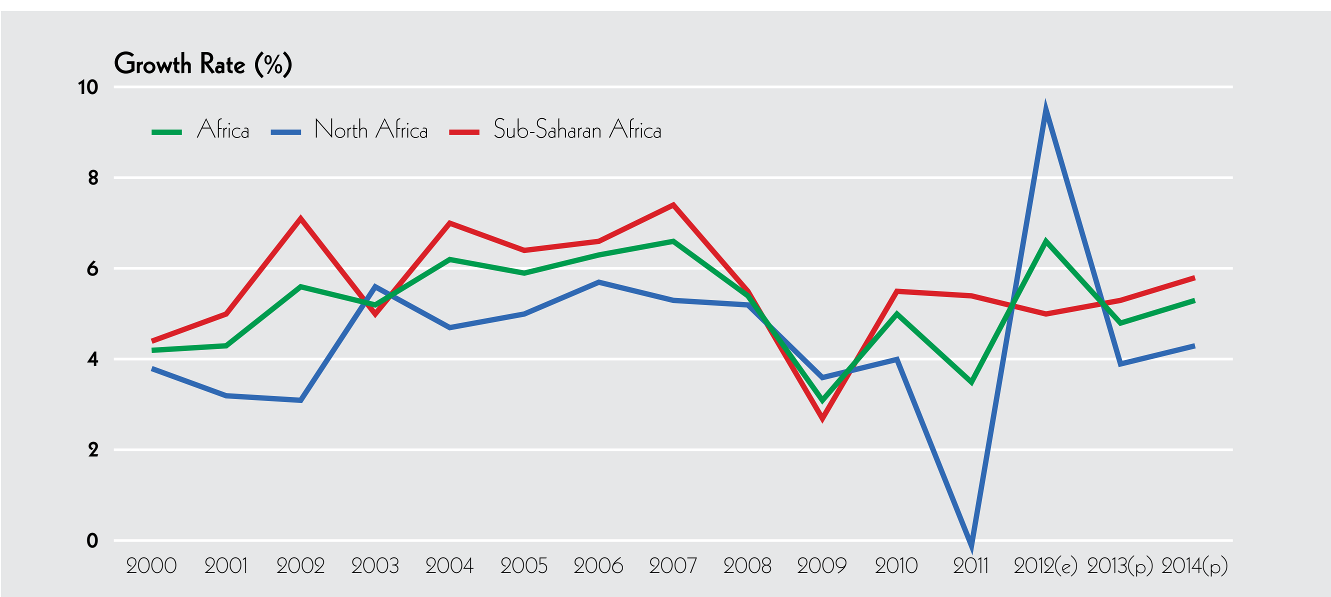
2 Main Drivers of Africa's Economic Performance

2.1 A Decade of Robust Growth

Africa's economic growth over the past decade has been robust. Figure 2.1 displays the trends in Africa's GDP between 2000 and 2012, with projections for 2013 and 2014. The figure shows that since 2000, economic performance has been impressive, averaging more than 5 percent. Average growth in sub-Saharan African (SSA) was especially higher at 5.6 percent relative to 4.5 percent for North Africa. In 2011, growth in North Africa was affected by the Arab uprising, which also dragged Africa wide growth rate to 3.4 percent from 5 percent in 2010. Nonetheless, in 2012, growth in North Africa rebounded strongly to about 10 percent, lifting Africa's growth to nearly 7 percent. As Figure 2.1 shows, Africa's economic growth rate between 2013 and 2014 is projected to remain relatively solid, averaging above 4 percent.

Since 2008, the world economy has undergone significant strain, impacting on growth across all the regions. However, in the face of these global headwinds and domestic supply shocks and civil conflict, Africa has been resilient. Thus, between 2008 and 2011, the period of great global uncertainty, the African economy grew by more than 4 percent, ahead of Latin America and Caribbean (3.4 percent) and Europe and Central Asia (0.2 percent). However, Africa's growth was half the growth rate in East Asia and the Pacific (8.5 percent), which benefited

Figure 2.1: Africa's Economic Growth (2000-2014)



Source: African Development Report 2012 team based on data sourced from the AfDB database.

from China's continued expansion. Thus, comparatively, Africa has weathered the effect of the global economic crisis more strongly than in previous episodes.

Although real GDP growth has been robust, in per capita terms, Africa still lags behind other developing regions, such as East Asia and the Pacific and the Latin America and Caribbean countries, as shown in Figure 2.2.

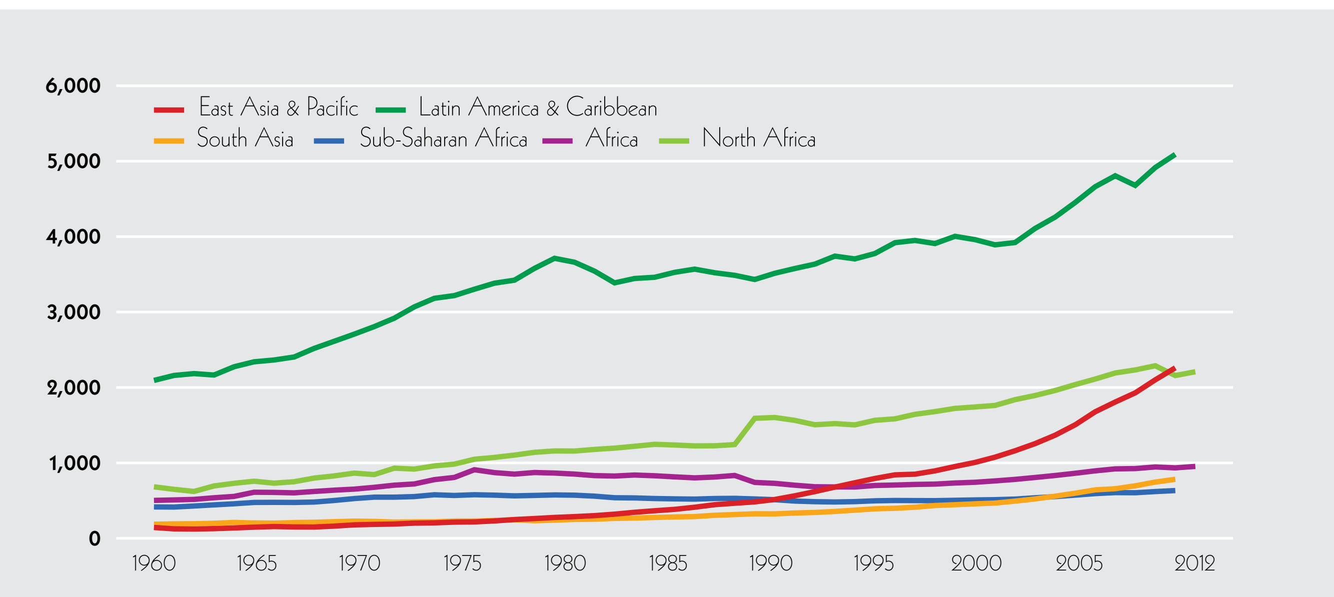
2.2 Factors Underlying Africa's Recent Economic Growth

There is a wide discussion of the factors underlying Africa's renewed economic growth (see AfDB et al., 2012; AfDB, 2011; McKinsey & Company, 2010;). The role of high commodity prices on driving growth has dominated the discourse. Between 2000 and 2010, 30 percent of the continent's GDP was linked to the use/exploitation of natural resources (AfDB et al., 2011; McKinsey & Company, 2010). Export of agricultural products, oil, metals and minerals account for some 70 percent of the export revenue for SSA (Mills and Herbst, 2012). For example, the high economic growth observed in some oil exporting countries such as Angola and Chad can be directly linked to increases in commodity oil price which more than quadrupled to US$ 112 per barrel in 2012 from less than US$ 20 per barrel in 1999. This reflects Africa's continued dependence on natural resources.

However, not all fast-growing countries are dependent on natural resource commodities. An analysis of the sectoral patterns shows that growth in Africa has become increasingly broad based, with other sectors gaining in importance in recent years (McKay, 2013). In particular, African countries have seen an increased share of agriculture, manufacturing and services. Thus, Africa's growth has been more than a resource boom (see Figure 2.3). Indeed, some non-resource exporting countries, such as Rwanda and Ethiopia, have registered higher growth rates in the last decade comparable to that by some of their counterparts heavily reliant on commodity exports.

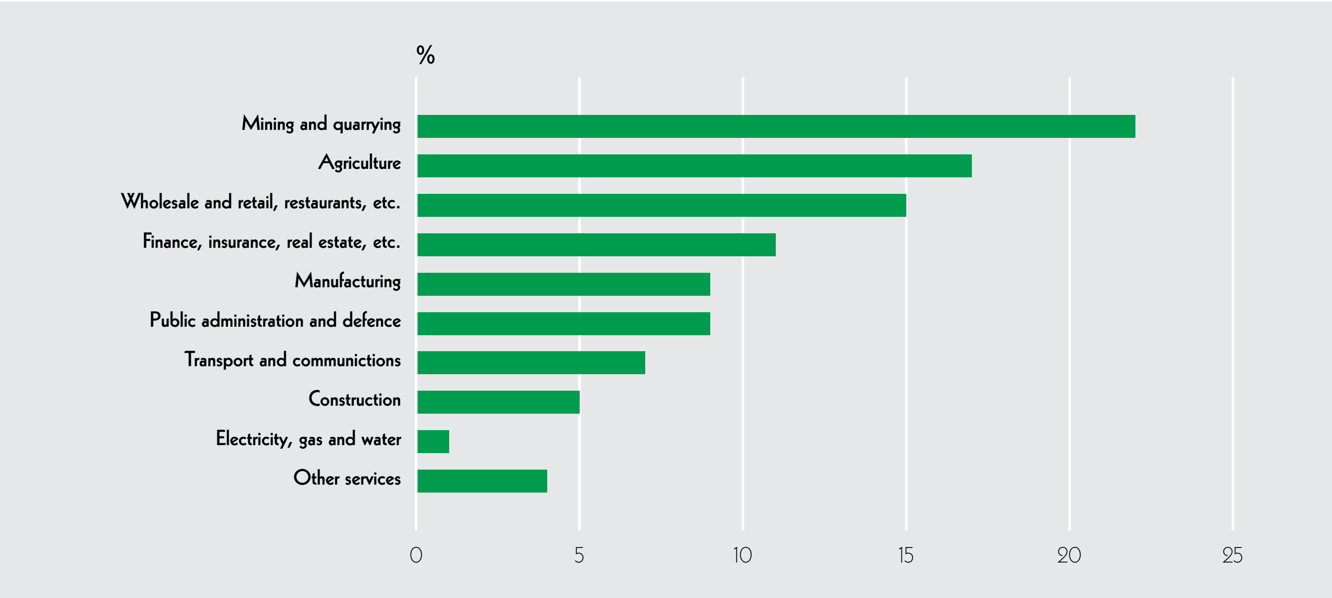
Regardless of the composition of exports, one of the key drivers of Africa's growth has been the increasing orientation of trade towards fast-growing emerging markets. This has

Figure 2.2: GDP Per Capita by Region (Constant 2000 US Dollars)



Source: African Development Report 2012 team based on data sourced from AfDB and World Bank database.

Figure 2.3: Sectoral contribution to GDP (Percent, 2012)



Source: AfDB Statistics Department

helped reduce the continent's trade vulnerability to economic crisis plagued traditional markets such as the Europe and the United States.

There are several other factors that have contributed to Africa's impressive growth performance (AfDB et al. 2012; Aryeetey et al. 2012; Radelet 2007).

A number of countries in Africa have recorded marked improvements in the level of democracy and accountability, while better economic policy management is now a norm rather than an exception in several countries.

The level of external debt in many countries is also substantially lower than that seen in the 1990s, while foreign direct investment has increased, resulting in new technologies. Coupled with sustained remittances flows from Africa's diaspora population, foreign inflows remain important drivers of growth on the continent.

The decline in the prevalence of armed conflict and the return to democracy have led to the emergence of a new generation of political and business leaders which places a high premium on governance, accountability, and economic revival. Growth has also benefited from the rise in domestic demand, spurred by increased consumption as Africa's middle class has expanded in recent years.

2.3 Impact of Africa´s Economic Performance

2.3.1 Impact on Poverty

Despite rapid economic growth, the pace of poverty reduction has been slow in Africa and inequalities remain high and widespread. Table 2.1 presents poverty rates and corresponding change in poverty levels in African countries for which data are available. This is weighed against average annual growth in GDP per capita. Table 2.2 provides summary statistics.

The data in Table 2.1 show that poverty decreased in 20 of the 24 countries for which data were available. Overall, poverty decreased by an average of about 0.77 percentage points per annum for all the 24 countries. Poverty in sub-Saharan Africa fell by an average 0.84 percentage

Table 2.1: National Poverty Rates and GDP Per Capita

Country	Initial Year	Poverty Rate in initial year	Final Year	Poverty Rate in final year	Total Change in poverty rate	Percent Annual Change in poverty rate	Average Annual Per Capita GDP Growth Rate
Benin	2006	37.4	2010	35.2	-2.2	-0.55	1.09
Burkina Faso	1998	60.2	2003	40.7	-19.5	-3.90	3.03
Cameroon	1996	53.3	2007	39.9	-13.4	-1.22	1.73
Chad	1995	43.4	2003	55.0	11.6	1.45	2.03
Cote d'Ivoire	1998	36.4	2008	42.7	6.3	0.63	-1.17
Egypt	1996	19.4	2008	22.0	2.6	0.22	3.10
Ethiopia	1995	45.5	2005	38.9	-6.6	-0.66	2.89
Ghana	1999	39.5	2006	28.5	-11.0	-1.57	2.46
Guinea	1994	63.9	2007	53.0	-10.9	-0.84	1.41
Kenya	1997	52.3	2005	45.9	-6.4	-0.80	0.14
Madagascar	1997	73.3	2005	68.7	-4.6	-0.57	0.20
Malawi	2004	52.4	2009	39.0	-13.4	-2.68	3.27
Mali	2001	55.6	2006	47.4	-8.2	-1.64	2.98
Morocco	1999	16.3	2007	9.0	-7.3	-0.91	2.97
Mozambique	1996	69.4	2008	54.7	-14.7	-1.23	5.19
Nigeria	1996	65.6	2004	57.8	-7.8	-0.98	2.08
Rwanda	2000	60.4	2011	44.9	-15.5	-1.41	4.39
Senegal	1995	61.4	2006	40.0	-21.4	-1.95	1.61
S. Africa	1995	31.0	2006	23.0	-8.0	-0.73	1.61
Tanzania	1992	38.6	2007	33.4	-5.2	-0.35	1.95
Tunisia	1995	6.2	2005	3.8	-2.4	-0.24	3.53
Uganda	1996	44.4	2009	24.5	-19.9	-1.53	3.75
Zambia	1996	68.1	2006	59.3	-8.8	-0.88	1.47
Zimbabwe	1995	42.0	2003	72.0	30.0	3.75	-2.43

Sources: Compiled by African Development Report team using data from World Bank's WDI and McKay (2013)

Table 2.2: Correlation Between Poverty and Economic Growth

Average Annual Change in Poverty Rate	
All Countries	-0.77
Sub-Saharan Africa	-0.84
Sub-Saharan Africa excluding Zimbabwe and Cote d'Ivoire	-1.16
Sub-Saharan Africa excluding Zimbabwe, Chad, and Cote d'Ivoire	-1.31
Correlation between Annual Change in Poverty and Annual Per Capita GDP Growth Rate	
All Countries	-0.69
Sub-Saharan Africa	-0.67
Sub-Saharan Africa excluding Zimbabwe and Cote d'Ivoire	-0.36
Sub-Saharan Africa excluding Zimbabwe, Chad, and Cote d'Ivoire	-0.41

Source: Computations by African Development Report 2012 team based on data in Table 2.1

points per year, marginally higher than the sample mean. Countries with relatively high rates of poverty reduction were Burkina Faso, Ghana, Malawi, Mali, Mozambique, Rwanda, Senegal, and Uganda. However, Chad, Cote D'Ivoire, Egypt and Zimbabwe recorded increases in poverty levels.

Not surprisingly, growth and poverty are related. As shown in Table 2.2, the simple correlation between annual economic growth and the decline in poverty across all countries is -0.69 (for sub-Saharan Africa, it is -0.67). This implies that countries with high rates of economic growth such as Uganda, Rwanda, and Senegal, have greatest chance of reducing poverty. In contrast, countries with relatively low rates of economic growth have low possibility of reducing poverty as evidenced in Cote D'Ivoire and Zimbabwe. This suggests that the recent growth in African countries has reduced poverty, albeit marginally.

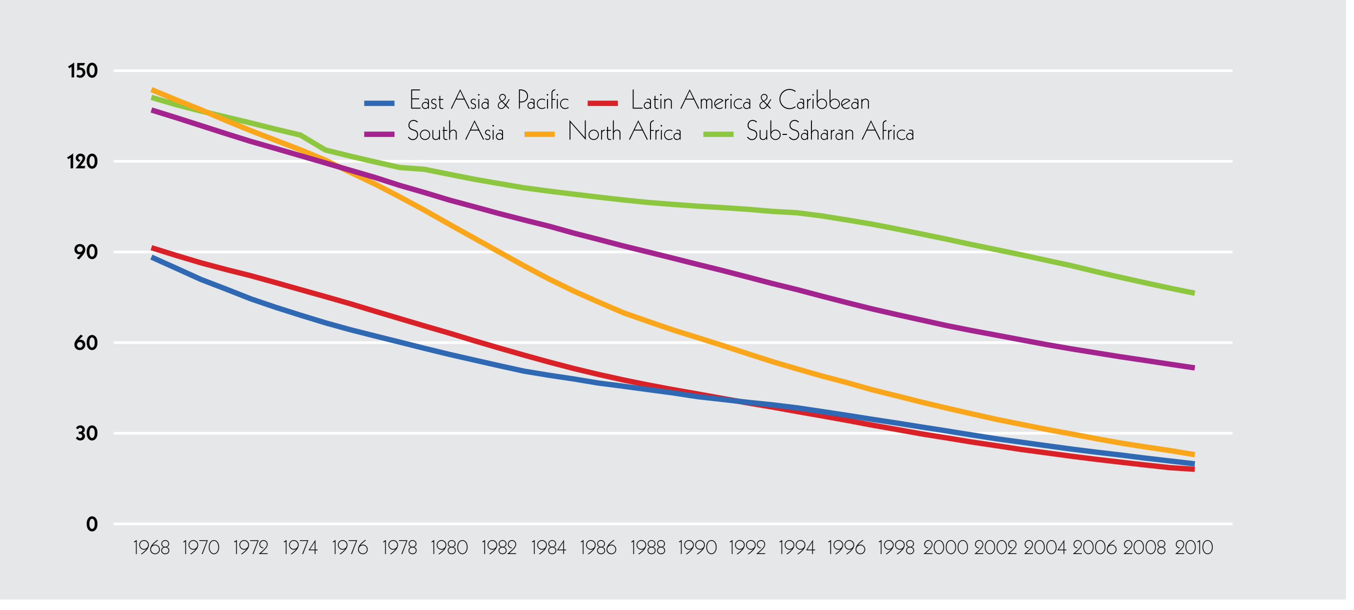
2.3.2 Non-Monetary Measures of Poverty

Africa's favorable economic performance and concomitant reduction in poverty in recent years are also reflected in a slight improvement in social indicators. Figure 2.4 compares the infant mortality rate in Africa with other developing regions. In all developing regions, the infant mortality rate continuously declined in between 1970 and 2010. While sub-Saharan Africa experienced a modest decline during the 1980s and early 1990s, its performance from the mid-1990s onwards was notably stronger. North Africa has been especially successful in reducing infant mortality rates.

There have also been corresponding improvements in life expectancy (Figure 2.5). East Asia and the Pacific, North Africa, and Latin America and the Caribbean have the highest level of life expectancy and have shown a steady improvement throughout the fifty-year period depicted. Sub-Saharan Africa's improvement slowed during the economic stagnation of the 1980s and 1990s but accelerated as the economy grew in the 2000s. These gains are particularly illuminating given the devastating impact of the HIV/AIDS in SSA (Mwabu, 2012).

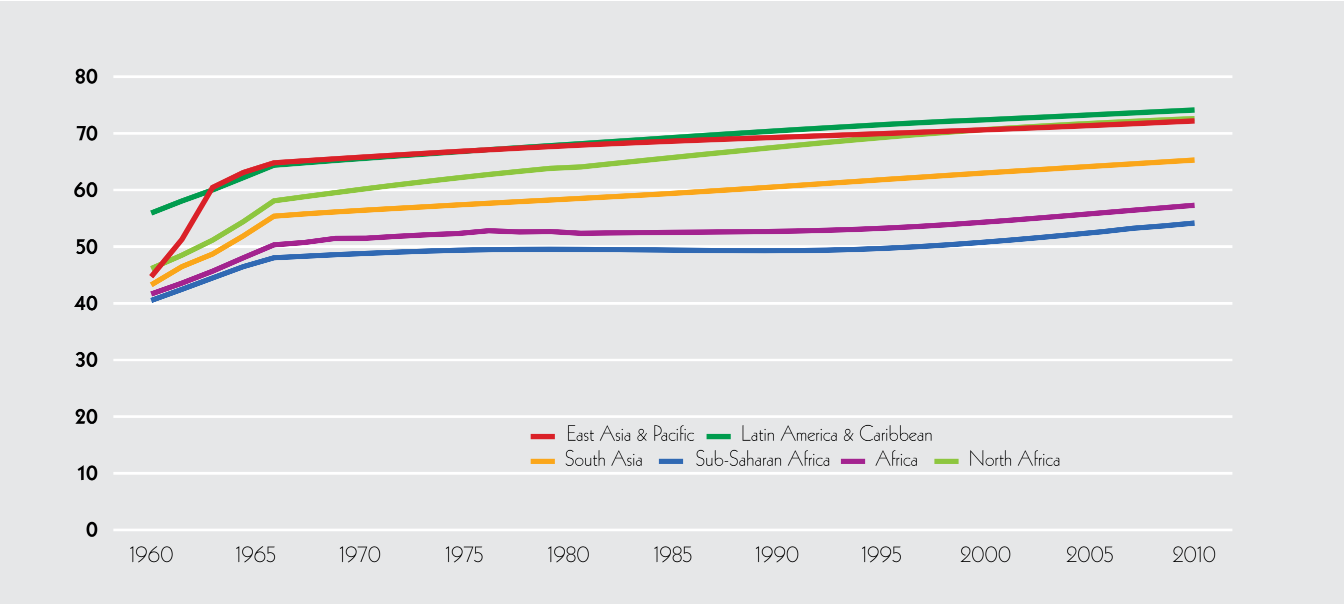
Figure 2.6 shows that since 2000, sub-Saharan Africa has significantly narrowed the gap in primary school

Figure 2.4: Infant Mortality Rate in Developing Countries by Region (Deaths per 1000 births)



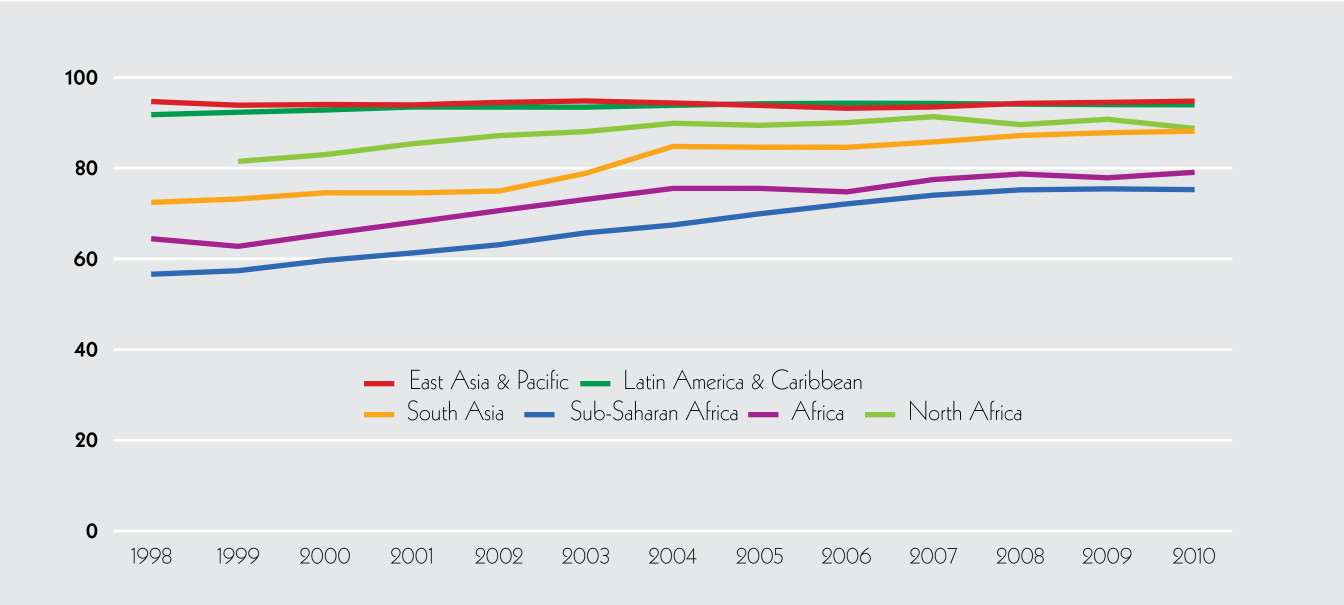
Source: Statistics Department, AfDB; World Development Indicators, World Bank.

Figure 2.5: Life Expectancy at Birth in Developing Countries by Region (Number of years)



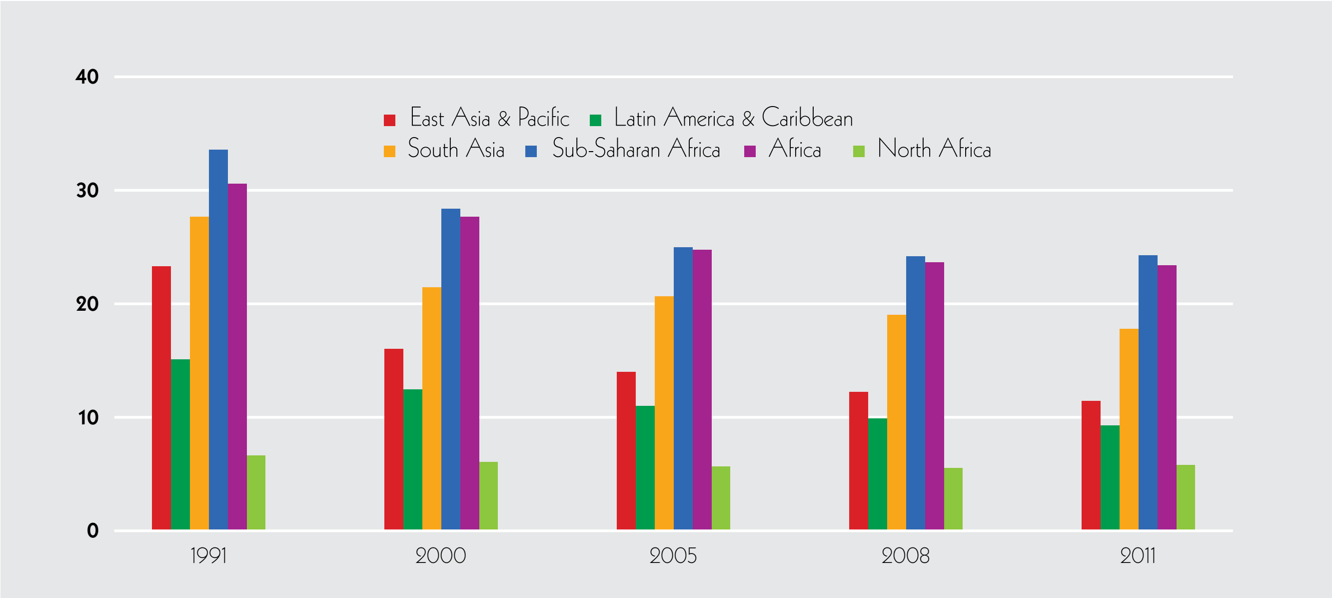
Source: Statistics Department, AfDB; World Development Indicators, World Bank.

Figure 2.6: Net Primary School Enrollment Rate in Developing Countries by Region



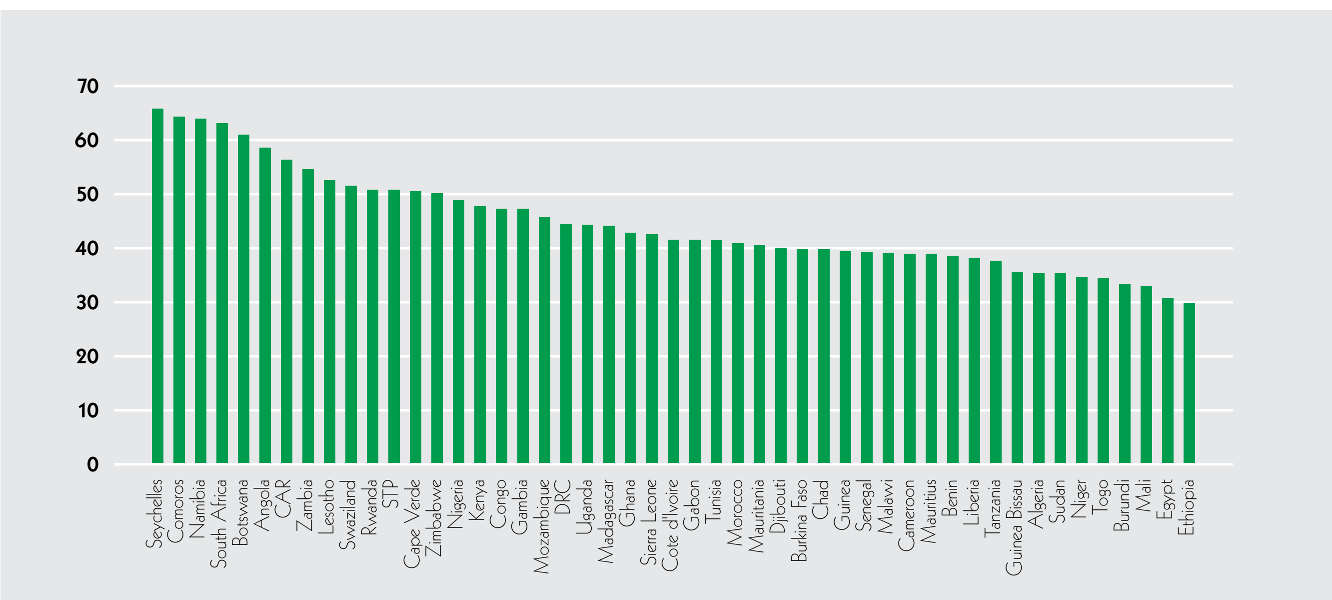
Source: Statistics Department, AfDB and World Development Indicators, World Bank.

Figure 2.7: Prevalence of Malnourishment in Developing Countries by Region (percent of population)



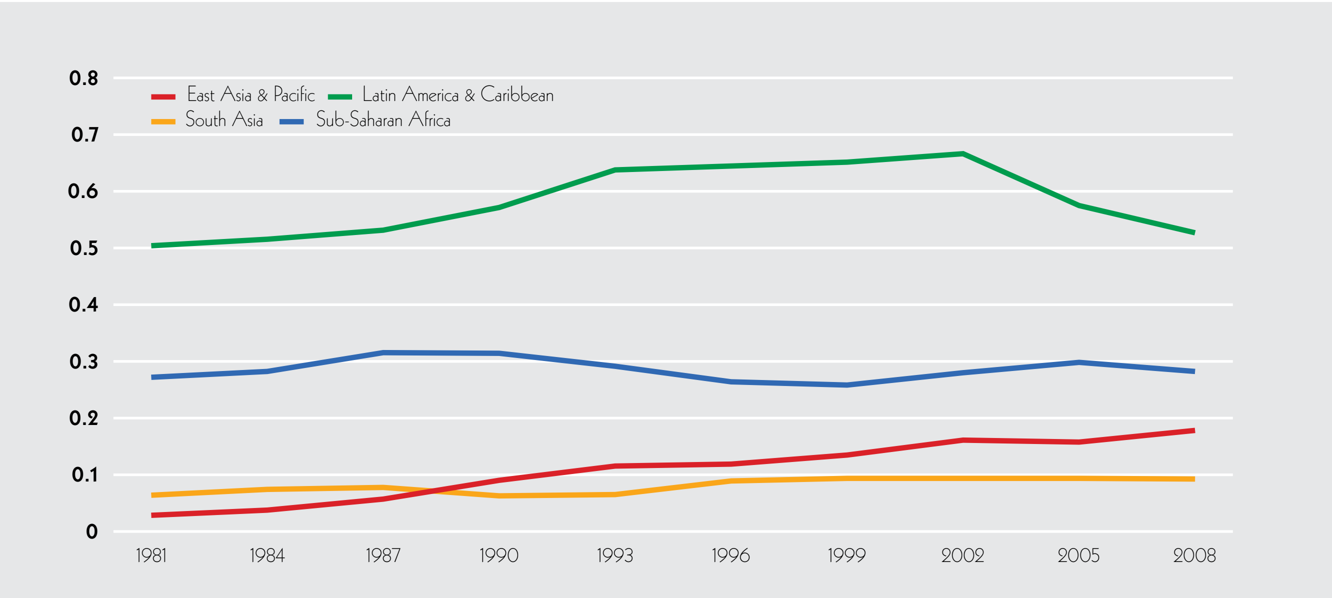
Source: Statistics Department, AfDB and World Development Indicators, World Bank.

Figure 2.8: GINI Index for selected African Countries



Source: AfDB et al. (2012), based on the latest Demographic and Health Survey of the respective countries.
Note: STP is Sao Tome and Principe; DRC is Democratic Republic of Congo; CAR is Central African Republic

Figure 2.9: Average within Country Inequality in Developing Countries by Region



Source: Ravallion and Chen (2012).

enrollment rates[2] relative to other developing regions of the world, including North Africa[3].

In Figure 2.7, we see that the prevalence of malnourishment in sub-Saharan Africa declined progressively between 1991 and 2011. Similar trend is observed for other regions. However, in North Africa, malnutrition prevalence rates were essentially flat, but the rates were almost five times lower than in sub-Saharan Africa.

2.3.3 Impact on Inequality

As discussed earlier in this chapter, the increase in per capita GDP recorded over the last decade and a half has helped reduce poverty, but only modestly. This implies that the benefits of growth have not been shared equally among the African populace. Figure 2.8 reveals that income inequality, measured by the Gini index, ranged from 30 percent in Ethiopia to 68 percent in Seychelles. Africa's average Gini index stood at 45 percent. This shows a greater degree of inequality than all other regions of the world, except Latin America (Günther and Grimm, 2007). Furthermore, in 2011, 6 of the world's 10 most unequal countries were in Africa: Namibia, South Africa, Lesotho, Botswana, Sierra Leone and Central African Republic (the latter two are classified as fragile states).

The evidence provided by the Gini index is corroborated by data from household consumption and income surveys. On the basis of 850 household consumption surveys spanning 1979-2011 in 125 developing countries, Ravallion and Chen (2012) confirm the large inequalities in sub-Saharan Africa relative to other developing regions of the world (see Figure 2.9). Overall, the evidence suggests that the impressive growth in Africa since 2001 has not substantially led to a lowering of income inequality.

2 This is defined as share of school-aged children enrolled in school compared to the total population of school aged children.

3 Increased enrollment may accomplish little if the education received is of very low quality; in parts of Africa, there are real concerns with respect to the quality of education (Gauthier and Wane, 2012).

2.3.4 Impact on Natural Resources and GHG emissions

Available evidence suggests that Africa's recent growth has been underpinned by increased exploitation of renewable natural resources beyond their regenerative capacity and by an increasing amount of GHG emissions. The level of environmental damage and natural resource depletion is approaching alarming proportions, threatening future growth prospects and progress achieved in social indicators (World Bank, 2012).

Land Degradation

Human-induced soil degradation is now visible in the vast majority of developing countries[4]. According to UNEP's (1992) Global Assessment of Soil Degradation (GLASOD), degradation of cropland affected 65 percent of agricultural areas in Africa, compared with 38 percent in Asia and 51 percent in Latin America. More recent estimates show that 4 to 12 percent of Africa's GDP is lost due to environmental degradation, with 85 percent of this loss attributed to soil erosion, nutrient loss and changes in crops (Olson and Barry, 2003). In Ghana, Diao and Sarpong (2007) predicted the reduction in total agricultural GDP from 2006–2015 due to land degradation to be approximately 5 percent.

Globally, estimates show that land degradation could reduce global food production by as much as 12 percent over the next 25 years, pushing world food prices as much as 30 percent higher (Pender, 2009). The harmful effect of residuals from pesticides in food and drinking water is also becoming a major health concern for farmers as well as consumers.

Loss of Forest Cover

Economic activities and demand for affordable fuels have led to widespread deforestation and forest degradation in Africa. African countries accounted for over half of global forest loss between 2000 and 2005 and the net forest loss amounted to 3.4 million hectares per year during the period 2000–2010 (FAO, 2007; 2011). Of the ten countries with the highest rates of forest loss, seven were in Africa[5]. Rates of forest loss are highest in western and northern

4 Little reliable data is available on the extent of land degradation in Africa.

5 Comoros, Burundi, Togo, Mauritania, Nigeria, Benin, and Uganda.

Figure 2.10: Loss of Forest Cover in Africa

Source: UNEP (2002)

Africa, which also have the smallest areas of forest cover. Although rates of forest loss are lower in southern and central Africa, the higher absolute area of forest in these regions means that the total area of forest lost per year is higher (see Figure 2.10).

The data on loss of forest area hide the thinning of forests due to degradation, which is estimated to account for over one-third of all forest biomass loss in the continent (Lambin et al., 2003; Murdiyarso et al., 2008). In some countries, this share could be much higher, although the data are plagued by unreliability. For example, in central Mozambique, degradation is estimated to contribute to two-thirds of net biomass loss (Ryan et al., 2011).

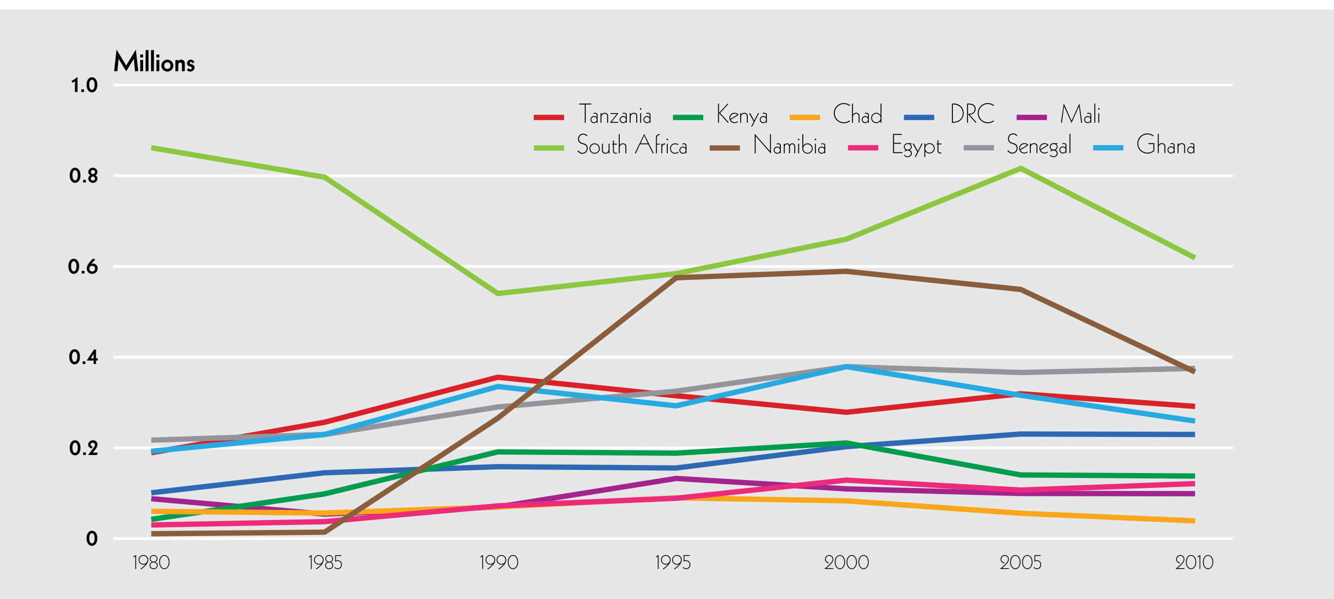
The large-scale forest loss aggravates climate change by contributing to GHG emissions. The CO_2 stored by Africa's forests is estimated at 60 billion tons (Unmüßig and Cramer, 2008). Africa's relatively high rates of forest loss in the 12 most densely wooded countries in the region accounted for 1.1 billion tons of CO_2 in 2005 (FAO, 2007; UNDP, 2007). Africa's humid forests, particularly in western and central Africa, have particularly high concentrations of carbon stocks, taking into account carbon in the soil, litter, and dead wood. While dry forests have less carbon, they account for around 42 percent of tropical forest area in Africa, and are therefore an important element of any policy linked to forests and climate change (Murphy and Lugo, 1986; Murdiyarso et al., 2008).

Water Scarcity

Although water availability varies considerably within and across countries, water across Africa is generally becoming increasingly scarce due to growing demand as a result of population growth, agricultural expansion and industrialization. The over-use of water resources is evidenced by the fact that some of Africa's important aquifers are depleting faster than the rate of recharge.

This is of concern given that most countries, particularly in the desert areas of Africa such as Libya, Egypt, Algeria, Tunisia, Namibia and Botswana, receive very little precipitation and therefore rely heavily on groundwater resources. In general, groundwater represents the major source of water in northern Africa (Braune and Xu, 2010). For instance, in Libya, groundwater accounts for 95 percent

Figure 2.11: Inland and Marine Fisheries Catches (tons) of Selected African Countries



Source: FAOSTAT (database), Food and Agriculture Organization, Rome.

of freshwater withdrawals. Groundwater also provides 80 percent of domestic and livestock demands in Botswana, and the same magnitude for Namibia's rural population (UNEP, 2010).

Recent studies show that most aquifers in Africa are unsustainably mined, such as those found in the large sedimentary basins of Lake Chad and under the Sahara desert (Stock, 2004). In Kenya, the Nairobi aquifer has dropped over 15 metres since the 1960s and the Naivasha aquifers have dropped over 7metres (Oteino, 2013).

Depletion of Fish Stocks

Since the mid-1990s, several countries have experienced stagnating catches or sustained declines in overall fish catch (see Figure 2.11). There are estimated to be more fishers than the small-scale coastal and inland fisheries can sustain. Catches and the size of fish caught are decreasing, reflecting overfishing (Markwei et al., 2008). This is attributable to overcapitalization and intensification of individual fishing effort in capture fisheries (Whittingham et al., 2003). High levels of illegal activity have especially put additional pressure on the fisheries (NEPAD, nd).

Trend in Greenhouse Gas Emissions

Africa emits a relatively low amount of GHG in comparison to other regions in the world (see Table 2.3). An average African generates 13 times less GHG than their North American counterpart (OECD, 2009; IEA, 2011; IEA, 2012a). However, during the last decade the total CO_2 emissions from the continent increased by 35 percent, reaching about 930 million tons in 2010 (IEA, 2012a). The bulk of CO_2 emissions in Africa can be traced to a small number of countries. From 1971 to 2009, South Africa, Egypt, Algeria and Nigeria on average contributed about 76 percent of the continent's total annual CO_2 emissions. The continent accounted for about 31 percent of the world CO_2 emissions from gas flaring, with Nigeria as the major contributor with 36 percent of CO_2 emissions in Africa's total emissions and 11.4 percent to the world total (IEA, 2011; IEA, 2012a).

2.4 Conclusion

The first decade of the 21st century has witnessed economic progress and some improvements in key welfare indicators. Poverty has declined, albeit modestly, while marked strides

Table 2.3: Population, Output and Carbon Emissions Across Regions (2010)

	Population (millions)	GDP (billions of 2005 dollars)	CO_2 emissions (Mt of CO_2)	CO_2 per capita (t CO_2/capita)	CO_2/GDP (kg COs/ 2005 dollars)
World	6,825	50,942	30,326	4.44	0.44
OECD countries	1,232	37,494	12440	10.10	0.34
Middle East	205	1,196	1547	7.56	0.66
Non-OECD Europe and Eurasia	338	1,533	2606	7.71	0.77
Asia	2229	3,217	3331	1.49	0.37
China	1345	4,053	7311	5.43	0.78
Non-OECD Americas	455	2,197	1065	2.34	0.25
Africa	**1022**	**1,252**	**930**	**0.91**	**0.34**
Africa (share of global)	15%	2.5%	3.1%		

Source: African Development Report 2012 team based on data sourced from International Energy Agency (2012b).

Notes: Mt = million tons; t = metric ton; kg = kilogram have been made in reducing infant mortality, increased life expectancy, school enrollment, and lower prevalence of undernourishment. However, despite these gains, income inequality remains high and widespread while the environmental basis for growth and future poverty reduction is progressively being diminished. African economic growth is currently consuming natural assets on a scale which threatens growth prospects and overshadows the progress achieved in social indicators. Furthermore, African growth is slowly contributing to climate change. Loss of forest cover and GHG emissions from the fossil fuel based energy sector are the main drivers for this trend.

The persistence of environmental degradation and continued inequality in African countries necessitates a shift towards more inclusive and sustainable growth. Thus, African countries should pursue green growth pathways. The necessity for green growth becomes even more apparent considering the development challenges in the 21st century. The details of these challenges and opportunities for green growth are given in the rest of the Report.

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Green Growth and Africa in the 21st Century

3

Chapter

3 Green Growth and Africa in the 21st century

3.1 Introduction

The previous chapter concluded that there is a need for Africa's growth to become more inclusive and sustainable. The 21st century presents additional development challenges emanating from global and regional developments. This chapter considers four important and inter-related trends that are likely to mark important departures from the experience of the 20th century. These trends relate to climate change, population growth, and the influence of both of them on energy transformation and agricultural markets.

3.2 Climate Change

3.2.1 Climate Change from a Global Perspective

To begin, two aspects of climate change merit particular mention. The first of these is the time dimension. The accumulation of greenhouse gases in the atmosphere over the past century is already influencing today's climate. For example, since the beginning of the 20th century, the global average temperature has already increased by about one degree Celsius. Manifestations of this warming are already clearly visible. Particularly in the absence of mitigation policy, the trend towards increased temperatures is likely to accelerate over the course of the 21st century (IPCC, 2007a) and hence climate change impacts are likely to become more profound with time.

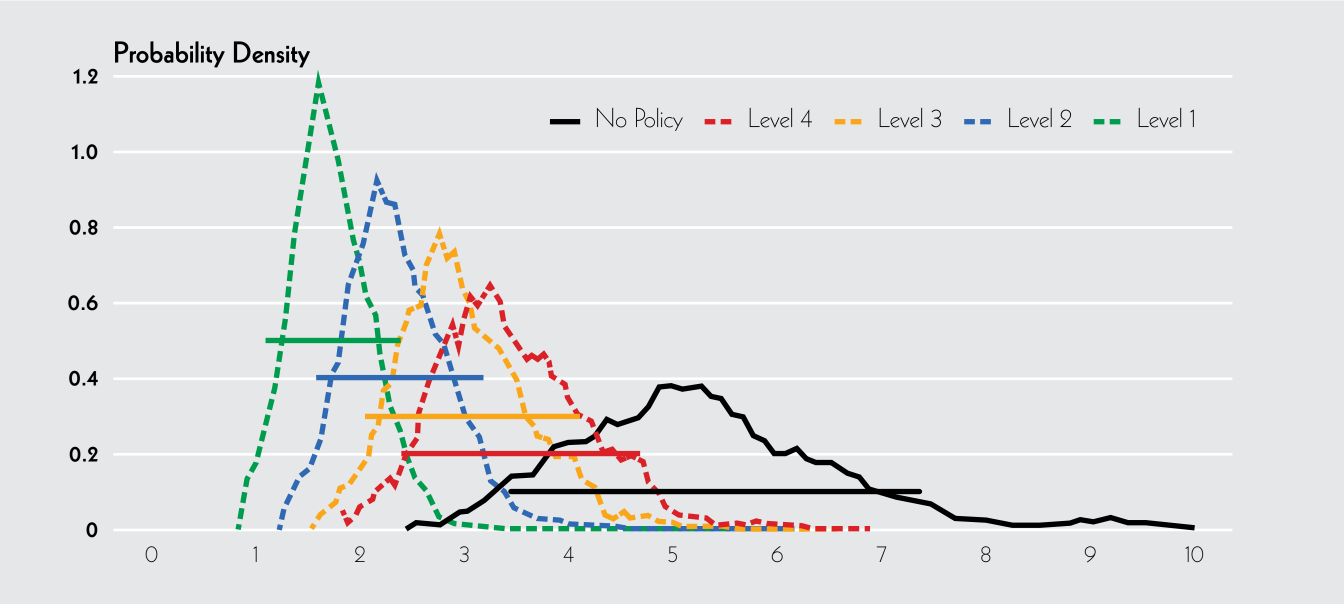
The second aspect relates to uncertainty. Information presented on climate change is based on projections and probabilistic assessment. While there are some aspects that can be considered as certain, such as an increase in heavy precipitation events in some regions, an increase in the number of warm days and nights, and rising sea levels, other impacts of climate change, especially regional and local impacts, are often deeply uncertain (IPCC 2012). For example, while total rainfall globally is robustly predicted to increase, the distribution of future rainfall both across space and seasons is exceedingly difficult to predict (IPCC, 2007b).

Figure 3.1 is somewhat complex but encapsulates well these two aspects of climate change. The figure is drawn from Webster et al. (2012), who employ a flexible model designed to reproduce the projections of a wide range of three-dimensional Atmosphere-Ocean General Circulation Models, including the models underlying the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC). This flexibility permits the exploration of the range of plausible outcomes given uncertainties in emission paths and the response of the climate system.

The horizontal axis shows projected global mean temperature change in degrees Celsius, comparing the end of the 20th century with the end of the 21st century. The vertical axis is a measure of likelihood[6]. The colored lines in the figure represent an attempt to define the range of potential temperature changes by the end of the 21st century and the likelihood that any given set of outcomes will occur under each of the policy scenarios for limiting global emissions of greenhouse gases. A number of implications arise from the figure.

6 To be precise, the vertical axis is the probability density that describes the likelihood for climate change to reach a temperature increase under the different scenarios. For each of the values, the higher the probability density, the higher the likelihood is. Yet, unlike probability, the probability density can take on values greater than one.

Figure 3.1: Estimated Distribution of Global Mean Surface Temperature Change in Degrees Celsius by 2100



Source: Webster et al. (2012).

» The extent of global temperature increase is uncertain. This is true even though estimating global average temperature change is one of the more robust outputs of existing general circulation models (GCMs). Consider the black line labeled "No Policy," which corresponds to a scenario in which global emissions are effectively unlimited by mitigation policy measures. In this scenario, the rise in global average temperature ranges from a minimum of about 2.5 degrees Celsius to more than 10 degrees Celsius, with the most likely outcomes clustered around five degrees Celsius.

This uncertainty in temperature outcomes arises from two sources. First, the quantity of additional greenhouse gases that will be added to the atmosphere over the remainder of the 21st century is uncertain. This quantity depends upon economic growth rates, population growth rates, technology and a host of other factors, including mitigation efforts (although this is assumed to be absent in this scenario). Second, the response of the global climate to a given increase in concentrations of greenhouse gases is not known with certainty. Different approaches to modeling the earth, oceans, and atmosphere yield different results. Experts disagree on, for example, the speed of response of the global climate to changes in the composition of the atmosphere[7].

» Extreme outcomes are possible. Under the "No Policy" scenario, the odds of global temperature rise greater than seven degrees Celsius by the end of the century are a bit less than one in ten. Of course, the distributions depicted in Figure 3.1 are themselves uncertain and are highly likely to shift on the basis of more refined analysis. Nevertheless, the prospect of the global climate tipping irreversibly towards a vastly warmer equilibrium level constitutes one of the most potent arguments for the implementation of mitigation policy in the near term (Weitzman, 2011).

7 As a corollary, it can be seen that the range of temperature outcomes by mid-century, around 2050, is considerably smaller and shifted to the left. A graph similar to Figure 3.1 but focused on 2050 (not shown) would show a temperature rise of roughly between one and three degrees Celsius in the "No Policy" scenario.

» Policy is powerful. The remaining lines in Figure 3.1 depict temperature outcomes under various mitigation policy scenarios. The most aggressive is called Level 1 Stabilization, which reflects stabilizing atmospheric concentrations of greenhouse gases at the end of the century at about 560 parts per million (ppm) CO_2 equivalent (CO_2eq), an approximate doubling relative to pre-industrial levels. Levels 2, 3, and 4 reflect, respectively, concentrations of about 660, 780, and 890 ppm CO_2eq at the end of the century, while the "No Policy" scenario reflects a median concentration of about 1330 ppm. The important point from the figure is that effective global mitigation policy drastically reduces the probability of extreme outcomes – a highly desirable result.

The global economic costs of attaining the various levels of stabilization are the subject of considerable debate. The IPCC AR4 (IPCC, 2007b) reports a range between a slight global GDP gain and about a 4 percent loss in global GDP by 2050 for stabilization at around Level 1 (see Table 5.2 of the AR4 Synthesis Report)[8]. Costs for Level 2 and other scenarios are likely to be considerably less. The range of cost estimates is due principally to different assumptions about flexibility across energy sources and rates of technical progress. The cost estimates also implicitly assume the design and implementation of reasonably efficient mitigation policies. It is widely agreed that inept mitigation policies could cost much more.

3.2.2 Climate Change and Africa

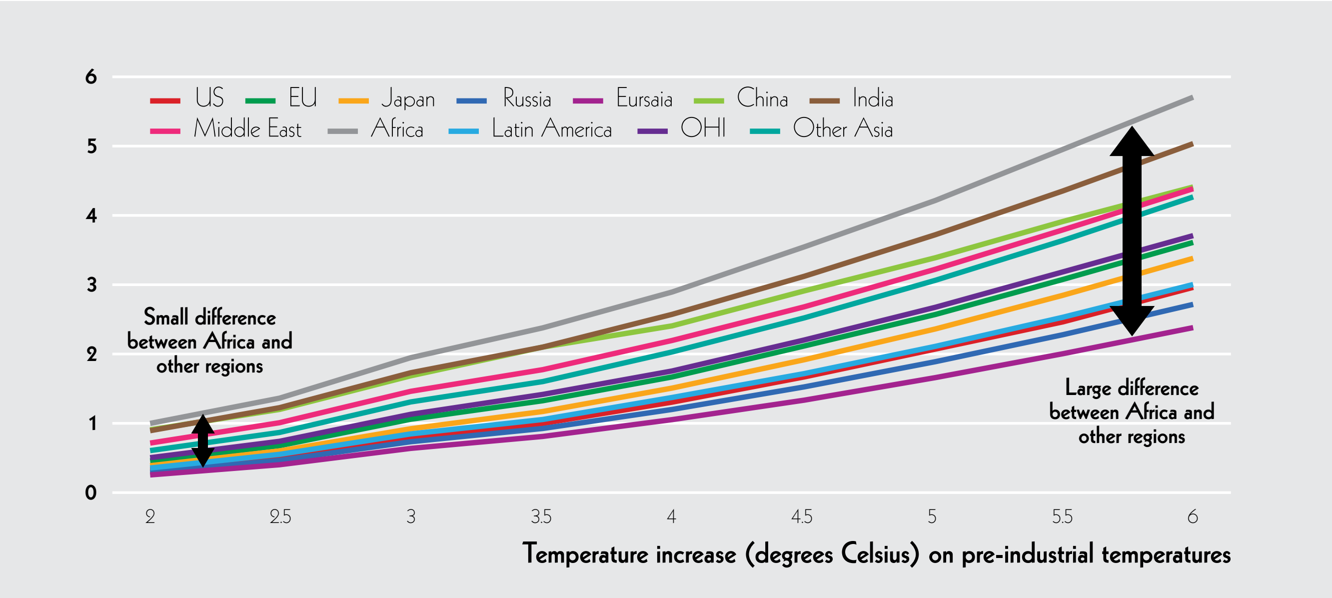
From all of this, two broad implications for Africa are clear, both of which represent sharp breaks from 20th century paradigms. First, regardless of the policy choices made by the rest of the world, Africa should prepare for higher temperatures and other downstream implications of climate change. Given the desultory state of global mitigation policy, it may not be possible to restrain emissions within the boundaries implied by Level 1 stabilization. Based on Figure 3.1, the odds are that Level 2 stabilization will not be sufficient to restrain global temperature rise below two degrees Celsius, implying temperature rises associated with *"dangerous anthropogenic interference with the climate system"* (United Nations, 1992) in the latter half of this century. Africa, with its high climate sensitivity and relatively low adaptive capacity, is widely viewed as being particularly vulnerable (IPCC, 2007c). This is also illustrated by Figure 3.2, which presents estimates of damages in major regions at different temperature increases. It shows both that Africa is the region facing the highest damages and that the higher the temperature increase, the greater the difference in damages between Africa and other regions.

How soon climate change will begin to seriously impair African development prospects is a matter of some debate. The debate on the implications for agricultural yields is perhaps the best developed. Some studies have suggested strong impacts in the relatively near term. For instance, in its discussion of Africa, the working group II contribution to the AR4 states that *"projected reductions in yield in some countries could be as much as 50 percent by 2020, and crop net revenues could fall by as much as 90 percent by 2100, with small farmers being the most affected"* (IPCC, 2007c). Recent work by Lobell et al. (2011) using experiment station data on maize field trials in Africa finds that *"roughly 65 percent of present maize-growing areas in Africa would experience yield losses for one degree Celsius of warming [likely to occur prior to 2050] under optimal rain-fed management."* Thus, access to food will be severely affected (Rosenzweig and Parry, 1994; Parry et al., 2005; Cline, 2007; Lobell et al., 2008).

Other studies report much smaller impacts, at least to 2050. As an indicative example, Ringler et al. (2010) use process-based crop models developed by the International Food Policy Research Institute (IFPRI) and report an average reduction in maize yields in sub-Saharan Africa of about 5 percent due to climate change by 2050. Impacts on root crops, such as cassava and yams, are reported to be stronger, while impacts on rice, millet, and sorghum are negligible or even very slightly positive.

8 The costs of achieving Level 1 stabilization would now be higher because the world has not yet begun any serious mitigation program. Consequently, levels of emissions and stocks of greenhouse gases in the atmosphere are higher than assumed in the models employed for the AR4.

Figure 3.2: Effect of Climate Change by Region



Source: Vivid Economics (2012).

Recent economy-wide assessments conclude that, while expected climate change is highly unlikely to positively support overall growth/development and may be strongly negative for some sectors and regions, climate change is not likely to preclude growth and development prospects for the continent prior to 2040 or 2050 (World Bank, 2010a; World Bank, 2010b; Arndt et al., 2012). In addition, these analyses often find strong impacts outside of agriculture, with an emphasis on extreme events and loss of infrastructure, with agriculture results similar to those of Ringler et al. (2010). Of course, substantially larger losses in crop yields would produce bigger macroeconomic effects, particularly with respect to poverty reduction.

Besides the impact on yields and overall growth, the effects of climate change also depend on the behavioral response of farmers to extreme conditions. When faced with recurrent droughts and related environmental calamities, farmers in Africa have already developed different mechanisms for coping with these extreme events. Belay et al. (2005) and MoFED (2007) provide both micro and macro level analyses of the main coping strategies employed by farmers during adverse climate conditions, especially drought. The sale of animals was found to be the most frequent coping strategy, highlighting the use of livestock as a buffer stock to insulate consumption from unexpected fluctuations in income. However, sale of livestock may not completely compensate farmers for their losses. In the case of Burkina Faso, Fafchamps et al. (1998) show that, during some of the worst drought years in recent history, sale of livestock compensated only up to a third of fluctuations in income. This finding suggests that traditional coping strategies may not be sufficient against harsher climatic conditions.

Another behavioral response of farmers to extreme conditions can be migration out of agriculture. Evidence suggests that environmental change influences rural migration. Two early studies trying to establish causal relationships between environmental variables and the decision to migrate out of agriculture in Africa were undertaken by Henry et al. (2004a, 2004b). They found that, in Burkina Faso, environmental factors (both rainfall change and land degradation) indeed influence decisions to move out of rural communities. Similar findings have been documented by Gray and Mueller (2012), who investigate whether farmers respond to rainfall variability through migration out of agriculture in rural Ethiopia. Their study shows that drought triggers outmigration in Ethiopia and that households with smaller land holdings are more vulnerable than others, thus documenting the nonlinear effects of environmental change on communities. The main implication of their finding is that mobility as a response to environmental change will occur, but only partially, with barriers to participation by some groups such as females.

The wide range of estimates in the source and magnitudes of impacts are indicative of the uncertainties that bedevil adaptation policies. For instance, scientific research is unclear on whether African countries should prepare for a dryer or wetter future. Due to these uncertainties, much recent work on adaptation emphasizes flexibility and policies that provide benefits across a broad array of outcomes (Hallegatte, 2009; World Bank, 2010a; World Bank, 2010b; Arndt et al., 2012). For example, greater attention to agricultural research, regional river basin management, and vulnerability of infrastructure to extreme events can be supported across a broad array of climate futures. This work also frequently emphasizes a strong confluence between the adaptation agenda and the development agenda. Put simply, more developed societies generally have the human and institutional capabilities to cope with shocks and to take advantage of new opportunities. Hence, policies to generate an educated population, combined with flexible and functional institutions, may be some of the most potent and important in the adaptation agenda.

While there may be some disagreement on the implications of one, two, or even three degrees of warming for development prospects for Africa, there is widespread agreement that higher levels of warming produce greater impacts at an exponential rate. At some point, these impacts could completely overwhelm the ability of societies to adapt. The point at which global warming becomes catastrophic for African development prospects is not known. The best policy is to take steps to prevent potentially catastrophic outcomes, which leads to the second broad policy implication.

Africa has strong incentives to help catalyze, in the near term, the implementation of effective and efficient mitigation policies on a global basis. As noted, the entire range of temperature outcomes in the No Policy scenario depicted in Figure 3.1 lies above the two degree Celsius level that is characterized as dangerous[9]. The most likely outcomes under No Policy, warming of around five degrees Celsius, may well prove catastrophic for Africa, even if the outcome does not reach the extreme right hand tail of the distribution. In short, the entire No Policy distribution is unacceptable. The global green growth agenda and African long-run development prospects may well be tightly intertwined, particularly when one extends the view to the latter half of the 21st century.

3.3 Africa's Population Growth and Demographic Transition

> *"Demographic transitions have occurred in every region of the world except for most of sub-Saharan Africa, where fertility rates have declined only slightly"* (Kimenyi, 2012: 282).

Fertility rates, defined as the expected number of births per woman, have declined in sub-Saharan Africa from 6.7 in 1981 to about 4.9 in 2010. Despite this decline, fertility rates in sub-Saharan Africa remain vastly higher than other regions of the world. The fertility rate in 2010 in South Asia, the region with the second highest fertility rate in the world after sub-Saharan Africa, is 2.7, and this figure is trending downward fairly rapidly. In short, South Asia is achieving a demographic transition, and sub-Saharan Africa has barely begun.

Among other implications, this delayed demographic transition implies a very young age structure of the population. This stands in contrast to western countries, which are burdened with aging populations (AfDB, 2011). As the majority of the population in Africa is either at the very beginning or has not yet entered their child bearing years,

9 It is noteworthy that studies using an energy-balance model (unlike the IPCC, which uses a general-circulation model) found lower climate sensitivities (see, e.g., Huber et al., 2011; Forster and Gregory, 2005). However, even with this lower climate sensitivity, the world is on a trajectory to exceed 2 degrees Celsius warming, which is the level at which the climate system is dangerously influenced.

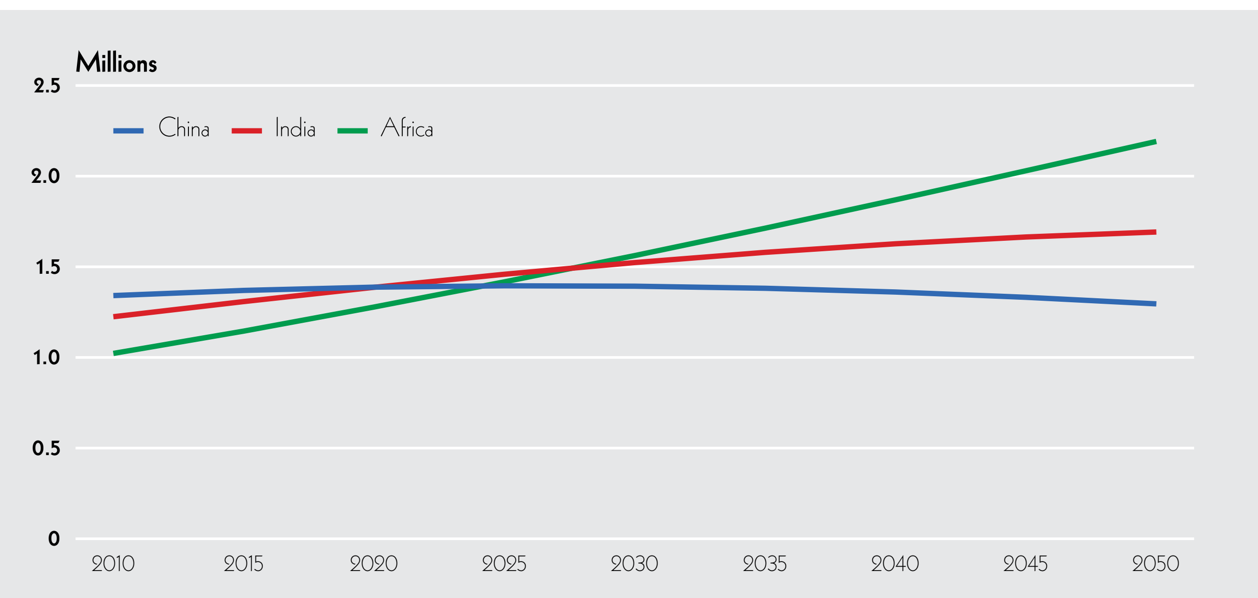
there is considerable momentum in the rate of population growth. Consequently, global population growth to 2050 is set to be concentrated in Africa, particularly sub-Saharan Africa. The medium variant of the United Nations' population projections indicates that Africa will account for nearly half of all global population growth between 2010 and 2050. Outside of Africa, global population is projected to grow by 21 percent between 2010 and 2050. In Africa, the population is projected to more than double over the same period.

The upshot is that Africa's total population is rapidly becoming very large. Figure 3.3 illustrates the medium variant population projections for China, India, and Africa. By 2025, the population of Africa surpasses the population of China, and, by 2030, it surpasses the population of India. By 2050, nearly one person in four on the planet will be an African (see Figure 3.4). About 90 percent of the population of Africa, or more than one person in five on the globe, is projected to reside in sub-Saharan Africa.

There are at least three important implications for population growth looking forward into the 21st century as compared with the 20th century. One implication for Africa is a potentially larger work force that can be more productive, provided the right educational measures and employment opportunities are created. But, in conjunction with other trends, the second implication is that more people will need to share natural resources at a time when many ecosystem goods and services are in decline (MEA, 2005). The demand for natural resources and their products will thus be increasing. As discussed later in this Report, the absolute number of households relying on traditional biomass for cooking fuel is predicted to increase, indicating that increases in population are likely to outweigh shifts to "modern" fuels (OECD/IEA, 2010). An estimated additional 120 million hectares[10] will be needed to support the required growth in food production by 2030, assuming current practices (FAO, 2003). This evidence suggests that trends of natural resource depletion not only need to be halted but reversed. Lastly, the African weight

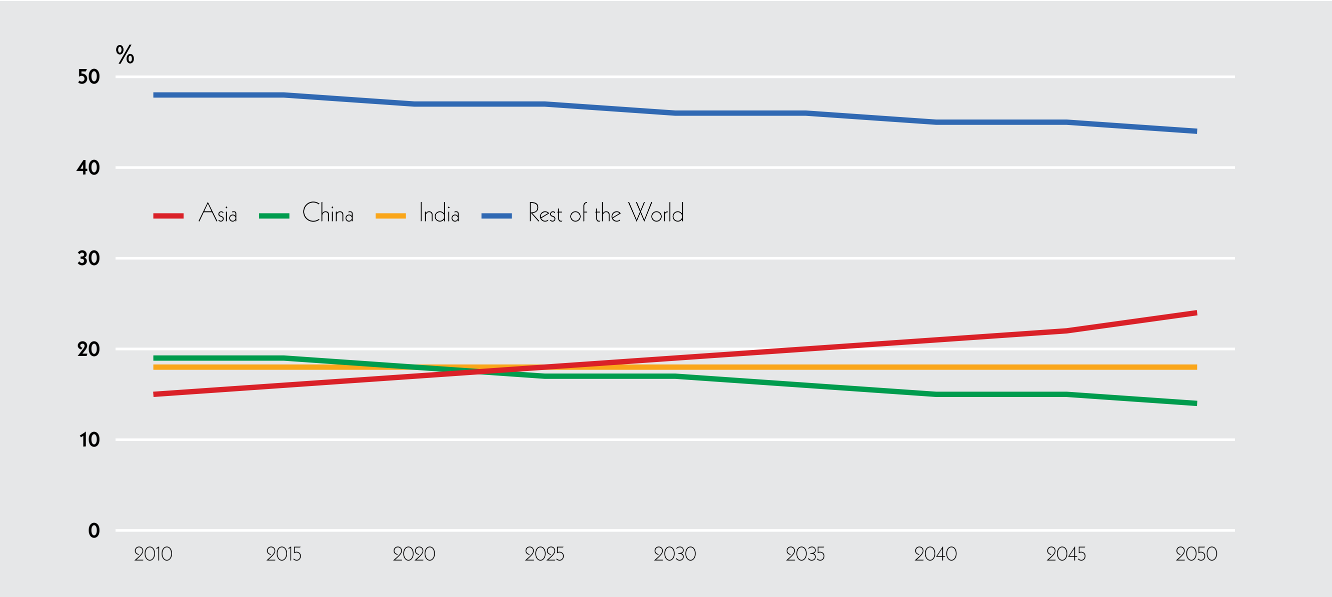
10 This roughly equals the size of South Africa.

Figure 3.3: Medium Variant Population Projections for Africa, China and India until 2050



Source: African Development Report 2012 team based on United Nations Population Division.

Figure 3.4: Global Population Shares for the UN Medium Variant Projections



Source: African Development Report 2012 team, based on United Nations Population Division.

in the global system will become increasingly large. This is particularly true if, as desired, current growth trends persist such that Africa's economic weight increases along with its population weight. Accordingly, Africa's share of global GHG emissions will also increase.

3.4 Global Energy System Transformation and its Implications for Africa

3.4.1 Global Energy System Transformation

The extent of the global transformation in energy systems that is required to stabilize the climate is very substantial. In order to achieve stabilization goals in the range of Level 1 or Level 2 stabilization, global emissions must peak in the near term and then begin to decline (Meinshausen, 2006). This will require a serious change in trend from the previous 200 years, when emissions effectively grew continuously over the whole period.

At this point, it is perhaps useful to step back and consider the three basic options for mitigation policy with respect to emissions from fossil fuels. They are:

(i) Reduce global gross domestic product (GDP) [de-growth].

(ii) Increase output (GDP) per unit of energy input [energy efficiency].

(iii) Reduce greenhouse gas emissions per unit of energy use [energy transformation].

The first option has the virtue of being technically feasible; however, it is deeply unpopular almost everywhere for good reasons. Effectively, it is a nonstarter. The second option is very attractive – almost nobody is against getting more output for less input –and constitutes an important element for achieving global mitigation objectives. The scope for low cost mitigation is greatly expanded when the second option is combined with the third option – energy transformation. There are myriad options with significantly reduced or negligible emissions, such as nuclear power, hydropower, solar, wind, and fossil fuel-fired electricity generation with carbon capture and storage technologies. Options with reduced emissions relative to the current fuel mix, such as natural gas and biofuels, also potentially constitute a part of the shift[11]. If the "No Policy" scenario of Figure 3.1 is to be avoided and Level 1 and/or Level 2 stabilization is to be attained, these sources of energy are likely to become dominant parts of the energy production/use mix on a global scale. The more countries that partake in this energy transition, the easier the transition will be to attain on a global basis.

3.4.2 Energy System Transformation in Africa

From the perspective of African policy-makers, the appropriate policy response to this energy transition is tricky. To what degree should Africa participate in this transition? After all, the vast majority of the stocks of greenhouse gases in the atmosphere originated outside of Africa. While contributing little to the problem, Africa stands at or near the front of the line of those who will suffer from it. At the same time, Africa, particularly sub-Saharan Africa, suffers from a yawning development gap with the rest of the world. Nevertheless, a series of observations argue for engagement in the energy transition.

» As indicated, Africa has powerful incentives to see implemented effective and efficient global mitigation policies. The degree of influence that Africa has in catalyzing effective and efficient mitigation policies on a global basis is not likely to be large; nevertheless, Africa has strong interests in effectively using whatever influence it does have. This implies engagement in the mitigation debate and attention to the energy transition.

» Beyond the gains in terms of climate change avoided from emissions stabilization, a global transition to reliance on clean energy technologies may promote African competitiveness. Africa is certainly well endowed with renewable energy potential, as will be discussed in Chapter 5. In addition, due to a large land endowment, low yields, and significant untapped irrigation potential, Africa has the potential to substantially increase agricultural production, including biofuels. Under an effective global emissions cap, Africa may be well placed in terms of energy costs in comparison with other regions of the world.

» In the desired state of the world, where an effective global mitigation regime is in place and Africa is growing rapidly, African nations eventually will have to develop an energy production/consumption mix characterized by low emissions. The wealthier nations of Africa would logically be first in line to do so. Indeed, South Africa has already begun. It is targeting emissions reductions relative to a baseline path and is planning to introduce a carbon tax in order to help achieve those reductions (see Chapter 8 and Alton et al., 2012).

If the relevant question is not whether Africa engages in the energy transition but when, then emissions considerations might quickly become relevant to decision-making in most African countries, even in the near term. Major public investments in transport and power system infrastructure have the potential to strongly influence the energy production and consumption mix for decades, if not longer. As much of this infrastructure has not yet been built, the opportunity clearly exists for deliberate choices that include global and local environmental considerations.

» Finally, even though relatively little has happened to date, there are real prospects for external financing mechanisms that may increase the attractiveness of lower emissions development pathways. Opportunities for green growth financing will be further discussed in chapter 7.

As emphasized above, this is tricky ground for African policy-makers whose goal is to rapidly shrink the development gap between Africa and the rest of the world. Nevertheless, the principal point is that global environmental considerations represent a new element that rationally enters the 21st century decision-making equation in Africa as elsewhere. This is particularly true for large-scale energy and transport infrastructure decisions, the design of which is a key part of the green growth agenda. Emissions are likely to become a more salient element in decision-making processes over time.

11 Biofuels may lead to net emissions if they provoke land use changes, such as forest clearing, that release CO_2 (Fargione et al., 2008).

3.5 Agricultural Markets and Price Volatility

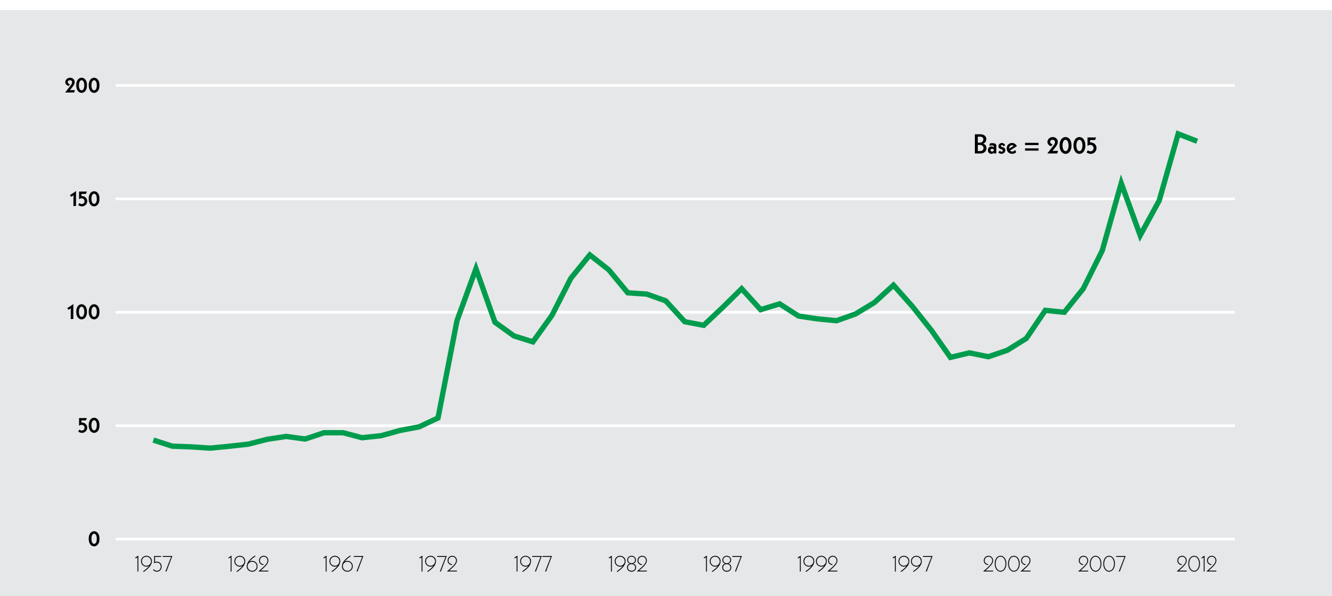
Figure 3.5 depicts the world food price index for the period 1957 to 2011. During the latter half of the 20th century, prices received by farmers remained relatively stable in real terms. This stability was interrupted in the early 1970s when prices received by farmers briefly rose above the levels of 1957, the first year for the depicted price series. Food prices thereafter followed a slight downward trend such that, by the end of the 20th century, prices had declined by about 40 percent from the price spikes in the 70s.

Since 2002, this decline has ceased and been replaced by a consistently rising trend. Food prices are proportionally higher than at any time in the past 50 plus years.

Factors contributing to high and volatile food prices in the 21st century include:

- Traditional demand side factors, including income and population growth. The ongoing transition towards a diet with more meat that is occurring in countries with rapid income growth, such as China, India, and, to a lesser extent, sub-Saharan Africa, is adding significantly to overall grain demand.
- Supply side factors such as climate change, resource depletion, and competition for land and water from municipal and industrial users. Each of these factors limits growth in agricultural production.
- Biofuels create a link between agricultural markets and energy markets. If prices for fossil fuels, particularly oil, remain relatively high, then the potential for converting agricultural production into fuel creates an enormous source of demand for fuel feedstocks, which provides support to global agricultural prices generally through competition for land and other resources (Abbott et al., 2009).

Figure 3.5: Food Price Index (2005=100)



Source: African Development Report 2012 team based on International Finance Statistics IMF online data.

» The potential for constraints on agriculture that could arise from climate change mitigation activities. Mitigating climate change requires reducing GHG emissions from agriculture, because agriculture account for 14 percent of total emissions, principally due to emissions of nitrous oxide and methane as a result of current agricultural practices (UNFCCC, 2009). In order to reduce GHG emissions, programs such as REDD+ seek to preserve forests instead of clearing forest land for agriculture.

As African countries are frequently significant exporters of agricultural products and importers of food, these factors, including their combined implications for agricultural prices, create potentially profound differences between the 20th and 21st centuries. This section turns now to a discussion of some of the implications for African development strategy and the green growth agenda.

3.6 Implications for the Green Growth Agenda in Africa

As discussed in Chapter 2, for the first extended period since the 1970s, Africa has been experiencing sustained economic growth and poverty reduction. The clear challenge is to build on existing growth and poverty reduction momentum while confronting new and existing challenges. This report is entitled "Towards Green Growth" and not "Green Growth Tomorrow." This is an important distinction because, as highlighted by Resnick et al. (2012), tradeoffs exist at both large and small scales.

For example, construction of the Grand Inga dams raises the promise of vast amounts of (near zero emissions) hydroelectric power. At the same time, dams often inflict local environmental damage. In addition, centralized power generation sources run the risk of disruption either at the generating point (what if rainfall declines significantly in the Congo River basin due to climate change?) or via the distribution system. As a second example, limited land and the desire to maintain existing forests and wild grasslands augur for intensified land use to meet food and fiber needs. This frequently implies greater use of fertilizers and pesticides, which impose environmental costs.

In some cases, environmental and development objectives are substantially aligned. Recent decreases in the costs of solar power, for example, may make it the preferred option, especially in villages that are distant from existing grids, with or without consideration of environmental externalities. Obviously, these options should be identified and exploited. Nevertheless, tradeoffs across environmental objectives and between environmental and development objectives cannot be wished away. They can, however, be minimized through well-informed and deliberate choices. In particular, extending the time horizon beyond the very short term focuses on the longer run complementarities in economic and environmental systems and allows for an evolutionary approach towards greener growth.

Fomenting a demographic transition appears to be an area where there are few tradeoffs between environmental and development objectives. The experiences of East and South Asia indicate that unintended consequences can accompany a demographic transition, in the form of distorted sex ratios due to a preference for male children. The extent to which this potential unintended consequence would manifest itself in Africa is not clear, and it is certainly not clear that delaying a demographic transition would help to mitigate whatever manifestation of preference for a particular sex that might appear. As a result, from both a development and an environmental perspective, moving to foment a demographic transition, while quickly diagnosing and dealing with unintended consequences, merits serious consideration as part of a green growth agenda.

Policies to adapt to a warmer climate will be required under all climate change scenarios. Unfortunately, uncertainties over the manifestations and downstream impacts of climate change substantially complicate the formulation of adaptation policies. A green growth agenda should recognize these uncertainties and pursue flexible and robust measures that yield benefits across a broad array of climate outcomes. In addition, because more developed societies are likely to be better equipped to handle a given temperature rise than less developed societies, development is, in itself, an adaptation strategy. In sum, there is time to develop and time to adapt but little time to waste. Those countries that arrive in 2040 or 2050 with desultory institutions and a poorly educated population mired in low-productivity subsistence agriculture may encounter serious difficulties.

The more extreme warming that may occur in the latter half of the 21st century and beyond is cause for great concern. Once the climate system drifts far from historical ranges, the outcomes of such changes are likely to be negative, especially for Africa. How negative is deeply uncertain. Very bad or even catastrophic outcomes appear to be disturbingly likely and certainly cannot be ruled out (Weitzman, 2011). Barring a major change in the science or the emergence of some brilliant geo-engineering solution, the climate of the latter half of the 21st century depends, to a very high degree, upon what the world decides to do about the climate issue in the relatively near term. With respect to mitigation policy in the relatively near term, the stakes for Africa, particularly future generations of Africans, are very high.

Mitigation focuses on the energy transition and agricultural systems. There is good reason for African policy-makers to avoid being railroaded into higher cost or less reliable energy systems, especially if the rest of the world is not seriously engaging in mitigation. At the same time, there is no reason to ignore promising new energy technologies. Under a green growth agenda, emissions considerations should enter the calculus today with respect to major investments in transport infrastructure and energy systems. Consider first hydropower. Whatever the merits and demerits of large scale hydropower investments, the hydropower potential in Africa merits a close look. For example, the Grand Inga project holds the potential to serve as a key element in a transition towards a cleaner energy future in Africa in general and southern Africa in particular. This is not to say that construction of Grand Inga should begin now. Rather, it is to say that the green growth agenda obliges a close look.

Given the continent's considerable endowments, solar and wind power are two other obvious near-zero emissions energy sources. At least from the perspective of African countries that are not major exporters of fossil fuels, effective global mitigation policy will likely confer three additional benefits. First, it tilts global energy production towards sources, such as solar, wind, and hydropower, in which Africa likely has competitive advantages. Second, mitigation policy should spur further technological advance in solar and wind power production, which is likely to favor the continent. Third, relative to no emissions policy, effective mitigation is highly likely to drive down the producer price of fossil fuels (Paltsev, 2012). As most African countries are likely to remain net importers of fossil fuels for decades to come, this is likely to provide a significant gain for these countries[12].

Africa's deficits in transport infrastructure and power systems are well documented (World Bank, 2009; Mafusire et al., 2010; AfDB, 2011). About the only advantage these deficits confer is the ability to wisely choose systems appropriate to the 21st century development context. The same can be said of cities and urbanization. Over the next 40 years, Africa's population is set to more than double in size (Figure 3.3) and to urbanize rapidly. From this perspective, the vast bulk of the African urban landscape of 2050 has yet to be built. In short, the shape of the inter-related triangle of cities, transport systems and energy systems is largely a matter of choice. Wise choices in these areas are a critical component of both the green growth and development agendas.

The last critical component is African agriculture, which lies at a confluence of all the trends discussed in this chapter. The importance of agriculture in a green growth agenda is difficult to overstate. Agriculture is critical for growth and poverty reduction; it is strongly influenced by population growth; it is impacted by climate change; it is potentially a source of low emissions energy via biofuels; it is a significant source of emissions through inputs, production practices and land use changes; it is a potential

12 Obviously, for major fossil fuel exporters such as Angola or Nigeria, relative declines in fossil fuel prices represent terms of trade declines. Whether this is a good or bad thing depends upon whether these natural resources represent a blessing or a curse (Sachs and Warner, 2001).

emissions sink through, for example, reforestation and sustainable land management; and it is strongly influenced by trade and world market conditions. Ideally, African agriculture should stimulate growth and poverty reduction, feed growing populations, provide energy through biofuels, adopt low emissions practices, serve as an emissions sink where possible, and profit from a relatively firm global price environment. African agriculture must face these and other challenges while simultaneously coping with climate change and preserving the natural resource base on which it is founded. The high prevalence of low-productivity subsistence agriculture adds further complications.

There is no magical policy formula for meeting the manifold challenges facing African agriculture. The details of an effective green growth agenda in agriculture are almost certain to be region/country specific. At the same time, it is clear that, under a green growth agenda, agriculture requires particular attention.

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Optimal Management of Natural Capital in Africa

4

Chapter

4 Optimal Management of Natural Capital in Africa

4.1 Introduction

Chapters 2 and 3 discussed the need to pursue green growth pathways in response to Africa's unsustainable growth and potential challenges of the 21st century. The current chapter discusses green growth with regards to natural capital including agricultural land, fisheries, forest resources and tourism, in order to achieve their sustainable management. It presents strategies to maximize benefits from these natural capital.

An unfortunate reality is that wealth in natural resources does not necessarily lead to development, at least not in the case of Africa. As noted by Barbier (2010), "countries with a high percentage of resource-based commodities to total exports or to GDP tend to have lower levels of real GDP per capita, lower growth rates, higher poverty levels and a higher proportion of their populations living in poverty." This "resource curse" works through rent-seeking behavior of those responsible for managing these resources and the frequent policy failures in optimizing rents and making sure that these are reinvested in productive ways. While this past mismanagement of natural capital has been a serious policy failure, there is nonetheless great potential for future growth and poverty alleviation with a green growth agenda that improves policies, abolishes misdirected subsidies, and invests in natural resource management and appropriate institutions.

Without efficient and sustainable management of natural capital, the continent is bound to fail on crucial development objectives such as poverty alleviation, inclusive growth, and food and water security. In the face of tradeoffs between long-term sustainability and immediate economic needs, a better balance can be struck with improved information, investment and management. The challenge facing the continent, then, is to ensure that near-term development needs are met, while attaining a development trajectory that does not jeopardize sustainability and economic growth prospects over the longer term.

4.2 Optimal Management of Agricultural Lands

Agriculture is a key example where practices with immediate benefits, such as pesticide and fertilizer application, impose threats to sustainability. However, green practices have the potential not only to protect the environment but also to help achieve the goals of poverty reduction and food security. This is because green agriculture can ensure the productivity of the agro-ecosystem on which the majority of Africans depend for their livelihood. In this section, evidence is presented that green growth practises can successfully achieve these objectives. In order to preserve the natural systems upon which food security depends, strategies for adapting to climate change will also be necessary.

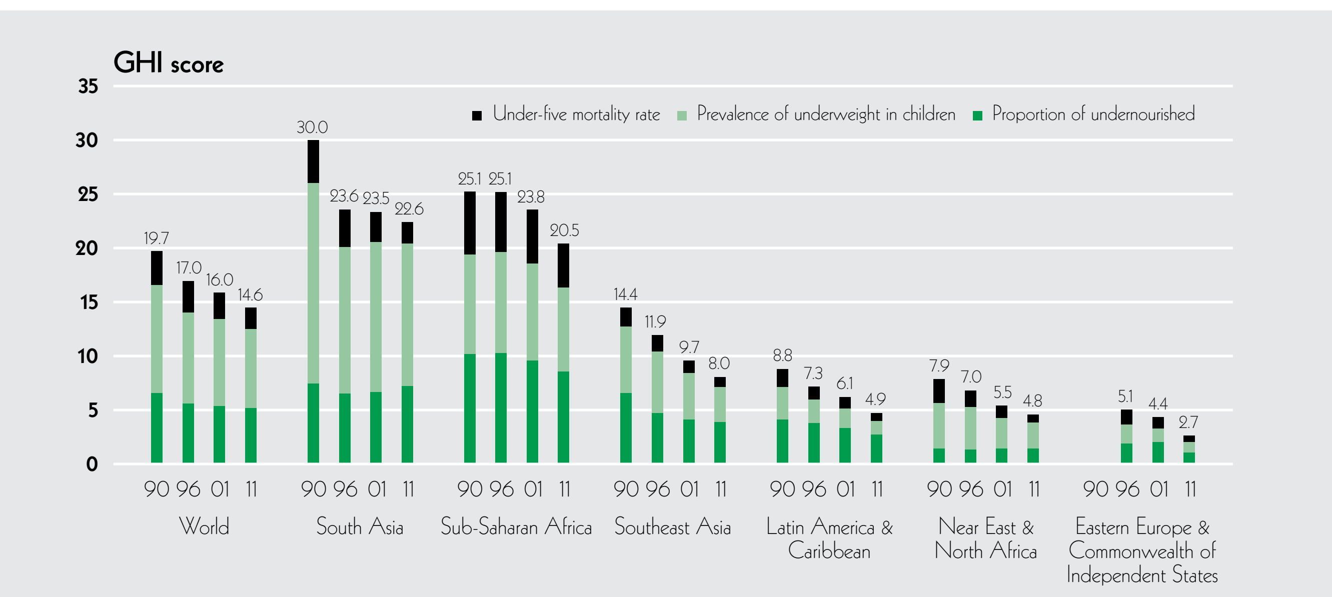
4.2.1 The Role of Agriculture in Meeting Socioeconomic Needs

Agriculture remains at the center of the continent's socioeconomic development. It contributes a third of the continent's GDP, albeit with regional diversities driven by differences in weather and climatic conditions, the economic value of agricultural products, and the importance of other resources. The majority of Africans live in rural areas. The number of people living in rural areas in sub-Saharan Africa is expected to only start to decline around 2045, according to the International Fund for Agricultural Development (IFAD)'s 2011 Rural Poverty Report. SSA has the highest incidence of rural poverty in the world, with 60 percent of the rural population in SSA living on less than US $1.25 a day, and almost 90 percent on less than US $2/day (IFAD, 2010). Because so many rural poor depend on agriculture, increasing agriculture production can help reduce poverty and narrow income disparities. In fact, agricultural growth is more pro-poor than growth led by the non-agricultural sector (World Bank, 2007). There is also a considerable amount of evidence that suggests that agricultural investments could accelerate overall economic growth, even in cases where agriculture itself grows at a slower pace than non-agriculture activities, largely due to multiplier effects from agriculture to non-agricultural sectors (Haggblade et al., 2007).

Hunger is still a major concern for Africa, though there is variation across countries. The Global Hunger Index (GHI) – an index that combines child malnutrition with adult malnutrition and the child mortality rate – shows that hunger remains prevalent and at a level characterized as "serious," especially in SSA. The highest GHI scores occur in South Asia and SSA, with a score of 22.6 and 20.5 respectively in 2011 (see Figure 4.1). Compared to this, the score for North Africa (together in a group with the Near East) is low, at 4.8. The countries with extremely alarming GHI scores in 2011 – Burundi, Chad, the Democratic Republic of Congo, and Eritrea – are in SSA (von Grebmer et al., 2011). Countries with less favorable agricultural conditions tend to have relatively high child malnutrition (Benson et al., 2004), suggesting that agricultural development promotes food security. As a positive example, Ghana was successful in reducing its GHI score by 59 percent from 1990 to 2011 by combining investments in agriculture (provision of information and inputs such as pesticides and fertilizer) with improvements in infrastructure, rural development, education, and health (Kufuor, 2011).

For these reasons, African countries have prioritized agriculture-led development as a way of promoting overall economic growth. The continent has committed itself to

Figure 4.1: Contribution of Components to 1990 GHI, 1996 GHI, 2001 GHI, and 2011 GHI



Source: von Grebmer et al. (2011).

implement the Comprehensive Africa Agriculture Development Program (CAADP) developed by the African Union's New Partnership for Africa's Development (AU/NEPAD). CAADP seeks to foster economic growth by providing a strategic framework for raising agricultural productivity. It targets an average annual growth rate in agriculture of at least 6 percent by 2015. Adoption of sound agriculture and rural development policies is encouraged through four "pillars" or themes: sustainable land and water management, market access, food supply and hunger solutions, and agricultural research. To ensure that governments have the resources needed to implement CAADP, AU countries signed the Maputo Declaration in 2003, agreeing to increase budget allocation to the agriculture sector to at least 10 percent of their respective national budgets by 2008. As of 2011, only 8 of 53 countries have met this target (Science and Development Network, 2011).

In contrast to the increasing agricultural productivity in other regions, most of the increase in agricultural production in Africa has come through agricultural extensification. Cultivated area in Africa has almost doubled in recent years (Bluffstone and Köhlin, 2011). In cases where agricultural intensification has been pursued through the addition of commercial inputs, particularly in the context of the Green Revolution, evidence shows that the impacts include yield increases, but these were varied and uneven across regions, countries, individuals and crops (Lipton and Longhurst, 1989). Additional concerns with agricultural intensification relate to the limited impacts that it had on job creation, as well as environmental problems (Magnus, 1996), which in some cases resulted in declining yields and reduced genetic diversity (Rosegrant and Livernash, 1996).

4.2.2 Can Green Agriculture Alleviate Poverty and Ensure Food Security in Africa?

Because of the problems associated with agricultural intensification using commercial inputs, green agriculture is increasingly being seen as an alternative strategy. Herren et al. (2012) define "green agriculture" broadly as *"the use of farming practices and technologies that simultaneously: (i) maintain and increase farm productivity and profitability while ensuring the provision of food on a sustainable basis, (ii) reduce negative externalities and gradually lead to positive ones, and (iii) rebuild ecological resources (i.e., soil, water, air and biodiversity 'natural capital' assets) by reducing pollution and using resources more efficiently."*

Green agricultural practices have the potential to transform agriculture from a large contributor of GHG emissions to a net carbon sink that mitigates GHG from other sources. More efficient management of carbon and nitrogen flows in agricultural ecosystems not only reduces emissions but can also, for example, sequester carbon by storing vegetative carbon in agroforestry systems. These practices can, at the same time, reduce farmers' dependence on purchased inputs, thus reducing the financial risks of indebtedness and the health risks of pesticide use. Green farming practices involve a combination of interrelated soil, crop and livestock production practices in conjunction with the discontinuation or reduced use of external inputs that are potentially harmful to the environment and/or the health of farmers and consumers. Experiences from the Tigray region of Ethiopia illustrate how green agriculture can raise yields and household income, improve the environment, and attract much-needed community and government support (Kassie et al., 2009).

Agroforestry, for example, presents opportunities for agricultural production, food security and income generation, as well as environmental protection. Agroforestry is defined as any land use system that involves the deliberate retention, introduction or mixture of trees or other woody perennials with agricultural crops, pasture and/or livestock to exploit the ecological and economic interactions of the different components (Nair, 1993; Young, 1997). Compared to conventional agriculture, agroforestry offers more potential for agricultural lands to sequester carbon and maintain biodiversity (Schoeneberger, 2008). In addition, trees and shrubs protect agricultural soil from erosion and sand storms, therefore improving soil fertility and contributing to food security. Thus, agroforestry is an example of sustainable agricultural practices and a vital component of resilient ecosystems and livelihoods. Strategies for realizing the carbon sequestration potential of agroforestry in Africa must take into account political economy considerations, the importance of inclusive governance for managing natural resources, and linkages between agricultural and forest policies.

Green agricultural practices can outperform conventional ones. Green methods include integrated pest management, integrated nutrient management, low-tillage farming, agroforestry, aquaculture, water harvesting, livestock integration, nitrogen fixing crops, etc. Evidence from an extensive review of data from Africa and Asia shows that these practices resulted in productivity increases of 59 to 179 percent (Pretty et al., 2006), while also reducing adverse effects on the environment and generating environmental goods and services (Pretty et al., 2011). Similarly, a 2008 analysis of 114 projects in 24 countries showed that organic or near-organic practices more than doubled yields compared to traditional methods and chemical-intensive conventional farming (UNCTAD and UNEP, 2008). The same study also found that organic farming provided environmental benefits such as improved soil fertility, better retention of water, and resistance to drought. Similarly, an impact assessment study in Burkina Faso showed that conversion to organic farming was associated with improved farmers' incomes, food security and overall livelihoods (Pineau, 2009).

The success of green agricultural practices depends on thorough assessments. The studies presented above show that the popular myth that organic agriculture cannot increase agricultural productivity is not necessarily true and will in reality depend on country or location specific characteristics, as well as on the type of sustainable agricultural practices adopted. It is important to emphasize, however, that the impact of organic farming on productivity is a hotly debated issue with mixed research results.

For instance, Seufert et al. (2012) examine the relative yield performance of organic and conventional farming systems globally using a meta-analysis and find that the yield differences depend largely on system and site specific characteristics. These findings highlight the need to further investigate the factors that limit organic yields, together with assessments of the social, environmental and economic costs and benefits of both conventional and organic farming systems.

A mix of conventional and green practices is an option. Some studies (e.g. Marenya and Barrett, 2009) find strong synergies between inorganic fertilizers and soil organic matter. Organic and inorganic fertilizers, therefore, should be seen as complements rather than substitutes. For example, combining inorganic fertilizers with manure improves fertilizer use efficiency and soil moisture conservation (Vanlauwe et al., 2011). This underscores the importance of combined approaches such as Integrated Soil Fertility Management, in which inorganic fertilizers are applied in tandem with agricultural practices that increase the soil's organic matter content.

Organic products create export opportunities for African countries. The demand for organic products in high-value food markets in Europe and North America has been growing by 10 to 25 percent per year (ICROFS, 2010). The transformation of farming practices in Africa towards green agriculture might open new and high-returns market opportunities. Eastern Africa's experience shows that organic farming can benefit smallholder farmers if the right organizational framework and market links exist. For instance, the program Export Promotion of Organic Products from Africa (EPOPA) helped create links between farmers in Uganda and Tanzania and export markets and resulted in increases in productivity and farmers' incomes. This illustrates that organic agriculture can improve access to high-value markets and generate much-needed foreign exchange earnings. However, the cost of certification of organic products remains relatively high for most smallholder farmers.

Under the right conditions, green agriculture can increase agricultural productivity. Additionally, the combination of sustainable practices with conventional ones can have similar impacts, although this may be less desirable for the environment. A thorough evaluation of national and local characteristics holds the key for identifying which approach is most suitable.

4.2.3 Adaptation in Agriculture

Because climate change is projected to reduce the productivity of many staple crops, African agriculture has to adapt. Chapter 3 discusses in detail some of the research findings of the impact of climate change on agricultural yields. Although this remains a much debated issue, the IPCC suggests that, at lower latitudes, in tropical dry areas, crop productivity is expected to decrease for even small local temperature increases of 1 or 2° C in the region. In many African countries, this impact will be evident in the medium term as, for example, yields from rain-fed agriculture could be reduced by up to 50 percent by 2020 (IPCC, 2007). Affected crops include cassava, maize, millet and sorghum (Schlenker and Lobell, 2010). Climate change will also have negative implications for livestock, as different animals can be sensitive to changes in climatic conditions (Seo and Mendelsohn, 2007).

As also discussed in Chapter 3, traditional coping strategies may not be sufficient to shelter households against harsher climatic conditions, and new adaptation responses will be required. Given this, a growing amount of research documenting the challenges faced by farmers has been conducted. Deressa et al. (2008) show that farmers' choices are influenced by the wealth of the head of household; access to agricultural extension services and credit; information on climate; and agro-ecological settings and temperature. This suggests that the main barriers are lack of information on adaptation methods and financial constraints. Correspondingly, Di Falco et al. (2011) found that access to credit, extension services and information are the main drivers behind adaptation.

4.2.4 Reducing Food Waste

Another adaptation mechanism is reduction of food waste and food losses. This can contribute to both food security and environmental objectives by simultaneously increasing food availability and reducing pressure on the resource base. Food waste refers to the discarding of potentially usable food and occurs along the entire food value chain, while food loss refers to reduction in food quantity and quality which makes it not suitable for human consumption (Grolleaud, 2002). In most African countries, food waste and loss occur mainly post-harvest, due to poor transport and infrastructure facilities, including poor storage, processing and packaging facilities. Gustavsson et al. (2011) find that, in sub-Saharan Africa, 25 percent of fruits and vegetable products that enter the processing and packaging stage are wasted or lost. The corresponding figures for cereal are 3.5 percent, 15 percent for roots and tubers, and 9 percent for fish and seafood.

Food waste and loss raise at least two interrelated policy and developmental concerns. First, Africa already suffers from low agricultural productivity, meaning food waste and loss will further undermine efforts to enhance food security, especially in light of growing populations. Second, disposal of organic waste, particularly via landfilling, coupled with transportation of food that is later thrown away, contributes to GHG (largely methane) emissions (Hartman and Ahring, 2006). Food waste and loss also implicitly indicate waste of embodied key energy and resources, such as water, energy, land, labor and capital along the agricultural value chain. Avoiding waste would in turn imply less deforestation and thus avoidance of GHG emissions.

Reducing food waste and loss should therefore be one of the elements of green growth strategies in Africa, as it presents opportunities for innovation and saving resources. Possible interventions include development of infrastructure to reduce post-harvest losses. This could include improved transport and logistics management, improved packaging and reduced portion sizes, and recovery of edible losses from processors and retailers.

Agriculture cannot be considered in isolation from two other key areas of natural capital: forests and water. The connection to water is obvious. As for forests, green agricultural practices may reduce the need for farmers to clear new land for planting, while maintaining forest cover can prevent soil erosion. The next section will consider issues for the sustainable management of water, followed by a discussion of forests.

4.3 Optimal Management of Water Resources

Water resources are crucial inputs for economic activities such as agricultural and industrial production. This section discusses green growth solutions to sustainably manage water because these can enhance economic growth. For example, management technologies such as irrigation can increase agricultural production, and thus contribute to food security and poverty alleviation. Green solutions to manage water resources are increasingly important in building resilience to climate change. Sustainable water management will mean that African countries can continuously derive benefit from this vital resource.

4.3.1 The Role of Water Resources in Meeting Socioeconomic Needs

Water resources are critical determinants of agricultural productivity. Currently, the agricultural sector is by far the biggest user of water resources in Africa. As indicated in Figure 4.2, the agricultural sector represents 85 percent of the total annual water withdrawals. The remainder is allocated for domestic use (10 percent) and industrial use (5 percent). Because the bulk of the African population depends on agriculture for their livelihoods, water is critical in reducing poverty and enhancing food security. Water is particularly important in African agriculture due to the prevalence of small-scale subsistence farmers who often have low levels of technological inputs that could help them increase the efficiency of other non-water factors of production. In the less developed parts of the continent, the share of water used in agriculture is currently higher than withdrawals for domestic and industrial uses. However, there are large disparities in freshwater withdrawals among different sub-regions and countries in the continent. For example, the percentage for Mali, Mauritania, Sudan, Swaziland, and Madagascar is over 90 percent, while it is below 10 percent for Central Africa and Equatorial Guinea.

Although agriculture is the principal user of water resources, domestic, municipal and industrial uses of water are increasing. Moreover, Africa's rising urbanization trend and rising incomes are increasing competition for water between agriculture and non-agriculture (municipal and industrial) uses. Africa's urban population is projected to grow by about 45 percent from 2010 to 2030, according to UN HABITAT (2010). By 2030, almost half of the African population will be living in urban areas, and this share is projected to increase to over 60 percent by 2050. Thus, food and water security for Africa's rapidly growing urban population is a matter of serious concern in the medium to longer-term. Water management will involve tradeoffs between these sectoral users, as well as between meeting economic growth targets and avoiding further depletion and degradation of this resource. Water should, therefore, be viewed as an economic, social and political issue encompassing all sectors of the economy.

4.3.2 Integrated Water Resources Management

Because agriculture is the largest consumer of water, the discussion on efficient water management focuses mainly on agricultural water. Delivering and applying water to crops more efficiently and increasing crop yields per liter of water (and also livestock and aquaculture water productivity) are thus critical to enable the continent to meet rising food demand and competition from non-agricultural users. Three broad sets of green growth strategies for integrated water resources management can be identified. These include (i) Water Harvesting (Storage and Distribution Infrastructure); (ii) Water Conservation and Water Demand Management; and (iii) Water Governance and Institution Building. These strategies can also serve as critical adaptation measures to cope with the effects of climate change, thus smoothing water availability and safeguarding agricultural production against volatility. Moreover, green growth strategies can contribute to economic growth as, for example, irrigation contributes to increases in agricultural yields.

Figure 4.2: Annual Freshwater Withdrawals by Region (as Percentage of Total Freshwater Withdrawal)

Source: African Development Indicators 2011, World Bank.

4.3.2.1 Water Harvesting, Storage and Distribution Infrastructure

Water harvesting, storage and distribution infrastructure are critical in countering seasonality in water availability and thus protecting populations against climate change and variability. Yet, a large proportion of Africa's population, particularly in SSA, depends on rain-fed agriculture, which is highly vulnerable to climate variability and change. So far, efforts by African governments to invest and develop water storage mechanisms are minimal. Currently, countries in SSA store only 4 percent of their annual renewable flows, compared to industrialized countries that store between 70 and 90 percent of the flows (WWAP, 2009). Water storage is vital for irrigation, water supply, hydropower, and flood control. Given Africa's vulnerability to climate change impacts, a key challenge is to ensure that infrastructural developments, including those relating to water harvesting, storage and distribution, are resilient to climate change impacts and as resource-efficient as possible.

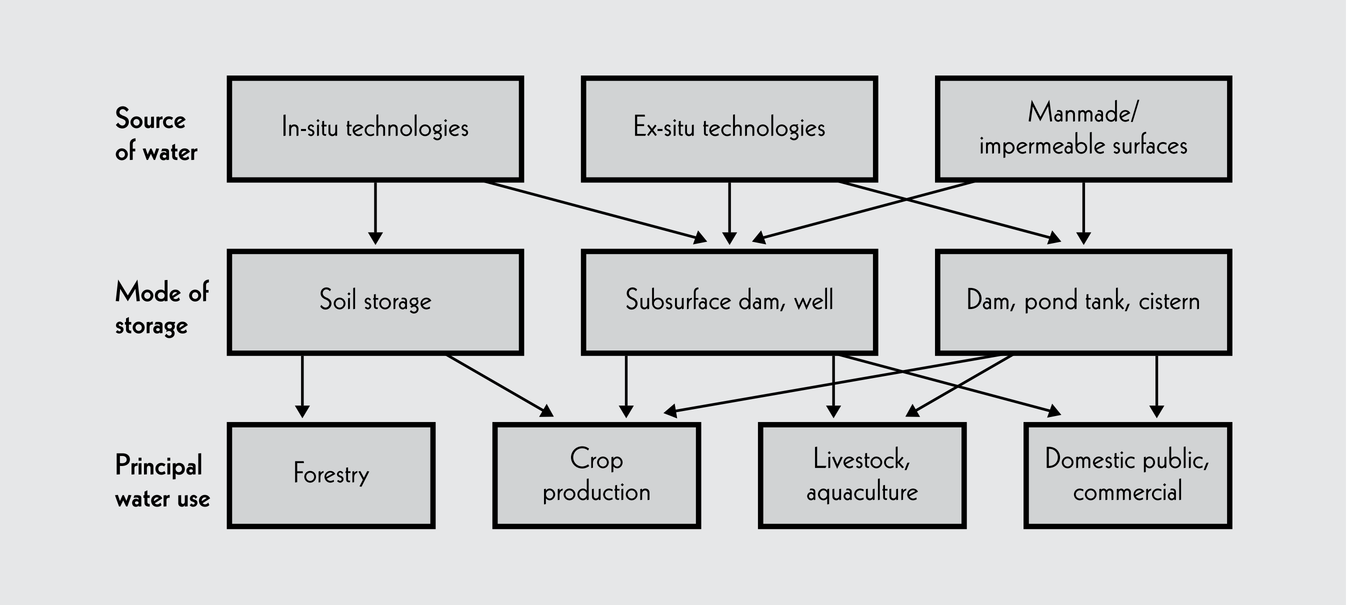
Specific areas to invest in terms of infrastructure include the following:

Rainwater Harvesting and Storage

Rainwater harvesting (RWH) can mitigate the effects of temporal shortages of rain to cover both household needs and productive use. RWH involves concentrating, diverting, collecting, storing, utilizing and managing runoff for productive use. Figure 4.3 shows a schematic diagram of rainwater harvesting technologies based on source of water and water storage type. It gives an overview of which storage types can be used for which sources of water. Furthermore, it shows which storage types can be applied to efficiently use water for natural capital or sectors of the economy.

RWH generates a number of other benefits including reduced erosion due to reduced surface runoff, improved quality of ground water, a rise in water levels in wells and bore wells that are drying up, and drought-proofing. RWH offers an ideal solution in areas where there is sufficient

Figure 4.3: Schematic of Rainwater Harvesting Technologies Based on Source of Water and Water Storage Type



Source: UNEP/SEI (2009).

rain but adequate ground water supply and surface water resources are either lacking or insufficient. A RWH system is particularly useful in remote and difficult terrain.

Irrigation and Drainage

Irrigation has the potential to boost agricultural productivity. Irrigated yields are typically one to three times higher than those of rain-fed crops (Svendsen et al., 2009)[13]. In Africa, irrigation could raise productivity by at least 50 percent (You et al., 2011). Yet, irrigation remains underdeveloped in Africa, other than North Africa and South Africa. Food production is almost entirely sustained through rainwater. African countries irrigate only about 5 percent of their collective cropland, which is significantly lower than other world regions, such as Asia, with around 30 percent (Salami and Ajao 2012). Other studies also highlight the limited irrigation of African lands compared to the rest of the world (see Figure 4.4). The disproportionate contribution of Africa's small irrigated area to agricultural production suggests that returns to additional investment in irrigation would be high, both in terms of greater food security and greater production for export (Svendsen et al., 2009). Not all countries in Africa under-utilize their irrigation potential. Close to two-thirds of Africa's irrigated land is concentrated in five countries: Egypt, Morocco, Sudan (all in northern Africa), Madagascar and South Africa (ibid). However, some of these examples, especially in northern Africa, show how irrigation practices can become unsustainable.

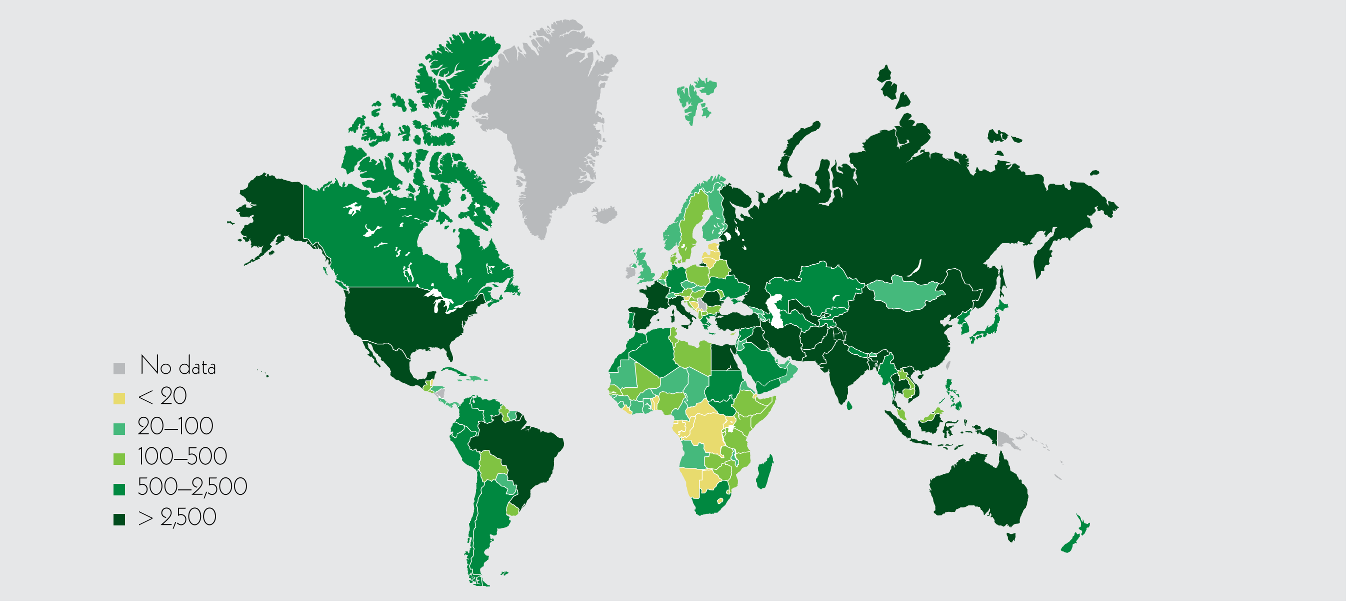
The effect of irrigation on food security and poverty is, however, dependent on equitable distribution of water to farmers, as well as on the choice of crops cultivated. Depending on differences in access to water, irrigation may affect rich and poor farmers differently. Moreover, its impact on the incidence of rural poverty depends critically on the extent to which productivity gains "trickle down" through increases in income and employment for all categories of the poor.

Groundwater Development

In the right circumstances, groundwater can provide a secure, readily available, sufficient and cost-effective

13 Irrigation is only one of the capital investments and inputs that Africa needs to boost agricultural productivity. Others may include fertilizer, improved seed technology, technologies to reduce postharvest losses, and access to markets. The relative merits and potential synergies of organic and commercial inputs are discussed above.

Figure 4.4: Area Equipped for Irrigation (1000 ha)



Source: UNEP/SEI (2009).

source of water supply. It is especially important in extensive drought-prone areas of southeastern, eastern and northern Africa – where the average rainfall is less than 1,000 mm per annum. Indeed, groundwater is the main source of water for 70 percent of the population in the Southern African Development Community (SADC) region. It is also particularly important in livestock rearing areas, where livestock are both a "banking mechanism" and also a drought coping strategy. Groundwater also supports village subsistence-level cropping and water supply for community industries.

To maximize benefits from groundwater, governments must provide information on its occurrence and quality, build capacity, and promote investments. In many parts of the continent, groundwater resources have not yet been fully explored and tapped; the exception is northern Africa, where groundwater withdrawal is equivalent in quantity to about 20 percent of annual rainfall (UN-Water/Africa, 2006). However, some of Africa's important aquifers are losing water faster than the rate of recharge. Recent studies show that most aquifers in Africa are unsustainably mined, such as those found in large sedimentary basins of Lake Chad, and those under the Sahara desert (Stock, 2004). Governments and development practitioners, therefore, need to identify and scale up good practices to promote efficient groundwater source development, maintenance and protection. Groundwater development is highly specialized, which means capacity building should form a huge part of development strategies. In addition, existing groundwater capacity needs to be used much more effectively. Significant efforts are required to develop new training partnerships between northern and southern institutions, and to increase the provision of training at various levels within Africa.

Flood Control and Protection Structures

Flood control and protection structures reduce the negative impact of floods on livelihoods, land and ecosystems. Climate change is expected to increase the frequency and intensity of floods in the region. Of all hydro-meteorologically caused natural disasters, floods and storms not only occur with the highest frequency but also result in the highest number of fatalities and cause most of the economic loss (KfW, 2011). There is evidence that floods

in Africa have increased in severity. For example, the 1999-2000 floods in Mozambique, Botswana, Zambia and South Africa flooded some 200,000 ha of cropland and affected more than 150,000 families (Mpofu, 2000). Therefore, additional flood control measures are needed to protect livelihoods and capital investments. These measures should have the broad aim of reducing the negative impact of floods on land, ecosystems and human settlements. Measures to minimize the negative impacts of floods (i.e., flood control and protection measures) can be divided into two groups: structural measures and non-structural measures. Examples of structural measures include storage dams, dykes, reservoirs and channels diverting floodwater, called floodways or flood embankments. Examples of non-structural measures includes flood zoning, flood plain management, flood warning systems, emergency and evacuation plans, education and awareness, and insurance.

4.3.2.2 Water Conservation and Water Demand Management

Water conservation and water demand management (WC/WDM) refers to the efficient use of water and the management of the total quantity of water abstracted from a source of supply, using measures to control waste and undue consumption. According to DWAF (Department of Water Affairs and Forestry, South Africa) (1999) water demand management is "the adaptation and implementation of a strategy by a water institution to influence the water demand and usage of water in order to meet the following objectives: economic efficiency, social development, social equity, environmental protection, sustainability of water supply and political acceptability." A broad range of economic, socio-cultural and technical approaches and instruments are applied for WC/WDM, including: (i) tariffs, metering and credit control; (ii) user education, awareness raising and stakeholder involvement; and (iii) leakages detection and use of water saving devices. Many African countries have adopted WC/WDM measures to eliminate water losses and increase water efficiency or productivity. A widely adopted economic measure is the tariff system; Box 4.1 illustrates the effect of WDM measures on efficient use of water.

4.3.2.3 Water Governance and Institution Building

Recently there has been a renewed emphasis on "water governance" in response to climate change impacts. Water governance refers to *"the range of political, social, economic and administrative systems that are in place to regulate the development and management of water resources and provision of water services at different levels of society."* (UNDP et al., 2002). Water governance highlights policy options for sustainable, equitable and efficient water

Box 4.1: Water Demand Management Examples

Zimbabwe

The city of Bulawayo implemented a water demand management system in 1999. Measures adopted include developing awareness among water users about the need to conserve water; block tariffs to discourage excessive water usage; pressure management and leak detection systems; and improvements in the operation and maintenance of water infrastructure. These measures have reduced water consumption to an average of 75 litres/capita/day, in comparison to 200 to 300 litres/capita/day in similar suburbs in Harare.

Morocco

In Souss Amont, the scarcity of water, combined with the increase of irrigation water tariffs, led farmers to adopt water-saving irrigation techniques, such as drip irrigation instead of sprinklers. The implementation of a tariff adjustment plan also resulted in a considerable increase in the areas equipped with drip irrigation. During the period 1996-2002, irrigation water tariffs increased by 40 percent; this has led to a more than 400 percent increase in the area equipped with drip irrigation.

UN-Water/Africa (2006)

resource management. These include decentralization and the development of new forms of local governance; local users' participation; private-public partnerships; and declining financial and technical roles of the state/public sector (Ngigi 2009).

Water governance reforms include Integrated Water Resource Management (IWRM) policies at the river basin and watershed level. Decentralized institutions include basin committees, Catchment Management Agencies, and, at the local level, Water Users' Associations (WUA). Most effective WUAs adopt a watershed or catchment management approach that encompasses protection/conservation and water resources management in order to allocate water equitably. Current policy reforms in Africa support establishment of WUAs as the basic unit of water resources management, thus decentralizing water resources management. WUAs charge nominal water fees to sustain their activities, which include operation and maintenance of water supply systems and watershed protection.

In certain African countries – South Africa, Zimbabwe, Niger, Kenya, and Tanzania, among others – there have been active efforts to reform the water sector and to provide a conducive and enabling policy environment. Yet, good water governance has in practice proven difficult to achieve, and in many cases the devolution of water sector decision-making authority to local levels has met limited success. Several factors have contributed to the difficulties of achieving good water governance. These include overlapping institutional mandates, excessive central government control over sector revenues, and intergovernmental transfers (Cowater International, 2008). Moreover, the objectives underlying policies and reforms at a national level often appear mutually exclusive (e.g., social equity and economic efficiency). Therefore, decision-makers are often faced with difficulties in striking a balance between these objectives when implementing water sector reforms.

In Kenya, for example, the Water Act of 2002 decentralized the management of water services. However, it failed to streamline the institutional mandates, and there remained overlaps in many roles (such as the city council and the water company). This lack of clarity is a fundamental governance challenge that the current policy debate should strive to address (Oteino, 2013). South Africa provides another example. Since 1994, the government has implemented a policy of irrigation management transfer (IMT) to reassign these functions from the state agencies to farmers (Perret, 2002). The adoption of IMT policies is mainly motivated by the need to reduce government expenditures on irrigation and to transfer irrigation power to farmers, including the power to modify management systems. However, the lack of existing farmers' organizations posed a strong hindrance to local institutionalization and to the success of the IMT process (Perret, 2002). In addition, most irrigation rights are given to men, when women are the actual irrigators (ibid).

Finally, improving governance in the water sector is not only about government systems and enacting policies and legislation; it encompasses a much broader range of factors, including engaging civil society, and, most importantly, ensuring that local capacities and competence are in place (Cowater, 2008). The experience of irrigation management transfer to farmers in Niger offers a good illustration of the practical challenges faced when implementing good water governance (Vandersypen et al., 2006). The reform process was too abrupt and ignored the time needed to build the capacity of local users to undertake their roles. It also assumed that farmers' organizations for water management would arise spontaneously, thereby overlooking social impediments to collective action.

4.4 Optimal Management of Forests

This section explores the role of the forestry sector in green growth pathways for African countries. The starting point is the importance of the sector as a provider of resources to meet some critical economic and social needs, mostly of the rural poor. Like any renewable resource, forests self-generate and could potentially provide a flow of benefits in perpetuity. However, immediate and pressing socioeconomic needs of many poor communities present a challenge to sustainable forest management. It is imperative that policy makers weigh the benefits associated with green growth solutions against the opportunity cost of the forgone economic and social opportunities associated with activities that degrade forests. This section introduces green growth strategies and concludes that current management strategies do not offer adequate economic incentives to halt forest degradation. Payments for ecosystem services in the context of international initiatives are one approach to sustaining stable levels of forest cover.

4.4.1 The Role of Forests in Meeting Socioeconomic Needs

More than half of Africa's population relies on forests for their livelihoods. People living close to forests derive considerable food security, fuel, and cash income from the nearby forests. For example, wild lands and forests in rural Zimbabwe, Tanzania, and South Africa provide between 15 and 58 percent of households' cash income (Kaimowitz, 2003). Around 70 percent of households use wood fuels (fuel wood and charcoal) for cooking and heating. Forests act as safety nets for many rural households, providing foods such as wild fruits, vegetables, and bushmeat, especially in western and central Africa (Kaimowitz, 2003). They also provide a broad range of environmental services (Somorin, 2010). These vital roles played by forests are often not captured in GDP statistics, in part because some countries do not collect or publish sufficient data, but mainly because most of the direct benefits of forests discussed above are not recorded or do not pass through markets.

Africa's forestry sector makes a small direct contribution to most countries' GDP, accounting for around 2 percent for the continent as a whole (Lebedys, 2004). Forest products account for around 5 percent of the region's exports (Kaimowitz, 2003). Figure 4.5 provides an estimate of the contribution of the formal forestry sector to GDP for a range of African countries. Overall, there has been very little industrialization of the sector, suggesting the potential for forestry to play a greater role in economic growth. As an example, Non-Timber Forest Products (NTFPs) are increasingly being integrated into international value chains. High profile examples include shea butter in western Africa and medicinal plants in southern and northern Africa. There is evidence that enhanced market opportunities for extracted tree products such as shea can have a positive impact on the sustainable management of the trees and the landscapes where they are found, suggesting an opportunity for green growth and poverty reduction through such livelihood opportunities (Masters et al., 2004). However, sustainable commercial exploitation requires appropriate property rights and could cause tensions with new carbon initiatives.

4.4.2 Tradeoff Between the Sustainable Management of Forests and Socioeconomic Needs

There is often a particularly distinct tradeoff between the sustainable management of forests and socioeconomic interests, arguably more so than in the case of other natural capital. Deforestation and forest degradation serve economic interests and social needs. Decreasing the rate of deforestation can therefore come at the expense of exports, growth in agriculture, and access to affordable fuels, at least in the shorter term. In the longer term, however, continued deforestation will cripple economic growth. Thus, a green growth pathway for forests in Africa that provides a stable rate of forest cover is desirable, in order for ecosystems to be protected and, at the same time, for households and businesses to be able to use forests as a source of income and energy.

In Africa, the expansion of smallholder and subsistence farming, particularly for the production of staple crops, is the key driver of deforestation (Fisher, 2010; Deininger et al., 2011). This can lead to employment opportunities for rural households and a more diversified export base (Resnick et al., 2012). Historically, such conversion has typically provided households with faster routes out of poverty than protecting those forests (Barry et al., 2010). For example, Mozambique has pursued a strategy of agricultural extensification, converting forests to agricultural land to grow sugar and jatropha for biofuel production. In addition, there are micro-enterprises that use forest products as key inputs, such as the collection of NTFPs and the production of charcoal and timber.

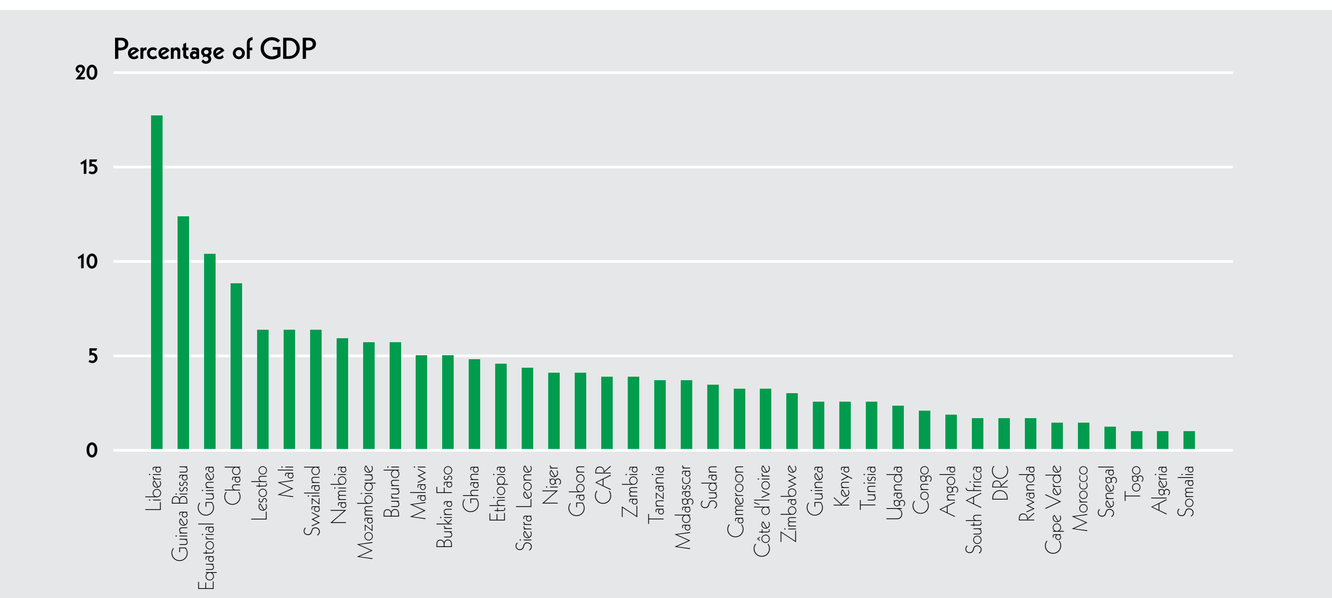
A further important driver of forest loss in Africa is fuel consumption. Over 80 percent of the wood that is harvested from sub-Saharan Africa's forests is used as fuel (Mercer et al., 2011). Central and southern Africa's dry Miombo forests provide charcoal for an estimated 25 million urban people (Campbell et al. 2007). In Africa as a whole, although the proportion of households relying on traditional biomass as their primary cooking fuel is predicted to fall, reflecting increases in income and a natural transition to preferred fuels, the total number of households reliant on traditional biomass is predicted to increase from 657 million in 2009 to 922 million in 2030 (see Table 4.1). In this context, banning the use of charcoal and other forms of traditional biomass, even if feasible, would push households to use fuels that are currently more expensive, and would harm rural and urban individuals whose livelihoods are based on the charcoal trade.

However, the continued loss of Africa's forests will lead to a no-growth scenario that should be avoided. In many rural areas, households are reported to be spending a longer time searching for fuelwood as degradation continues; this is time that could be spent in other economic activities. Unchecked illegal logging not only leads to loss of forests but denies African countries revenues from these forests. Deforestation can also affect the ecosystem services that forests provide beyond the immediate area, such as sustaining watersheds that supply water to urban areas. Likewise, the use of traditional wood fuels has well-known adverse health effects and is problematic for the climate for two reasons. One reason is the extraction of biomass and accompanying loss of carbon sequestration potential. The other reason is that black carbon, which has more warming potential than CO_2, is formed through the incomplete combustion of fossil fuels and biomass in cook stoves.

4.4.3 Sustainable Management of Forests

Green growth solutions to sustain Africa's forest stocks include halting deforestation, preserve and protect forests, improve forest management, reducing the dependence of households on natural forests for fuel, whether fuelwood or charcoal; and more afforestation to substitute for the exploitation of natural forests. Due to the critical role

Figure 4.5: Percentage Contribution of the Formal Forestry Sector to GDP in Africa



Source: Lebedys (2004).

forests play in climate change mitigation, it is imperative to protect Africa's forests. However, because sustainable management practices generate few direct net benefits at local levels, there is little economic incentive to engage in them. As a result, payments for ecosystem services (PES) are crucial, as they offer incentives to sustainably manage forests. Currently, international initiatives offer funding for such activities, although these initiatives are still the subject of reform, which is holding back their effectiveness.

Afforestation sequesters carbon and offers an alternative source of tree products. Afforestation implies the establishment of a stand of trees on a piece of land where there was no forest. It facilitates sequestration of CO_2, both in forest biomass (roots, stems, branches, and leaves) and in soil (Beedlow et al., 2004). The exact carbon sequestering capacity of a given forest land depends on a large number of factors, such as the species and mixture of trees in the forest, the age of the trees, and the climatic conditions. It is roughly estimated that 2.2 to 9.5 tons of CO_2 could be captured by an acre of forest (Birdsey, 1996). Tree planting for commercial purposes offers an alternative source of tree products that would otherwise be collected from natural forests. This could include fuelwood, charcoal, timber, and building materials.

There is a limited literature on afforestation in Africa, and most of it focuses on South Africa, where there has been the most experience. What evidence there is suggests that the impact of afforestation projects is mixed. In South Africa, afforestation has been implemented predominantly to supply timber. It is most appropriate for the wetter eastern areas, using exotic species such as European and North American pines which, unlike indigenous species, are not affected by local pests and diseases. "Patchwork" afforestation, which leaves riparian zones as open grasslands or indigenous forests, and corridors for fauna and flora movement, can help to retain biodiversity (van der Zel, 1997).

However, afforestation has had unintended consequences. For example, afforestation in Mpumalanga Province has contributed to the increased likelihood of extinction of a number of bird species, including some that are globally threatened (Allan et al., 1997). There is also evidence of conflict between afforestation to supply timber and the resulting reduction in catchment water yields (Smith and Scott, 1992). There appears to be consensus that, in South Africa, planted trees bring with them many benefits, but also have often resulted in reduced river flows; this is a particular problem, as water in the country has been identified as a key constraint to economic growth. This highlights a broader constraint: the scope for large-scale tree planting in Africa is limited by rainfall and water availability. Only locations with sufficient rainfall can support large-scale tree planting. For example, much

Table 4.1: Current and Predicted Dependence of People on Traditional Biomass as Primary Cooking Fuel by Region

	Millions of people			Percentage of population		
	2009	2015	2030	2009	2015	2030
Africa	657	745	922	67	65	61
Developing Asia	1937	1944	1769	55	51	42
Latin America	85	85	79	54	51	44

Source: OECD/IEA (2010).

of South Africa and the Sahel are not suitable because of low precipitation (Jindal et al., 2008). These limited findings suggest that relying on afforestation to provide wood products and to absorb carbon dioxide should be approached cautiously.

4.4.3.1 Payment for Ecosystem Services

For subsistence farmers in SSA, receiving payments for ecosystem services will enable them to diversify their income and improve their livelihoods. PES provide farmers or landowners with payments in exchange for services. They are a transparent system for the additional provision of environmental services through conditional payments to voluntary providers (Tacconi, 2012). The idea of PES hinges on "commodification of nature," by putting economic value on ecosystem services (Wunder, 2006). It is generally understood as a voluntary transfer of incentives – most often monetary – from beneficiaries to providers of ecosystem services, as long as incentives are made conditional to actual service provision (Corbera, 2012).

Forests provide a number of ecosystem services, including watershed management, soil conservation, crop pollination, nutrient cycling, carbon storage and habitat for biodiversity (MEA, 2005). As an ecological service, carbon storage in forests is increasingly receiving both scientific and political attention for a PES scheme. A new wave of international climate policy is being designed to include forests (especially tropical forests) in global mitigation efforts. This framework is called reducing emissions from deforestation and forest degradation (REDD), bolstered by conservation, sustainable management of forests and the enhancement of forest carbon stocks (REDD+). The REDD+ mechanism aims at generating financial incentives to protect and better manage forest resources, by providing financial rewards to countries that reduce carbon emissions caused by the loss and degradation of their forests (Corbera and Schroeder, 2011; Somorin et al., 2012; Corbera, 2012). It is in this light that many scholars and commentators have presented REDD+ as the world's largest PES experiment.

PES schemes are not generally well-developed in Africa. Thus, the REDD+ initiative, along with the Clean Development Mechanism (CDM), represent opportunities to provide financial resources for African countries to prioritize efforts and programs to enhance forest stocks, reduce forest biomass loss and enhance the livelihoods of forest-dependent communities. Chapter 8 will discuss the potential for these mechanisms to help finance green growth in Africa.

REDD+ initiatives in African countries and elsewhere remain at the pilot stage (Dutschke, 2008). Tanzania is more advanced than most African countries. The Tanzania Forest Conservation Group (TFCG) has chosen community-based forest management (CBFM), a specific type of participatory forest management (PFM), as the natural model for implementing REDD+. By choosing to emphasize CBFM as a forest conservation tool, TFCG implicitly recognizes the impact of community-level actions on forests and the importance of forests to local communities. REDD+ payments are made at the village level in response to verifiable reductions in the rate of nearby deforestation. Because of measurement difficulties, forest degradation has not been included in the REDD+ pilot. Each village chooses how to allocate the REDD+ funds, which may be divided amongst individual households and household members; spent on community projects such as schools, latrines, or a dispensary; or spent on protecting the village forests (Robinson et al., 2013).

There are few examples of CDM in Africa. The first temporary African CDM forest credits were issued in 2012 in Ethiopia for the restoration of 2,728 hectares of land. Similarly, in Niger, local communities have been involved in assisting in the re-sprouting of native species. This process required the strengthening of land rights of rural households, who now have legally recognized rights over their land, which therefore has become a valuable asset. Limits were imposed on cattle grazing on the forest lands, but communities now have a new income stream from sustainable harvesting of fodder, fuelwood, and other non-timber forest products (Brown et al., 2011).

REDD+ and CDM face various design challenges. Transaction costs associated with REDD+ and CDM appear high and imply lower payments per ton of emission savings. Furthermore, establishing baseline trajectories to predict future trends and then monitoring and verifying changes are both challenging and costly (Barbier et al., 2012). This helps to explain why there have been so few CDM forestry projects (Skutsch and Trines, 2010). In addition, without a comprehensive country-wide REDD+ strategy, local forest preservation efforts could simply displace these extractive activities to more distant but less protected forests (Robinson and Lokina, 2011). There are also equity concerns. For example, REDD+ initiatives in Tanzania reward villagers for reducing their use of the forest in exchange for payments. The costs that REDD+ imposes on rural households are not distributed evenly, but the cash payments often are.

Ultimately, whether REDD+ is effective, costs notwithstanding, will depend on the extent to which REDD+ funding is used to directly address the drivers of deforestation and forest degradation, and on the impact on equity and the poor.

4.5 Optimal Management of Fisheries

This section explores the socioeconomic role of the fishery sector in Africa. The sector both contributes to GDP and has the potential to reduce pressure on land for agriculture by providing an important alternative food source and a pro-poor livelihood option. However, increasing fishing pressure and the use of improved fishing technologies has resulted in many fish stocks being overcapitalized and overfished. As a result, green growth strategies are essential. Such strategies can also develop the resource to maximize the flow of benefits.

The Role of Fisheries in Meeting Socioeconomic Needs
The fisheries sector is very important to some African economies. Africa accounts for around 8 percent of total global fish landings. According to data sourced from FAO online database (FAOSTAT), total fish production is around 7.6m tons per year, of which 5m tons is from marine fisheries and 2.5m tons from inland fisheries. In Senegal and Namibia, fisheries account for around 7 percent of total GDP (Béné, 2006). An estimated 10 million people in SSA are small-scale fishers, processors, and traders (Markwei et al., 2008). However, as with forests, there are substantial benefits from fisheries that are not reflected in GDP and employment statistics. Fish protein features highly in diets, particularly in Senegal (47 percent of protein intake), Gambia (62 percent), Sierra Leone (63 percent), and Ghana (63 percent) (Global Fish Alliance, 2009). Overall, fish protein has been estimated to supply around 17 per cent of animal protein consumed in Africa, and is particularly important where livestock is scarce (Tidwell and Allan, 2001).

The fisheries sector has the potential to reduce pressure on land for agriculture. There are strong linkages between agriculture and fisheries (Resnick et al., 2012). Fish as a source of protein can take pressure off agriculture and therefore a country's forests. But the links also go in the other direction; fisheries can be harmed by fertilizer runoff from intensive agriculture. Even where the fisheries sector is not directly significant for growth and livelihoods, the condition and management of fisheries have direct spillovers for other natural resources. For example, as fish supplies have dwindled, the pressure on wildlife as an extractable source of protein can increase, as has occurred in Ghana (Brashares et al., 2004). Fishing therefore plays an important role in green growth pathways, provided that capture fish stocks and aquatic ecosystems are sustainably managed. A further appealing feature is that most fishing methods have a small carbon footprint.

Weak institutions and inadequate politics bedevil the fishery sector. Most fish stocks have historically been de facto open access, with little active management. When the population of fishers was lower, this was not necessarily a problem, as long as the offtake was at a level that allowed the fish species to regenerate and fishers to make a living from the sea, lakes, and rivers. However, increasing fishing pressure, improved fishing technology, and the use of technologies that permanently damage the fishery, such as dynamite fishing, have resulted in many fisheries being overfished. Consequently, increasing numbers of people depend on fisheries with decreasing stocks. In Box 4.2 and Figure 4.6, the case of Ghana's fisheries illustrates the challenges of the fishing sector. Similar problems are believed to affect some African inland waters, in particular Lake Chad (FAO, 2002).

NEPAD suggests that most inland fisheries have reached their maximum capacity (NEPAD, 2003), though there are few accurate and comprehensive data.

4.5.1 Optimal Management of Africa's Fisheries

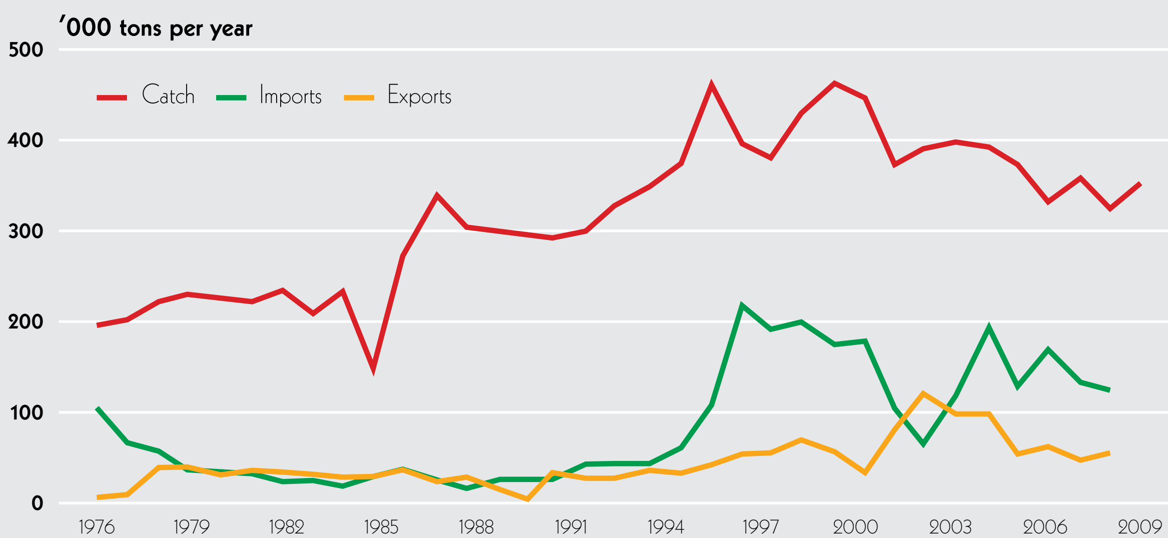
Green growth strategies for Africa's fisheries can take a variety of forms. Regulating catches is inevitable for fish stocks to recover, but this will hurt small-scale fishers in the short term. For offshore deep sea fisheries, fishing is typically dominated by large industrialized fleets. African countries sell access rights to international fishers because the countries cannot themselves exploit the economic benefits. In practice, the compensation that Africa's countries obtain is often lower than the value of the fish caught, as

Box 4.2: The Status of Ghana's Fisheries

Ghana's fisheries sector exemplifies many of the issues faced by African countries. The fish sector comprises marine fisheries (approximately 400,000 tons per year, dominated by artisanal fisheries that account for just under 300,000 tons), inland waters (40,000 tons) and a small amount of aquaculture (5,000 tons, mainly tilapia and catfish). Although Ghana exports some fish, it also imports over 400,000 tons of mainly low-quality fish that accounts for around half of domestic consumption. (See Figure 3.6) Both the quality and size of the fish catch has fallen (Orchard and Abban, 2011). Yet demand is predicted to increase from around 1 million tons in 2012 to 1.4 million tons in 2023 (FAO, 2004). Current government policies do not support the sustainability of the sector. The government has traditionally subsidized fuel for fishers, sold as "pre-mix," and recently has decided to subsidize outboard motors, resulting in distortions and contributing to over-capitalization of the sector. The country also lacks a comprehensive fisheries policy.

Although Ghana gets important foreign exchange from offshore fleets, its marine fishing is damaged by illegal fishing vessels, the use of illegal fishing gear, and illegal fishing by large vessels inside the Inshore Exclusion Zone. Consequently, Ghana's fish catch has started to decline, while imports increase. Ghana will have to increase either its imports or domestic supply. Given the depleted state of the inland and marine fisheries, the need to develop the aquaculture sector is particularly acute. An even better approach would be a long-term fisheries policy that would rehabilitate the stocks and ensure a pro-poor offtake.

Figure 4.6: Ghana's Fish Catch, Imports and Exports ('000 Tons Per Year)



Source: FAOSTAT, Food and Agriculture Organization, 2004; Kwadjosse 2009.

international fleets overfish offshore fish stocks. African countries need to improve governance to ensure compliance and also negotiate better contract arrangements to address these unsustainable practices. Aquaculture, which has been poorly developed on the African continent, has the potential to increase the amount of fish products, and thereby can help to reduce the pressure on capture fisheries. This section will next explore the role of green solutions to achieve sustainable fishery management.

Capture Fisheries

Fisheries in Africa can only be profitable if catch is regulated. Green growth measures include regulating fishing technologies and setting total catch limits. However, most fishers in lower-income countries do not have alternative livelihood opportunities while the fisheries are given time for their stocks to recover. During the early years of improving a fishery, fisheries managers face the challenge of fostering cooperation with villagers while restricting their fishing (Robinson et al., 2012). Kenya has shown some success in rebuilding depleted coastal stocks on its coral reefs, combining a network of closed areas with the banning of beach seines, which are a highly non-selective fishing technology, under an institutional arrangement of co-management with local communities. The greatest impact was where communities implemented both closed areas and gear restrictions (Worm et al., 2009).

Offshore fisheries are potential sources of income for African countries. European and other non-African fishing fleets dominate fishing in Africa's deep sea fish stocks. The United Nations Convention on the Law of the Sea stipulates that a country must make any offshore fish surplus available

to fleets of other countries if the country cannot fully utilize the fisheries resources in its exclusive economic zone (EEZ). Many African countries are in this situation, lacking capital and technologies to exploit the resource themselves. Catches from western Africa's offshore fisheries increased dramatically in the second half of the 20th century, from 600,000 tons in 1950 to 4.5m tons in 2000, predominantly fished by foreign fleets looking for new fisheries to supply markets in Europe, Russia, and China (Alder and Sumaila, 2004). For many coastal African countries, selling access rights to international fishers can make economic sense if the countries cannot themselves exploit the economic benefits (Atta-Mills et al., 2004).

The compensation Africa's countries obtain from offshore fisheries is often lower than the value of the fish caught. Few of the financial benefits or food security benefits are reaching the African countries. Notably, due to corruption, insufficient budgets for enforcement and weak state institutions, Africa's coastal countries lack the ability to manage and monitor these foreign vessels. There is evidence that these fleets employ bottom trawling close to inshore fisheries, which destroys coastal habitats and so reduces the potential of the fishery to regenerate. There is also evidence of inadherence to quotas, including using advanced technologies such as radar tracking devices and acoustic fish finders that make it easier to catch greater quantities than is permitted and that the fishery can sustain over time (Atta-Mills et al., 2004). Both deep sea and coastal fisheries have been depleted, reducing the long-term potential of the offshore fisheries and harming domestic artisanal fishing.

African countries need greater commitments to manage their offshore fisheries in order to prioritize benefits to their own countries rather than to foreign fishing fleets. Because offshore fish stocks often cross national boundaries, policy options need to include coordinated negotiation, cooperation and commitment of fishery agreements with foreign fleets by Africa's coastal countries, particularly along the west and southwest of the continent, along with much higher levels of credible enforcement, based on patrols, detection, and speedy punishments. African countries also need to engage in and drive the international agenda, particularly with respect to countries whose boats are fishing in its waters.

Aquaculture

Aquaculture can increase fish production substantially in Africa. Aquaculture can be defined as the cultivation of aquatic organisms under controlled conditions and can reduce the pressure on capture fisheries. It is one of the fastest growing food export activities globally in value terms (Thorpe et al., 2004). Global aquaculture has grown at around 8.8 percent per year between 1980 and 2010, with Asia accounting for around 70 percent of global production by volume. Aquaculture currently makes a very small contribution to total fish production in SSA, however. While aquaculture accounts for over a third of total fish production worldwide, that figure is just 3 percent in SSA. Though Africa's contribution to global production is small, it increased from 1.2 to 2.2 percent between 2000 and 2010, and is particularly important in Egypt (71 percent of Africa's total), Uganda (7 percent), and Nigeria (16 percent) (FAO, 2012).

Development of aquaculture in Africa has long been recognized as important (e.g., IAASTD). Yet, despite investments in the sector spanning five decades, there has been little growth in production until recently (NEPAD, nd). Aquaculture can be developed in inland freshwater and in coastal waters. Eastern Africa's coastal waters may be particularly suited to coastal aquaculture, for products such as seaweed, already farmed off Tanzania's coast, and shrimp farming. But there are also direct negative environmental implications, including cutting down of mangroves, release of eutrophicating substances, and the possible use of wild fish as an input. There are also socioeconomic implications, including the possible privatization of what were previously common pool resources.

Integrated Fishery Management as Part of a Green Growth Strategy

Fisheries and other natural capital mutually benefit one another. Challenges in linking inland fisheries to green growth strategies include increased competition for freshwater resources and damage to inland water ecosystems that can come about from deforestation and agricultural runoff. The potential is therefore clear also – improvements in reducing deforestation and agricultural externalities will have positive spillovers for inland fisheries. Similarly, protecting offshore fisheries can have positive spillovers for coastal communities. For example, in Ghana, over-fishing in the offshore areas has been shown to affect inshore stocks and so also harm coastal communities' livelihoods (Akpalu and Vondolia, 2012). Protecting inshore fisheries in turn has additional benefits. For example, protecting mangroves can protect key breeding grounds for fisheries as well as improve the resilience of coastal zones to hurricanes and storm surges, thus reducing capital losses due to coastal floods.

4.6 Sustainable Tourism

One of Africa's unique natural resources is its diversity of wildlife and ecosystems. The creation of parks and protected areas to conserve these natural resources is vitally important for long-term sustainability. Protected areas are common pool resources, providing societal as well as individual benefits (de la Harpe et al., 2004). The benefits include clean water provision, climate regulation, food security and ecotourism. In addition, protected areas store 15 percent of the global terrestrial carbon stock, assist in reducing deforestation, restrict habitat and species loss, and support the livelihoods of over one billion people (Bertzky et al., 2012). This natural capital, through the economic engine of tourism, is increasingly being put forward as an integral part of green growth strategies for Africa. This section explores the role of tourism as an employment provider, as a growing component of Africa's GDP, and as an avenue for investment in natural capital.

4.6.1 The Role of Tourism in Meeting Socioeconomic Needs

Tourism is a growing component of the service sector in Africa that can make significant contributions to economic growth and job creation. It has a vital role to play in enabling export diversification and attracting foreign direct investment (Blanke et al., 2011). During the financial crises in 2009, Africa was the only region in the world to show growth in tourism arrivals. The continent's tourism arrivals grew from 37 million in 2003 to 63 million in 2010, with international tourism receipts totaling US$ 44 billion in that year. By 2012, direct travel and tourism employment totaled 7.7 million people in Africa, 3 percent of total regional employment (World Bank et al., 2011). Furthermore, the informal sector plays an important part in the tourism industry in Africa, but is hardly accounted for in standard economic analyses of the impact of tourism. The ability of tourism to generate employment in the informal sector is one of the key opportunities presented by the tourism industry in developing countries (de Kadt, 1979 in Mitchell and Ashley, 2010)

A further benefit from employment linked to tourism is its potential impacts on female employment. According to a report submitted to the Commission on Sustainable Development of the United Nations in 1999, as cited in Mitchell and Ashley (2010), 46 percent of the tourism workforce comprises women. Due to the nature of many tourism operations in Africa, women are able to work close to their homes and children. This allows rural families to stay together while engaging in diverse livelihoods.

Ecotourism in particular is a green growth solution that provides support for the conservation of natural capital. The premise is that communities will conserve protected areas and biodiversity if they value them through the associated tourism. Investment in the tourism industry can thus help protect natural capital while supporting local economies through generating revenue and added value, creating jobs, and contributing to social welfare through improved access to services and infrastructure. Overall, ecotourism can provide the economic engine for the conservation of natural capital, and can provide an economic justification for the establishment and maintenance of protected areas, as well as opportunities for local people to reduce their dependence on resource extraction (Lockwood et al., 2006).

4.6.2 Challenges Facing the Tourism Sector in Africa

Despite these positive opportunities, there are a number of factors that challenge tourism's positive effects and its poverty reduction potential. Some of these challenges are:

Awareness: One of the main challenges facing the tourism sector in Africa is a general lack of awareness by government and the private sector of the value and potential of sustainable tourism as part of a green growth strategy. This lack of awareness has hampered investment in the industry and resulted in the implementation of restrictive policies, such as prohibitive travel restrictions (visas), high transaction costs for the private sector, etc.

Valuation: The valuation of protected areas, and effective communication of the benefits that can be derived from them, is essential to secure support for establishing and maintaining such areas. To date, there have been no effective systems for measuring the value of natural capital, protected areas, and the full impact of tourism. It is critical that national accounting practices are instituted in order to ensure that the true values are measured and that policy-makers make decisions based on these valuations.

Leakage: Leakage is the percentage of the price of a holiday paid by tourists that either leaves the destination in terms of imports or expatriated profits, or that never reaches the destination due to the involvement of foreign intermediaries (Meyer, 2008). Leakage can reduce tourism's role in development and poverty reduction (Mitchell and Ashley, 2010; Pleumarom, nd). Policy incentives aimed at reducing leakage as much as possible and increasing the income retained in communities should be explored and implemented.

Opportunity costs: Tourism creates costs as well as benefits. These costs include the opportunity costs of labor and the land being used for conservation rather than other uses such as agriculture. There are also socio-cultural impacts on local people, congestion, possible negative environmental impacts, and the commodification of local culture.

4.6.3 Policies for Improving Tourism Growth in Africa

Critical to the long-term success of tourism, and the associated conservation of natural capital, is awareness of the positive impacts of tourism on local and national economies. Concomitant with this is the need for an increase in education and awareness, knowledge and tourism skills training, as well as deregulation to allow for private sector investment and the emergence of local entrepreneurs. Each of these policy options is elaborated on below:

» *Tourism Satellite Accounts to assess the importance of the tourism sector:* The recent introduction of Tourism Satellite Accounts (TSAs) in various countries has provided a more accurate value of the tourism sector in the national accounts. TSAs allow the measurement of the indirect impacts of tourism on numerous other industries, including the manufacturing and supply of goods and services such as food, alcohol, linen, and toiletries. This results in extensive multipliers. In Senegal, the indirect jobs created by tourism are estimated to be one and half times the direct jobs: 18,000 indirect jobs compared with 12,000 direct jobs (Crompton and Christie, 2003 in Mitchell and Ashley, 2010).

» *Appropriate investment in education, skills training, etc.:* Education and improvements in local capacity are important in order for the economic benefits of tourism to be realized (Snyman, 2012). This includes building management capacity at the community level. The building of human capital can take many forms, including mentorship, transfer of skills, formal training and exposure to new technology and cultures (Briedenhann and Wickens, 2004).

» *Government support for the tourism industry:* Governments can support the tourism industry and ensure its sustainability by facilitating access for tourists (e.g., non-restrictive visa requirements) and providing good roads, air infrastructure, and health services.

» *Bringing in private investment and local entrepreneurs:* Governments also need to create the appropriate conditions for private sector investment in tourism and local supply chains, by reducing unnecessary taxes and incentivizing investment. The private sector should be encouraged to use local products and services. Tourism planning, including identifying tourism destinations, should promote market access for local entrepreneurs, in order to increase the amount of tourism spending that reaches the poor. Small business development and financial workshops in rural communities, as well as micro-credit schemes for local entrepreneurs, will also serve to spread the benefits of tourism further.

» *Optimal pricing policies for protected areas:* The inefficient capture of revenues by protected area agencies can be the result of poor pricing and allocation mechanisms, with parks deriving less for their services than the market is willing to pay (de la Harpe et al., 2004). Park fee structures should be based on visitor demand for access to protected areas and should consider equity and efficiency. There should also be a degree of flexibility in these structures (Eagles et al., 2002).

4.7 Concluding Remarks on Management of Natural Capital in Africa

This chapter has outlined a green growth strategy for natural capital in delivering development and environmental needs. The management strategy for each natural capital or sector varies according to its performance and the needs of society.

Agriculture remains an important sector for fostering economic growth, food security and poverty reduction. The evaluation of green agriculture practices showed that environmental sustainability and economic and social development go hand in hand. These practices protect the environment as well as ensuring the productivity of the agro-ecosystem. Whether green practices, or a combination of these practices with conventional ones, are advisable, depends on country or location specific characteristics, and therefore should be based on an adequate appraisal.

Water resources are vital goods for humans, as well as prerequisites for economic activities such as agricultural and industrial production. Green growth strategies for water management are important to strengthen the climate resilience of African countries. They can cushion current levels of economic production against the negative impacts of climate shocks.

Forests are an important source of energy and contribute to the economy through products such as timber. Unfortunately, many of the economic and social interests related to forests lead to deforestation and forest degradation. The tradeoff between environmental sustainability on the one side, and short-term use values on the other, is therefore particularly evident. Active governance is required if the forest capital is not to be depleted. One option is payments for ecosystem services through international initiatives such as REDD+ or CDM, which offer economic incentives for farmers to engage in afforestation or reforestation, and thus can provide a new source of income.

The contribution of fisheries to GDP in African countries is only moderate. Still, fisheries have the potential to reduce pressure on land for agriculture by providing an important alternative food source and a pro-poor livelihood option. Considering the current overexploited status of fish stocks, green growth strategies to achieve sustainable fishery management, such as catch restrictions, are essential for high returns in the sector in the long-run, but can lead to negative economic impacts in the short-run. Aquaculture, which is currently undeveloped, has great potential, and its growth could help alleviate the pressure on capture fish stocks during a reform period.

Finally, it is important to emphasize the impact of ecotourism on green growth. With appropriate policies in place, it can lead to a triple-win situation for all of the relevant dimensions of sustainable development.

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Energy Security, Fossil Fuels and Opportunities for Low-carbon Development

5

Chapter

5 Energy Security, Fossil Fuels and Opportunities for Low-carbon Development

5.1 Introduction

Chapter 4 outlined green growth strategies that have the potential to optimize the management of natural capital to meet important developmental objectives such as poverty alleviation and food security. For the fossil fuel sector, green growth strategies include pathways for development of low-carbon energy sources[14].

As highlighted in Chapter 3 as well, Africa is the region most vulnerable to the impact of climate change. Therefore, African countries have a good reason to participate in the global effort to reduce GHG emissions, even though they have no requirement to meet any specific emission reduction targets. Climate concerns, however, must be balanced against the role of fossil fuels in contributing to socioeconomic objectives and the state of the energy sector in Africa.

Africa is endowed with immense resources of oil, gas and coal. According to estimates, 45 out of the 54 African countries possess proven and/or probable oil and/or gas reserves, and most of these resources are untapped. Fossil fuels are a major source of revenues and foreign direct investment (FDI) in a number of African countries. On the other hand, energy access remains a huge challenge in the continent. As of 2008, 42 percent of the African population had access to electricity. This rate is projected to increase to 66 percent by 2040 (AfDB et al., 2011). This greater energy demand can be partly met by fossil fuel energy, which will lead to higher "subsistence" emissions. But low-carbon options can also increasingly play a role in addressing this challenge.

Africa is well-placed to generate renewable energy at low cost due to its abundant renewable energy potential. However, the challenges facing the energy sector in Africa mean that opportunities for low-carbon development only make sense if they contribute to economic growth and alleviate energy poverty.

This chapter discusses the state of the continent's fossil fuel endowment, production, and consumption, as well as the politics of fossil fuel subsidies. The chapter notes that fossil fuel subsidies are economically inefficient, benefit the richer than the poor and hinder the deployment of renewable energy technologies (RETs). The chapter also notes that these technologies are becoming cost competitive relative to technologies for conventional fossil fuel energy production. The declining costs relative to the overall benefits of RETs therefore make the deployment of RETs desirable. The chapter closes with a discussion on opportunities in energy efficiency and sustainable transport and cities as part of a green growth strategy.

5.2 Energy Security and Fossil Fuels

This section explores the status of the energy sector in Africa, focusing on two issues of particular relevance for a green growth strategy. The first one is the challenge of energy security in Africa. The other is the competition between fossil fuels and low-carbon options. Fossil fuels are the basis for Africa's energy sector since they make a

14 Fossil fuel sector and energy sector are used as synonyms throughout the chapter.

large contribution to total primary energy supply. However, fossil fuel pathways are not sustainable and low-carbon solutions need to enter the mix.

5.2.1 Energy Security

Fossil fuels, biofuels and waste are the most important sources of energy in Africa. Fossil fuels represent about 54 percent of total primary energy supply. As shown in Figure 5.1, oil, coal and natural gas contributed respectively 22 percent, 16 percent, and 12 percent to the continent's total primary energy supply in 2009. In 2010, about 80 percent of the continent's electricity was generated from fossil fuels. Projections indicate that this share will remain high for the next three decades. The other important sources of energy are biofuels and waste material, which account for 48 percent of energy supply. Chapter 4 has already pointed out the pivotal role of wood and charcoal for heating and cooking.

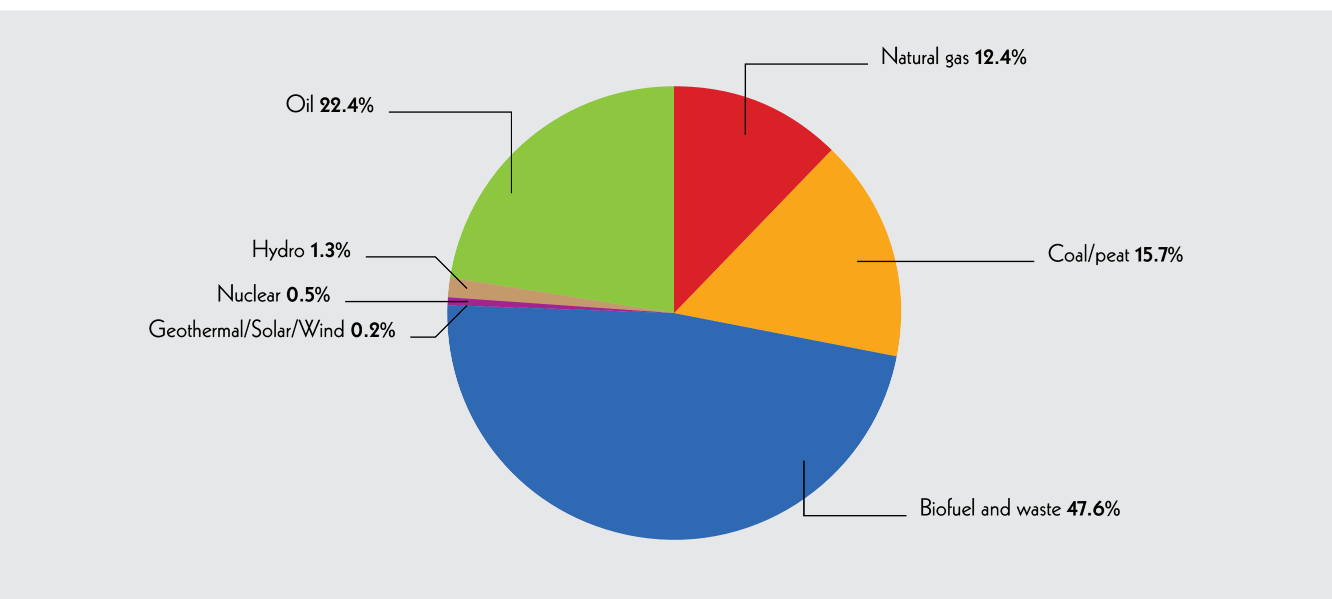
Lack of access to electricity for the majority of the population, and the continued reliance on traditional biomass by many Africans shows that Africa still lags behind the rest of the world in terms of access to modern energy and associated infrastructure, and institutional and technical capacity. Yet, access to modern energy is vital for improving social and economic conditions of the African population. For instance, electrification enhances lighting, gives access to communication tools, allows the mechanization of production, and enables refrigeration, which in turn helps in improving food security and healthcare conditions.

Africa continues to suffer from energy insecurity. Excluding North Africa, the cost of energy is much higher in Africa than in other developing regions. Africa´s refining capacities are either lacking or poorly maintained. Moreover, Africa has to meet its own energy needs as well as global demand for energy. As a result, most of the resources exploited do not benefit the African population.

5.2.2 Fossil Fuel Reserves in Africa

Africa is extensively endowed with fossil fuels, including oil, natural gas and coal. The continent's oil and gas landscape is fast-changing, and more and more reserves are likely to be discovered in the coming decades, especially in sub-Saharan-Africa (AfDB, 2011). In 2011, the continent accounted for about 9.5 percent, 8 percent,

Figure 5.1: Share of Total Primary Energy Supply in 2009



Source: IEA (2012)

and 4 percent of the global proven oil, natural gas and coal reserves, respectively (BP, 2012). Estimates by the African Development Bank and British Petroleum (BP) show that more than 122 billion barrels (BBLS) of proven oil reserves and almost 159 BBLS of potential oil reserves lie below the surface of the African continent (See Table 5.1). In terms of natural gas, the continent holds about 560 trillion barrels of cubic feet (TCF) of proven reserves and 319 TCF of potential reserves.

5.2.3 Production and Consumption of Fossil Fuel in Africa

The continent's share in global oil consumption has been increasing steadily since the 1960s, but at a very slow pace. Figure 5.2 show Africa's share in oil production and consumption from 1965 to 2011. A comparison of oil consumption in barrels per day across continents indicates that since 1965, Africa's average oil consumption was 518 thousand barrels per day (or about one barrel per capita) compared with about 3.2 million barrels per day (or about

Table 5.1: Oil and Gas Reserves in Africa - by Region

Region	Proven (million tons)	%	Probable	%
			Oil	
North Africa	55,122	45		
Southern Africa	15,030	12	76,000	48
East Africa	4,600	4	19,500	12
West Africa	39,510	32	52,550	33
Central Africa	8,500	7	10,750	7
Africa	**122,762**	**100**	**158,800**	**100**
			Gas	
North Africa	287,000	51	more to be discovered	
Southern Africa	60,000	11	57,000	18
East Africa	8,326	1		
West Africa	194,043	35	252,500	79
Central Africa	11,090	2	9,500	3
Africa	**560,459**	**100**	**319,000**	**100**
			Coal	
South Africa	30,156	95		
Zimbabwe	502	2		
Other African countries	1,034	3		
Africa	**31,692**	**100**		

Source: African Development Bank (2011) and BP (2012).

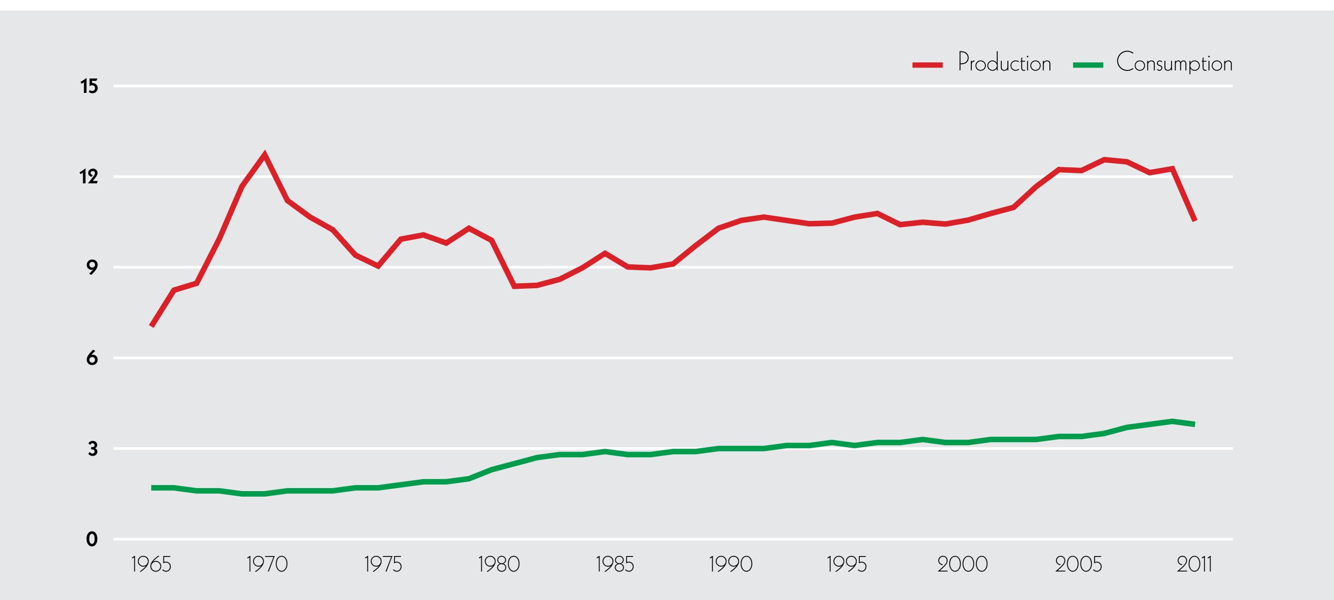
1.75 barrels per capita) in Asia and the Pacific, 11.2 million in Europe and Eurasia (or about 14.6 barrels per capita), and 13 million in North America (or 23.7 barrels per capita). In 1990, Africa's oil consumption was ten times lower than in North America. The ratio has declined to seven times mainly due to the financial crisis which has caused economic stagnation in most advanced countries.

Most African countries are net oil importers, even though some of them hold significant exploitable oil reserves. About 38 countries are net oil importers, which imply that they are frequently exposed to world oil price volatilities. Between 1965 and 2011, the continent's average share of global oil production was about 10 percent and there is a significant gap between the production share and the continent's consumption share with the latter remaining under 4 percent during the same period. Nigeria, Angola and Libya are the continent's main oil producers and account for about 75 percent of total African production, with more than 70 percent of their production exported. In 2009, about 75 percent of the 10.6 million barrels produced daily were exported. During the same year, the continent imported 915 thousand barrels daily, with South Africa accounting for almost 50 percent of these imports. The main reason for this paradox is closely related to limited refining capacity in Africa, which remained stuck at about 3 million barrels per day over the last two decades, representing just 3.6 percent of total world refinery capacity (BP, 2012).

Production of natural gas and coal increased during the last decade. Between 2000 and 2011, Africa's natural gas production almost doubled from 58.4 billion cubic meters (bcm) to 110 bcm. Most of the production is concentrated in Algeria and Egypt, which accounted for respectively, 28 percent and 40 percent. Over 55 percent of the natural gas produced in Africa is exported (IEA, 2011b).

During the same period, Africa's total coal production increased from 230.5 million tons to 259.5 million tons. Most of the coal – over 97 percent – was produced in South Africa. Out of Africa's total coal output, about a quarter was exported. The continent's share in the world's

Figure 5.2: Africa's Share in World Oil Production and Consumption, 1965-2011



Source: BP (2012)

coal production decreased during the last decade, from 4.9 percent in 2000 to 3.4 percent in 2011.

The discussion above highlights the significant proportion of African fossil fuel production that is exported: over 70 percent of crude oil, 55 percent of dry natural gas, and 23 percent of coal. Europe and China are the main trading partners for Africa's fuel exports, and about one-third of China's total oil imports come from Africa.

The industrial and transport sectors, especially road transport, are the biggest fossil fuel consumers in Africa. These two sectors accounted for about 22 percent and 47 percent, respectively, of total fossil fuel consumption in 2009 (Table 5.2). The transport sector is mainly fueled by oil and oil products. The industrial sector consumes about half of Africa's coal and natural gas. On the other hand, energy consumption in the residential sector accounted for 15 percent of total fossil fuel consumption in 2009.

5.2.4 Fossil Fuels as a Major Source of Revenues and Foreign Direct Investment in Africa

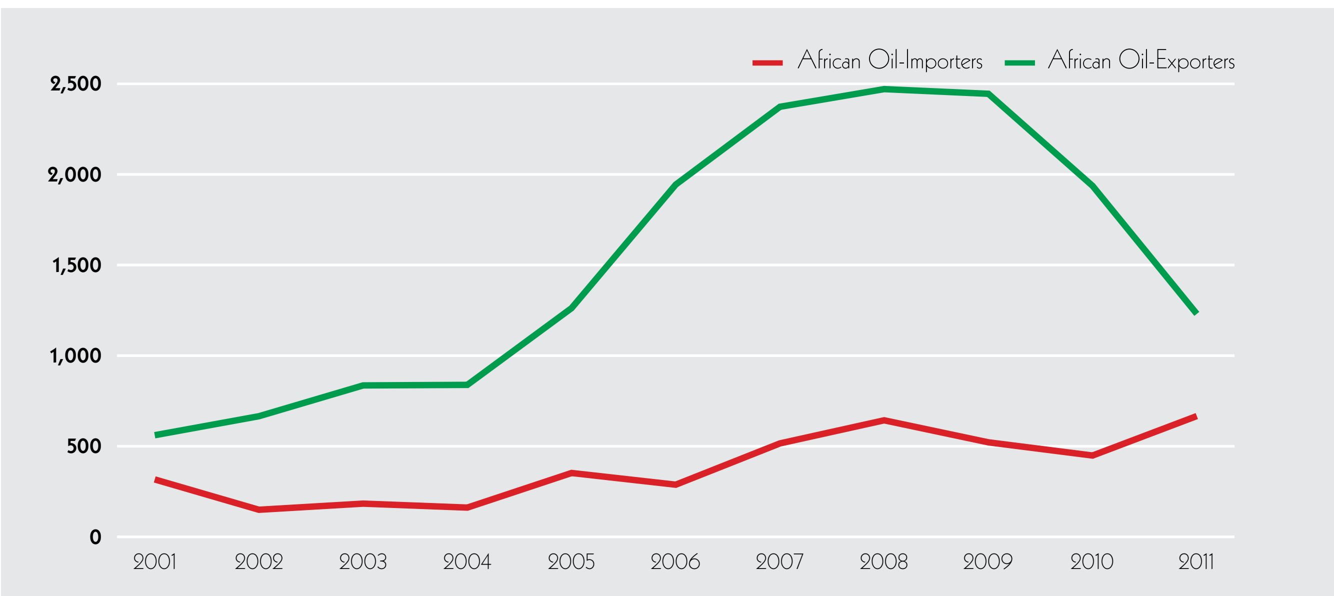
Fossil fuels constitute a major source of income for producing countries. As an illustration, oil exports account for about 80 percent of government revenues in Libya, Nigeria and Angola, while the share of government revenues from natural gas in Algeria stands at 60 percent (CIA, 2011). It has been shown that for oil and gas exporting countries, economic recovery since 2010 has been driven by export of these commodities (AfDB et al., 2012). A number of fossil fuel-rich countries (Algeria, Chad, Gabon, Libya, and Nigeria) use the revenues

Table 5.2: Sectoral Consumption of Fossil Fuels in Africa in 2009

	Coal/Peat	Oil/Oil products	Natural gas	Total	Share of total energy (%)
Industry	10,416	12,312	13,863	36,591	21.8
Transport	5	77,133	1,224	78,362	46.6
Residential	4,820	14,222	5,733	24,775	14.7
Commercial/Public Services	2,455	2,010	120	4,585	2.7
Agriculture/Forestry	171	5,854	6	6,031	3.6
Other uses	1,418	9,466	6,878	17,762	10.6
Total	**19,285**	**120,997**	**27,824**	**168,106**	**100.0**

Source: IEA (2012).
Note: Consumption is shown in thousand tons of oil equivalent (ktoe) on a net calorific value basis.

Figure 5.3: Average FDI Inflows to Oil Exporting and Oil Importing Countries (million US$, current)



Source: African Development Report 2012 team, based on UNCTAD data

generated from these resources to finance infrastructure development and public consumption.

Fossil fuels also attract foreign direct investments as shown in Figure 5.3. Between 2000 and 2009, about 75 percent of total FDI in Africa flowed to oil-exporting countries. The share of FDI flows in the extractive sector in sub-Saharan Africa stood at 89 percent and this share has increased since 2010. In North Africa, FDI flows to oil-rich countries decreased by 42 percent in 2011 in the wake of the Arab Spring as international investors adopted a "wait-and-see" attitude. This was in addition to the 32 percent cumulative decrease from the previous three years (AfDB et al., 2012).

5.3 The Political Context and Opportunities for Low-carbon Development in Africa's Energy Sector

Africa's vulnerability to the impact of climate change makes it imperative to pursue green growth pathways to mitigate these effects, including in the energy sector. Low-carbon development can either take the form of reducing greenhouse gas emissions per unit of energy use through deployment of renewable energy technologies or increasing output (GDP) per unit of energy input by improving efficiency.

However, fossil fuel subsidies deployed in many African countries undermine both of these options, by reducing the competitiveness of low-carbon fuel options and the incentive to improve energy efficiency. This section explores the political context for low-carbon development in the energy sector, with a particular focus on the role of fossil fuel subsidies. Boxes 5.1 and 5.2 below summarize the political context for two of the biggest emitters in Africa, South Africa and Egypt, as they pursue low-carbon pathways.

5.3.1 Justification for Fossil Fuel Subsidies in Africa

The debate on climate change and its impact suffers from a paradox, as many politically motivated actions run contrary to declared strategies for mitigating climate change. A clear example is the continued subsidization of fossil fuel energy, despite official commitments to phase them out. Indeed, following the increases in oil prices, some governments have intensified use of subsidies to avoid social instability.

There are different types of fossil fuel subsidies, depending on whether the country is an importer or an exporter of fossil fuels in the international market. For an importer, a subsidy is the difference between the international price (including all related costs) and the domestic price. For an exporter, the government can decide to fix the domestic price below the international price, and the difference is an indirect subsidy.

Although Africa's share in global energy subsidies is rather small, many African governments have direct or indirect subsidies; with South Africa and Egypt among the largest non-OECD countries with high fossil fuel subsidies. The subsidies are used to keep energy bills low for low-income households so as to maintain household purchasing power.

Box 5.1: Low-carbon Development in South Africa

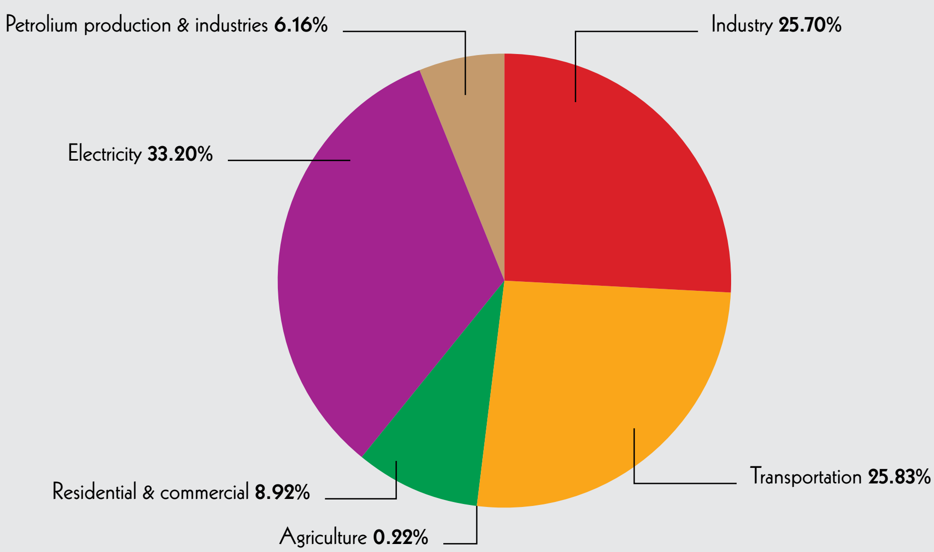
South Africa is a fossil fuel-rich country, holding almost 95 percent of the continent's coal reserves. The country's primary source of electricity generation is coal (94 percent), followed by nuclear power (5 percent), with natural gas and renewable energies such as hydropower contributing a marginal proportion. However, the country has also been the continent's biggest GHG emitter since 1971 and contributes about 1 percent of global emissions. Most of the country's GHG emissions are related to the exploitation of its coal resources. In 2009, South Africa's total CO_2 emissions were estimated at 369.4 million tons, with 80 percent coming from energy production and consumption, especially coal. The electricity and heat sector produced 62 percent of the country's CO_2 emissions. South Africa's GHG emissions per capita, as well as GHG emissions per unit of GDP, are nearly double the world average. These high numbers are explained by two factors. One is the fossil fuel-intensive nature of the economy, especially its reliance on coal, with negligible use of carbon sequestration technologies. The other factor relates to inefficient production techniques, transformation methods, and use of these fuels. On the other hand, South Africa is highly vulnerable to the effects of climate change. Large parts of the country are arid. Decreases and/or disruptions in patterns of rainfall often result in water shortages, desertification, and destruction of ecosystems, with large-scale negative impacts on the population. In the country's long-term mitigation scenarios, GHG emissions are projected to quadruple between 2003 and 2050 if no radical energy switch is made, especially in the electricity, industrial, and transport sectors (IEA, 2011a). Therefore, South Africa, as a member of the BRICS group , has assumed a moral responsibility to mitigate its emissions even though it has no specific emission reduction requirement. The announcement of a carbon tax, scheduled for 2015, can be considered a first step in this direction (All Africa, 2013).

Box 5.2: Low-carbon Development in Egypt

Egypt is well-endowed with oil and natural gas resources, with estimates indicating that the country has about 3.5 billion barrels of proven oil reserves, 75 trillion cubic feet of proven natural gas, and potentially more to be discovered (AfDB, 2011). Egypt's share in world GHG emissions was 0.70 percent in 2008, a slight increase from 0.40 percent in 1990. Electricity generation is the largest contributor to GHG emissions (33.2 percent), followed by transport (26.83 percent) and industry (25.70 percent), as illustrated in Figure 5.4. The transport sector is the most rapidly contributor of GHG emissions due to energy intensity and inefficient gasoline and diesel engines. In the industrial sector, the cement industry accounts for about 62 percent of GHG emissions.

Egypt is not required to meet any specific emission reduction or limitation targets in terms of its commitments under the UNFCCC or the Kyoto Protocol. However, the country has made some progress in terms of introducing mitigation measures in national plans. In 2007, the Supreme Council for Energy adopted a national strategy for energy supply and use. This strategy integrates the main policies and measures that could help in meeting the long-term challenges of the country's energy industry. It builds on a series of policies and measures to reduce GHG emissions in industrial processes and product use. For instance, Egypt has accelerated development of renewable energy by making efforts to substitute natural gas for oil in electricity generation, industrial and transport sectors and by promoting use of solar panels and wind energy in electricity generation. The government has also encouraged the use of efficient lighting systems. From 1990 to 2005, consumption of liquefied petroleum decreased from 75.6 percent to 51.6 percent of total energy consumption, while the share of natural gas increased from 24.4 percent to 46.5 percent. In addition, during recent years, serious efforts have been made to promote efficiency and decrease the costs of solar energy.

Figure 5.4: Sectoral GHG Emissions in Egypt



Source: Egyptian Environmental Affairs Agency (2010)

Governments frequently come under intense social and political pressures when they attempt to pass the full price of oil or other energy products to consumers. For example, in the West Africa Economic and Monetary Union (WAEMU), state-owned power utilities have maintained electricity prices below market prices.

5.3.2 The Case against Fossil Fuel Subsidies in Africa

A number of countries in Africa are taking steps to reform fossil fuel subsidies. For instance, during their meeting in Paris in April 2012, the CFA zone Ministers of Finance recognized the need to reform fossil fuel prices while putting in place appropriate social safety net programs to protect the most vulnerable. The need to reform subsidies is based on the environmental, social and economic impact of continued subsidization of fossil fuels.

The International Energy Agency (IEA) estimates that a global phase-out of all fossil fuel subsidies could cut energy-related carbon dioxide emissions by 6.9 percent by 2020 (IEA, 2011a). In South Africa, for instance, the removal of an average fossil fuel subsidy of 6.4 percent would improve annual economic efficiency by 0.1 percent of GDP and reduce energy consumption and CO_2 emissions by 6.3 percent and 8.1 percent, respectively (UNFCCC, 2007).

Fossil fuel subsidies tend to benefit high income earners relative to the poor. In Africa, an estimated 44.2 percent of fossil fuel subsidies go to the richest 20 percent, while the poorest 20 percent benefit from only 7.8 percent of these subsidies. Likewise, about 45 percent of subsidies for kerosene go to the richest 40 percent. In Senegal, the IMF (2008) found that the poorest 40 percent of citizens were benefiting from only 19 percent of LPG subsidies, while the richest 40 percent gained over 60 percent of these subsidies. In Mali, 43 percent of fossil fuel subsidies benefit the richest 20 percent of households, while only 11 percent go to the poorest 20 percent (Kpodar and Djiofact, 2010).

Fossil fuel subsidies pose a high burden on government budgets in Africa and so divert public resources away from priority areas such as education, healthcare and basic infrastructure investments. As international oil prices stay high, fossil fuel subsidies have become more and more unsustainable for many African governments. For instance, in Burkina Faso, between January 2011 and February 2012, the cost of subsidies for petroleum products amounted to about 49.5 billion CFA, representing 1.0 percent of 2011 GDP[15]. In 2011, subsidies accounted for 1.3 percent and 2 percent of GDP in Cameroon and Togo, respectively. The removal of such subsidies would thus free substantial resources that could be used in improving public services, better targeted social protection or infrastructure that supports green growth (World Bank, 2010).

5.3.3 The Politics of Fossil Fuel Subsidies

The political economy of fuel subsidies shows that governments often find it difficult to institute reforms to fossil fuel subsidies. Where such attempts have been made, they have often been met with resistance, resulting in quick policy reversals. With the recent rises in fossil fuel prices, many African countries have experienced popular protests demanding that policy-makers take measures to address the increase in the cost of living.

Since governments fear social and political instability, and given that subsidies are a tangible way to deliver services in return for political support and social peace, they are used as a bargaining tool and therefore very difficult to remove. Once a subsidy is introduced, it gets locked in. Thus, in the developing world, very few countries have been able to successfully remove fossil fuel subsidies.

Furthermore, resource-rich countries tend to suffer from corruption and weak institutions, with the result that the resource windfall does not reach the majority of the population. Petrodollars have instead encouraged rent-seeking behavior among a minority of elites, and corruption has acted as a substitute for equitable distribution of the nation's wealth (Magrin and van Vliet, 2009[16]). Under such conditions, citizens often have little confidence that the money saved from cancelling subsidies will be wisely reallocated for the benefit of the poor. This explains the widespread violent protests in many resource-rich countries during the recent rises in international oil prices (see Box 5.3 for the case of Nigeria).

Constraints from regional integration commitments may also prevent a country from successfully removing fossil fuel subsidies. For instance, in the case of Senegal, regional agreements between the WAEMU countries meant that the country had to stop the process of withdrawing the LPG subsidy (see Box 5.3 for the case of Senegal). Therefore,

15 CFA is the local currency of some francophone African countries. These countries also constitute the CFA or "franc zone".

16 In Lesourne (2009): Governance of Oil in Africa: Unfinished Business. Paris, les etudes Ifr.

Box 5.3: Challenges in Reforming Subsidies on Fossil Fuels

The Case of Nigeria

Nigeria is the sixth largest oil exporting country in the world. However, the country still imports a large portion of its petroleum products due to underinvestment in the energy industry and a lack of sufficient infrastructure. Since the 1970s, Nigeria has been subsidizing fossil fuels. However, due to high fluctuations in international oil prices, the costs of petroleum subsidies have become unsustainable for the government. Fossil fuel subsidies increased by 97 percent, from US$ 4.31 billion in 2010 to US $9.3 billion in 2011. Furthermore, these subsidies are a source of corruption, smuggling and rent-seeking, with several neighboring countries benefiting from Nigeria's cheaper oil. The country not only loses money from selling cheaper oil to the region but also loses the opportunity to make priority investments to develop its energy sector and save foreign exchange revenue. All these reasons pushed the government to take the decision to eliminate petroleum subsidies.

In January 2012, the authorities decided to abruptly remove fossil fuel subsidies. They chose the "Big Bang" approach, as the country had a track record of attempting a phased removal of fossil fuel subsidies that had been blocked by popular resistance. The decision resulted in a price increase from N65 (US$ 0.42) to N138 (US$ 0.89) per liter. As a consequence of this, the country erupted into civil strife and national demonstrations lasting more than a week. This forced the government to revise the price to N97 (US$ 0.63) per liter (Schiere, 2012).

The Case of Senegal

In the early 1970s, the government of Senegal decided to reduce deforestation by substituting charcoal consumption with LPG (liquefied propane gas) through LPG subsidization. Through this policy, all imported cooking equipment operating with LPG was exempted from customs duties. But by 1988, very few households had converted to LPG, and the government decided to subsidize LPG fuel itself (LPG cylinders of 2.7 kg and 6 kg only). After this measure was introduced, LPG stoves were widely adopted in the country. However, the subsidies became a growing fiscal burden and the government decided to remove them gradually, by 20 percent annual increments, starting in July 1998, up to 2002. However, the government plan was put on hold due to negotiations within the West African Monetary Union (WAMU) over harmonization of economic policies in the union. For this reason, LPG prices for the two smallest size cylinders remained unchanged for several years. In 2008, an IMF study estimated that the poor were not benefiting equally from the remaining subsidies. For these reasons, the government decided in June 2009 to remove LPG subsidies. Since then, LPG prices for 2.7 kg and 6 kg have fluctuated according to international market prices (Laan et al., 2010).

reforms of subsidy could take a regional dimension in order to come up with common agreements on the mode of implementation.

5.3.4 A Big Bang Approach or a Sequential Well-designed Approach in Reforming Fossil Fuel Subsidies?

Very few countries have so far successfully removed fossil fuel subsidies (see Box 5.4 for the case of Ghana). Therefore, it is important to initiate well-substantiated reforms. Winning strategies might include:

- » Conducting preliminary studies to assess the impacts of the reform.
- » Defining well-targeted reforms that focus on removing universal subsidies, which often never reach their original goals. If subsidies are maintained at all, they should be targeted to goods that are used by the poor. Reform should avoid subsidizing luxury goods that are used by well-off households.
- » Introducing a massive information campaign to explain the relevance of the reform to the majority of the population.
- » Initiating social protection measures that will replace the subsidies, so that the population can see tangible actions from the reform(s).
- » For fuel resource-rich countries, government's credibility, transparency and other governance indicators must be improved, especially as regards the management of fuel revenues.

» Separating the government from the process of fixing fuel prices. This can be done by establishing an independent authority in charge of determining fuel prices.

» A sequential and well-designed approach is much better and more peaceful than a Big Bang approach.

A sequential approach allows for assessment of the impacts of subsidies and their removal. This can then help authorities to better redesign policies that target the most vulnerable groups. The phased approach to reform can also enable people to adjust their behavior in response to gradual increases in prices. More importantly, reforming subsidies should be accompandied by a regime of well designed social safety nets to cushion the poor from the adverse effects of subsidy withdrawal. This would ease social tensions following the reforms.

Finally, reforms of the energy sector at the country level should be coordinated at the regional and continental level through the regional economic communities. Because reforms may have regional impacts, regional integration strategies should help in coordinating and harmonizing countries' efforts. As an example, the "Program for Infrastructure Development in Africa" (PIDA) is a joint initiative acting as a catalyst in supporting regional initiatives that can make the energy sector more integrated at the continental level.

5.4 The Role of Renewable Energies in Low-Carbon Development in Africa

Low-carbon development provides opportunities for the exploitation of renewable energies. At the continent level, in order to improve energy security, African countries and regional economic communities have set up ambitious programs which call for public-private partnerships to fully develop the continent's energy resource potential, especially through large-scale regional and continental renewable

Box 5.4: Ghana has Successfully Removed Fossil Fuel Subsidies

After several failed attempts, the government of Ghana finally succeeded in peacefully eliminating fossil fuel subsidies in 2005. To give the reform the best chance of succeeding, several strategies were implemented. The government initially commissioned an independent study on poverty and social impact assessment in order to identify the winners and losers of fuel subsidies and their removal.

It also put in place a massive advertisement campaign to assure citizens that the reform was in the best interests of the population, and that the money previously spent on fuel subsidies would be reallocated to social priorities. Furthermore, a new petroleum authority (NPA) was introduced and was charged with determining the fuel pricing formula. The establishment of this agency was aimed at detaching the government from the politically sensitive process of determining petroleum product prices and to make it more difficult for future governments to intervene in the process (IMF, 2006). Although the NPA is politically independent, it takes into consideration the political implications of its actions.

At the same time, the government initiated several social protection measures to compensate the poor for higher energy prices caused by the removal of fuel subsidies. In this regard, it eliminated primary and secondary public school fees, increased the number of public transport buses, put a price ceiling on public transport fares, invested in healthcare in poor areas, raised the daily minimum wage from US$ 1.24 to US$ 1.50, spread electrification to rural areas, and pursued its previous policy of cross-subsidizing kerosene and LPG (IMF, 2006). Even though trade unions protested against the reform, it was well received by the majority of the population (Laan et al., 2010).

The reform of fuel subsidies in Ghana has not been easy. In May 2009, the government was not able to pass the international price increase through to domestic prices and had to pay GH Cedis 7 million directly to the NPA for the last two weeks of May, and another GH Cedis 21.7 million for the first two weeks of June 2009. In addition, for the last quarter of 2010, government spending to avoid an increase in domestic fuel prices was about US$ 70 million. In 2011, fuel subsidies accounted for US$ 276 million. But, at the end of 2011, the government decided to cut subsidies following a depreciation of the Cedi, Ghana's local currency and pressure from the IMF urging the country to stop subsidizing fuels. In December 2011, the NPA CEO confirmed that pump prices will follow international crude oil market fluctuations if they remain in the range of US$ 107-110 per barrel (Reuters, 2011).

energy resources. The African continent has abundant energy resources which are yet to be exploited.

One reason is the cost of renewable energy technologies (RETs) compared with fossil fuel technologies. But this unfavorable cost differential is not uniform across the continent. There are many exceptions, and so any particular context should be examined on the basis of detailed knowledge of the location's renewable energy resources and the energy-service application. Furthermore, RETs are becoming increasingly cost-effective relative to fossil fuel energy sources.

A range of factors are responsible for the falling costs of RETs, including policy interventions that stimulate research and development (R&D), as well as policies aimed at supporting demonstration systems, and subsidies to encourage deployment and diffusion. Some RETs are already at the commercial or near-commercial stage, such as hydro, onshore wind power, and some geothermal technologies. The increasing deployment and diffusion of RETs is also creating downward pressure on costs through learning-by-doing mechanisms, scale economies, and increased competition in the various RET markets.

Table 5.3 provides a useful indication of the range of RETs, their primary energy sector, stage of maturity and primary distribution method. From the table, it is clear that RETs span the whole range from R&D to late-stage commercial, and offer both centralized and decentralized methods of distribution of energy carriers in many cases. Many RETs generate electricity as a primary function, but there are also several technologies that can provide thermal, mechanical or transport energy services.

Bio-energies provide the largest number of options for transport. As many of them are liquid or gaseous fuels, they also fit more easily into existing infrastructures of fuel supply, in some cases requiring relatively minor changes to transport technologies such as internal combustion engine vehicles. They also offer more flexibility and control than direct forms of renewable energy, as they can be burned where and when needed. However, they remain controversial for a number of reasons. One is that there is no consensus on the quantity of biomass potential in Africa (IRENA, 2011), with a wide range of figures quoted in the literature. Second, as discussed in Chapter 3, the growth of crops for biofuels can displace (or replace) food crops, which has led to intense debates and significant caution about the implications for many Africans in terms of access to food (e.g., Amigun et al., 2011; Anseeuw et al., 2011). Third, and related, higher-value biofuels (compared with food crops) can lead to "land grabs" or "green grabs," where the poor and vulnerable are themselves displaced from land that may have been their only source of subsistence – sometimes due to acquisition of land by firms based in other countries[17] (Deininger et al., 2011). Fourth, some biofuels lead to net emissions of greenhouse gases (Witcover et al., 2012). This can occur when the demand for biofuel crops is met by clearing new land, such as forests, grasslands and wetlands, resulting in depletion of the planet's carbon absorption stocks.

Many of these issues might be resolved if so-called second generation biofuels are realized. These fuels are derived from agricultural waste rather than the main crop and so could alleviate the fuel-food controversy (Murphy et al., 2011). However, they are still in development and so it is too soon to know whether they will work, how much they will cost, and whether new problems will emerge. It is also unclear whether, or to what extent, they will be GHG sources or sinks.

Energy efficiency provides additional opportunities to lower carbon emissions. This is true on both the demand and supply sides of the energy system. According to Farrell and Remes (2008), cost-effective energy efficiency measures could realize almost 20 percent energy savings compared with projected energy demand in Africa by 2020. Clearly this would represent significant avoided costs of energy supply infrastructure and lower costs to consumers, as well as potentially lower emissions compared with business-as-usual projections, independent of whether RETs are deployed. However, it is not clear whether Farrell and Remes (2008) have attempted to account for possible rebound effects – where, for example,

17 See discussion of creating an enabling environment in Chapter 8 for a discussion of policies solving the challenge of land grabs.

Table 5.3: Overview of Renewable Energy Technologies and Applications

Renewable Energy Source	Selected Renewable Energy Technology	Primary Energy Sector (Electricity, Thermal Mechanical, Transport)	Technology Maturity				Primary Distribution Method	
			R&D	Demo & Pilot Project	Early Stage Com'l	Later Stage Com'l	Central-ised	Decen-tralised
Bioenergy	Traditional Use Fuelwood/Charcoal	Thermal				•		•
	Cookstove (Primitive and Advanced)	Thermal				•		•
	Domestic Heating Systems (pelletsbased)	Thermal				•		•
	Small- and Large-Scale Boilers	Thermal				•	•	•
	Anaerobic Digestion for Biogas Production	Electricity/Thermal/Transport				•	•	•
	Combined Heat and Power (CHP)	Electricity/Thermal				•	•	•
	Co-firing in Fossil Fuel Power Plant	Electricity				•	•	
	Combustion-based Power Plant	Electricity				•	•	•
	Gasification-based Power Plant	Electricity			•		•	•
	Sugar- and Starch-Based Crop Ethanol	Transport				•	•	
	Plant- and Seed Oil-Based Biodiesel	Transport				•	•	
	Lignocellulose Sugar-Based Biofuels	Transport		•			•	
	Lignocellulose Syngas-Based Biofuels	Transport			•		•	
	Pyrolysis-Based Biofuels	Transport		•			•	
	Aquatic Plant-Derived Fuels	Transport	•				•	
	Gaseous Biofuels	Thermal				•	•	
Direct Solar	Photovoltaic (PV)	Electricity				•	•	•
	Concentrating PV (CPV)	Electricity			•		•	•
	Concentrating Solar Thermal Power (CSP)	Electricity			•		•	•
	Low Temperature Solar Thermal	Thermal				•		•
	Solar Cooling	Thermal		•				•
	Passive Solar Architecture	Thermal				•		•
	Solar Cooking	Thermal			•			•
	Solar Fuels	Transport	•				•	
Geothermal	Hydrothermal, Condensing Flash	Electricity				•	•	
	Hydrothermal, Binary Cycle	Electricity				•	•	
	Engineered Geothermal Systems (EGS)	Electricity		•			•	
	Submarine Geothermal	Electricity	•				•	
	Direct Use Applications	Thermal				•	•	•
	Geothermal Heat Pumps (GHP)	Thermal				•		•
Hydropower	Run-of-River	Electricity/Mechanical				•	•	•
	Reservoirs	Electricity				•	•	•
	Pumped Storage	Electricity				•	•	
	Hydrokinetic Turbines	Electricity/Mechanical		•			•	•
Ocean Energy	Wave	Electricity						
	Tidal Range	Electricity						
	Tidal Currents	Electricity						
	Ocean Currents	Electricity						
	Ocean Thermal Energy Conversion	Electricity/Thermal						
	Salinity Gradients	Electricity						
Wind Energy	Onshore, Large Turbines	Electricity				•	•	
	Offshore, Large Turbines	Electricity			•		•	
	Distributed, Small Turbines	Electricity				•		•
	"Turbines for Water Pumping / Other mechanical	Mechanical				•		•
	Wind Kites	Transport		•				•
	Higher-Altitude Wind Generators	Electricity	•				•	

Source: Moomaw et al. (2011).

consumers use saved money from lower energy bills to spend on other energy-intensive activities such as electrical appliances, undermining the initial energy efficiency savings and potentially increasing overall GHG emissions. Nevertheless, substantial reductions in energy demand appear to be possible.

This section will next focus on some of the clean energy options open to Africa, covering onshore wind power, solar energy and photovoltaic (PV) technology, biomass, geothermal and hydropower. Table 5.3 shows the potential applications of these options and the stage of development for each of them. After that, the discussion will turn to the feasibility of each of these technologies, in particular considering the expected benefits and costs. This will lay the groundwork for a discussion of low-carbon development pathways in Africa and how policy interventions could help create those pathways. This is followed by a discussion of the opportunities for RETs and energy efficiency in sustainable transport systems and cities.

5.5 Clean Energy Options: Potential Resource Indications in Africa

This section reports the potential of a sample of the renewable energy resources available on the African continent, in terms of the relevant technologies and energy services they can facilitate. It covers wind, solar, hydro and geothermal energy in terms of available electricity generation (the solar section considers PV technology only, while the geothermal section also considers heat potential), along with biomass in terms of its density of availability for heat, electricity and transport fuels.

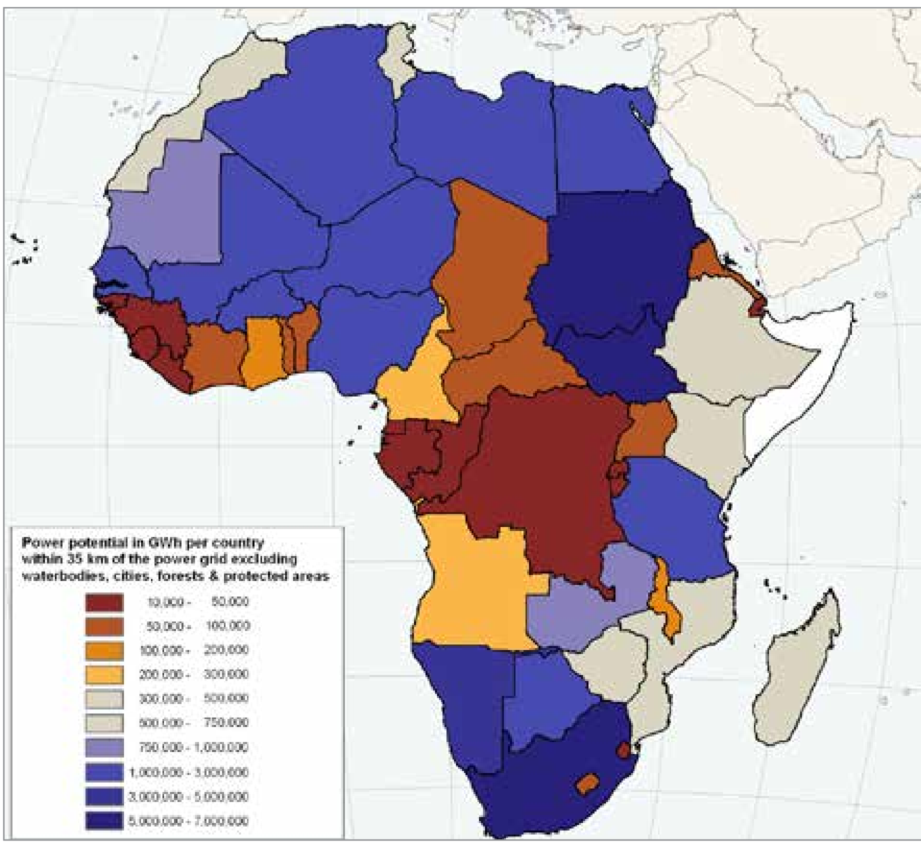
5.5.1 Potential Wind Power Production

The indicative potential for wind power in Africa is 1,000 GW, which is five times greater than Africa's total installed power generation capacity at present (IRENA, 2011). Although there are challenges with data availability, it appears that there are significant wind energy resources that could be tapped by many African countries (Belward et al., 2011). Figure 5.5 shows this potential in terms of what each country might expect if it were to install the latest wind turbines[18] within 35 km of the current grid infrastructure, at a density of 5 per square km, excluding water bodies, cities, forests and protected areas.

18 The study assumes modern technology wind turbines with a diameter of rotor blades of 80m and full working hours in a year (8760 h) and an "ideal" conversion coefficient of 59.3 percent (Belward et al., 2011).

At present, only a tiny fraction of this potential is being exploited. Most of this is in northern Africa but there are several projects either underway or under development in other countries, most notably in South Africa (IRENA, 2012a). More wind energy could be used if there were extensions to grid infrastructure. However, it is important to remember that there are huge data needs associated with assessing wind energy resources across the continent in detail, especially because wind resources depend on specific topographical features, land-sea circulations and other factors that make average wind speed data only indicative (Belward et al., 2011). This becomes particularly important for small-scale installations. Therefore, it is critical that much more effort be focused on developing fine-grained data sets of wind speeds across the continent.

Figure 5.5: Power Potential of Onshore Wind Energy Resources per Country



Note: Dark blue shows highest potential and red/brown shows lowest potential. Calculations are based on installation of the latest turbines within 35 km of the current grid infrastructure at a density of 5 turbines per square km. Land area excludes water bodies, cities, forests and protected areas.

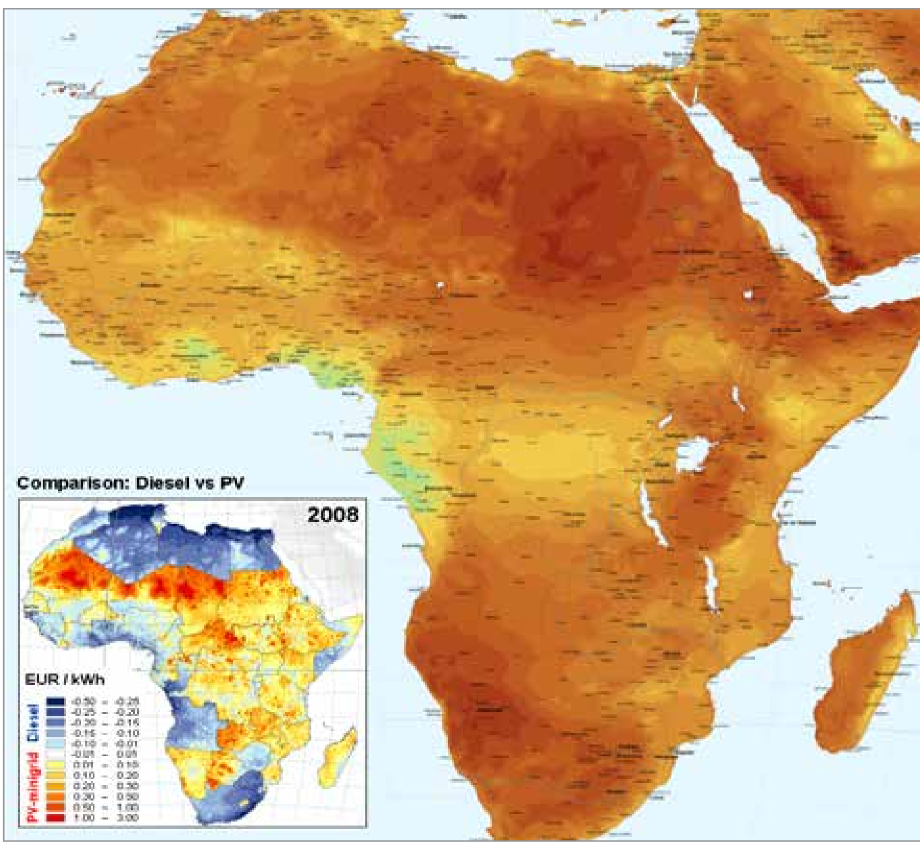
Source: Belward et al. (2011).

5.5.2 Photovoltaic Potential

The African continent receives enormous quantities of solar radiation that offers huge potential for exploitation using a wide range of solar technologies. IRENA (2011) suggests that there is much more than 10,000 GW of potential from solar energy. Figure 5.6 indicates this potential, focusing on electricity generation using PV. It also provides an assessment of where PV is likely to be cheaper than diesel powered generators.

As can be seen, there is no simple criterion for deciding which of the two technologies will be cheapest, but there are several reasons why costs vary so much. One is related to the solar resource itself – shown in the larger map (deeper brown indicates more solar energy available). A higher incidence of solar energy tends to mean lower electricity costs. Another reason is that diesel costs increase with remoteness of an installation because of fuel transportation and generator maintenance needs. The picture is further complicated by subsidies. As discussed in section 5.3, because many African governments subsidize diesel or other fuels (see Figure 5.7), diesel is cheaper than PV. A simple comparison of countries that heavily subsidize fossil fuels and those that do not suggests that these subsidies could often be a critical determinant of solar PV's cost competitiveness. This suggests that a more detailed analysis of costs than the data here allows should be undertaken when choosing PV or diesel. It also suggests that governments could consider subsidizing PV, as is already being done worldwide through feed-in tariffs (FITs), to encourage its adoption (Belward et al., 2011).

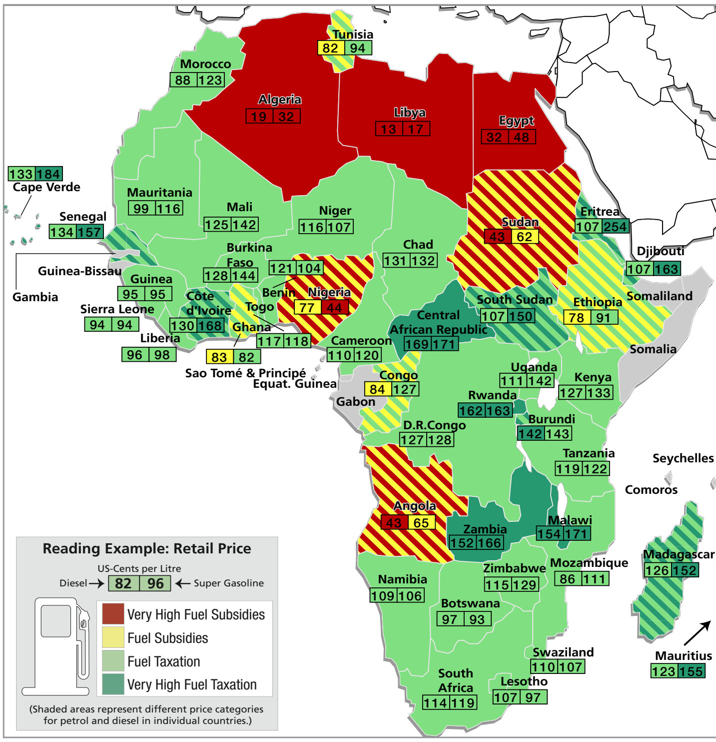
Figure 5.6: Solar Energy Resources, PV Versus Diesel Competitiveness



Note: This shows electricity generation using PV and, in the insert, an assessment of where PV is likely to be cheaper than diesel-powered generators. Costs vary according to the solar resource (large map), remoteness of installation (operating costs) and subsidies.

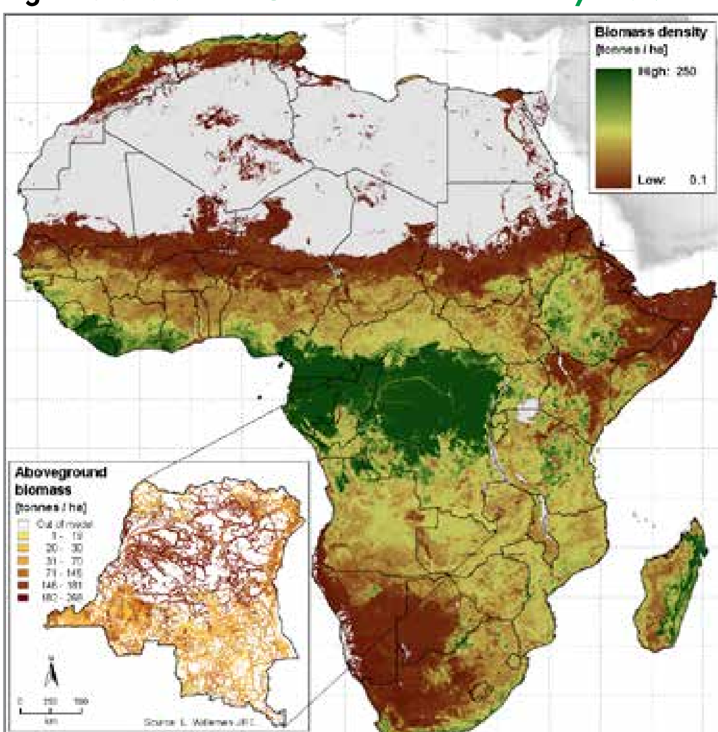
Source: Belward et al. (2011).

Figure 5.7: Retail Fuel Prices in Africa as of November 2011 (US Cents per litre)



Source: Wagner et al., (2011)

Figure 5.8: Above-Ground Biomass Density in Africa



Source: Belward et al. (2011).

5.5.3 Biomass Potential

Much of the African continent has medium to high densities of biomass resources (see Figure 5.8). Biomass is a potentially renewable energy source, depending on how the resource is managed. It also continues to be the predominant source of energy across the African continent, something that is not likely to change for many years. There is a wide range of opinion on the quantities of biomass potential. IRENA (2011) states that the literature claims anything from 8 EJ to 400 EJ per year, but suggests that 25-50 EJ, in addition to 20 EJ of traditional biomass, is probably more realistic.

Biomass offers more flexibility and diversity than other renewable energy sources. It can be burned when and where needed in order to convert the energy into useful services. It is both transportable and relatively controllable in operation, and can be traded more easily than other renewable energy resources, which require grid connections.

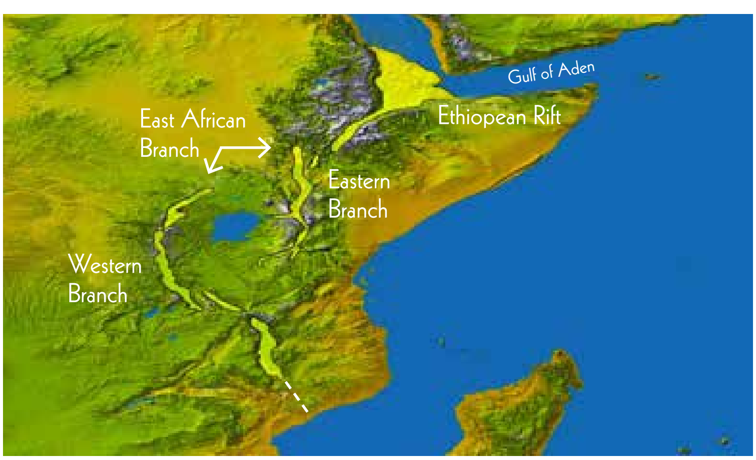
Biomass is not a homogeneous resource. There are many categories of bioenergy, including animal waste, crop residues, grass, wood, and fuels derived from bio-resources. Each of these provides different densities of energy, and each has different impacts on human health, the environment, and so on. For example, sugarcane grown for bio-ethanol tends to be more environmentally friendly than jatropha grown for biodiesel because the sugarcane tends to be more capital intensive and based on plantations. An intensive biofuels plantation approach might therefore be more in line with a green growth strategy, but would imply fewer employment opportunities than jatropha (Resnick et al., 2012).

5.5.4 Geothermal Potential in Africa

Geothermal energy is considered a renewable resource, in that any heat extracted for direct or indirect use is replenished by the heat flows beneath the earth's surface (Goldstein et al., 2011). In practice, a geothermal plant can extract heat at a rate faster than it is replenished. However, full recharge of the local resource is possible if the heat extraction is paused for a given duration. As such, with appropriate management, geothermal resources are sustainable. The potential heat available tends to increase with depth, but this also tends to increase the complexity and costs of projects. One of the important benefits of geothermal electricity generation is that it is predictable and so can be suited to base load power requirements, unlike some other renewable energy sources.

The geothermal potential in Africa is limited geographically, with most of it found in the East African Rift system (IRENA, 2012a). Even though this system passes through 12 countries, the bulk of the geothermal resource is found in the Eastern Branch of the system, where volcanic activity is most intense (see Figure 5.9). As a result, Ethiopia and Kenya are thought to have the best geothermal resources.

Figure 5.9: Geothermal Resources in Africa - the East African Rift System



Source: Geology.com (2011).

To date, however, only Kenya has exploited these resources significantly, with about 205 MW of capacity in place and a further 320 MW planned. In contrast, Ethiopia has installed only 4MW to date, although it may have much more geothermal potential. Table 5.4 shows the technical potential of different regions globally, giving lower and upper bounds to ranges at 3, 5 and 10 km depth. Table 5.5 gives current and forecast installed capacity of plant for both electricity generation and heat, projecting to 2015, for the same regions. As can be seen, Africa has a large

Table 5.4: Geothermal Technical Potential on Continents for the International Energy Agency Regions and Global Technical Potential

	Electric technical potential in EJ/yr at depths to:						Technical potentials (EJ/yr) for direct uses direct uses	
	3km		5km		10km			
Region	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
OECD North America	25.6	31.8	38.0	91.9	69.3	241.9	2.1	68.1
Latin America	15.5	19.3	23.0	55.7	42.0	146.5	1.3	41.3
OECD Europe	6.0	7.5	8.9	21.6	16.3	56.8	0.5	16.0
Africa	16.8	20.8	24.8	60.0	45.3	158.0	1.4	44.5
Transition Economies	19.5	24.3	29.0	70.0	52.8	184.4	1.6	51.9
Middle East	3.7	4.6	5.5	13.4	10.1	35.2	0.3	9.9
Developing Asia	22.9	28.5	34.2	82.4	62.1	216.9	1.8	61.0
OECD Pacific	7.3	9.1	10.8	26.2	19.7	68.9	0.6	19.4
Total	**117.3**	**145.9**	**174.2**	**421.2**	**317.6**	**1108.6**	**9.6**	**312.1**

Source: Goldstein et al. (2011).

Table 5.5: Regional Current and Forecast Installed for Geothermal Power and Direct Uses, and Forecast Generation of Electicity and Heat by 2015

	Current capacity (2010)		Forecast capacity (2015)		Forecast generation (2015)	
Region	Direct (GW)	Electric (GW)	Direct (GW)	Electric (GW)	Direct (TW/yr)	Electric (TWh/yr)
OECD North America	13.9	4.1	27.5	6.5	72.3	43.1
Latin America	0.8	0.5	1.1	1.1	2.9	7.2
OECD Europe	20.4	1.6	32.8	2.1	86.1	13.9
Africa	0.1	0.2	2.2	0.6	5.8	3.8
Transition Economies	1.1	0.08	1.6	0.2	4.3	1.3
Middle East	2.4	0	2.8	0	7.3	0
Developing Asia	9.2	3.2	14	6.1	36.7	40.4
OECD Pacific	2.8	1.2	3.3	1.8	8.7	11.9
Total	**50.6**	**10.7**	**85.2**	**18.5**	**224**	**121.6**

Source: Goldstein et al. (2011).

proportion of the world's geothermal resources but has yet to exploit them, compared with regions such as North America, Europe, or Asia.

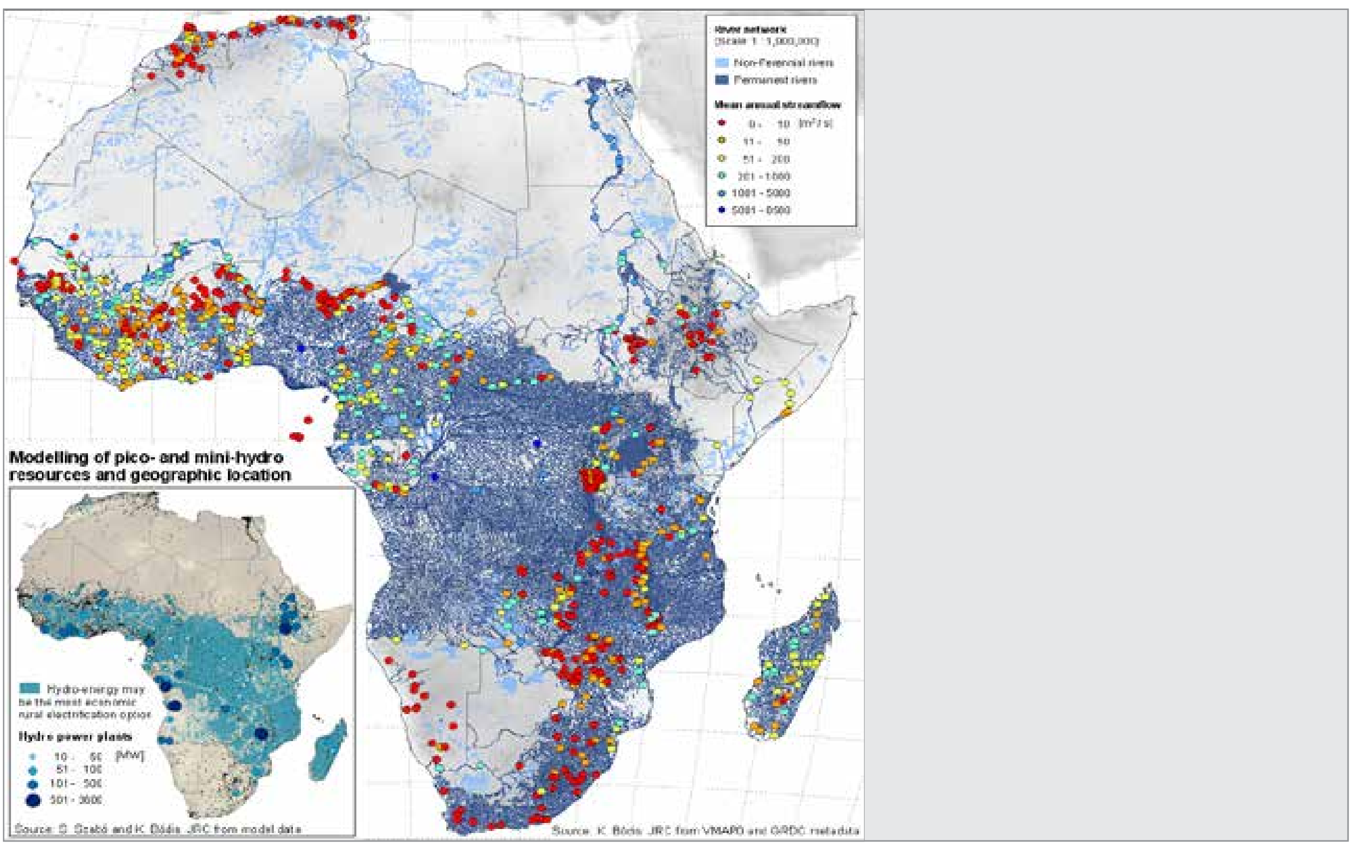
5.5.5 Pico (Mini) Hydro Potential

According to IRENA (2011), the hydro potential in Africa is 1,844 TWh, or three times Africa's current electricity production, of which only 5 percent is being exploited. As with most renewable energy sources, hydro resources are dependent on local climate and other parameters. An extra complicating factor for hydropower is the fact that the generator needs to be sited in or close to the water resource and the electricity then transmitted over a grid. According to modeling by Belward et al. (2011), about 30 percent of Africa's population lives in areas where small hydropower generation could provide the cheapest electricity option compared with extending the existing grid, installing diesel generators, or using PV. They also note that changes to subsidy policies for fossil fuels could increase the proportion of the population who might benefit from hydro or other renewable energy sources for electricity generation. Figure 5.10 shows the results of this study, including levels of hydro potential and existing hydro plants. The inserted map shows that a large swathe of central Africa is currently where the most economically attractive hydro potential lies.

5.5.6 Summary of Clean Energy Options in Africa

Africa has an opportunity to exploit a range of renewable energy sources. Particular countries have their own mix of resource endowments. Most of the continent enjoys abundant solar resources, although the north and west

Figure 5.10: Hydro Resources and Locations of Hydro Plants in Africa



Source: Belward et al. (2011).

are especially well served (see Table 5.6). East Africa has almost all the geothermal resources on the continent and Central Africa has a large share of hydro resources. All regions could benefit from biomass, with the caveat that the traditional use of wood and charcoal for cooking has its own environmental impacts. Wind energy resources are concentrated in the east and north, although there is a useful potential in the south. Most renewable energy resources, dependent as they are on the weather, can be influenced by microclimates.

Because adequate data are not always available in Africa, the potentials reported above are not definitive. Much more information is required across Africa, and in much finer detail. Considering that climate change will impact on the patterns of some of the renewable energy resources, the collection of such data will need to be a regular and frequent process.

5.6 Feasibility of Clean Energy Options

Having considered the resource potentials of renewable energies in Africa, the discussion now turns to the costs and benefits of RETs in delivering energy services. Three kinds of services are discussed: electricity, heat and transport. This lays a foundation for considering low-carbon pathways and how African countries might facilitate them through policy interventions.

5.6.1 Costs of Renewable Energy Technologies

A range of costs for any particular RET is more appropriate than a single figure. As discussed above, there are a wide range of context-specific factors that will influence the costs of implementing and operating RET installations. For example, a PV system installed at a location with abundant solar radiation, where there is plenty of local knowledge among financiers for lending for such installations, will have a significantly different cost profile than a PV system in a less well-endowed solar regime, where local financiers are unfamiliar with the technology.

Figure 5.11 shows a range of global costs for various groups of RETs for electricity generation, heat and transport. The lower bound of each range is calculated on the basis of the most favorable combination of factors, and the upper bound[19] on the basis of a much less favorable combination of the same factors. Figure 5.11 also shows the range of costs for non-renewable energy carriers (excluding taxes and subsidies). Median costs are shown as solid lines to

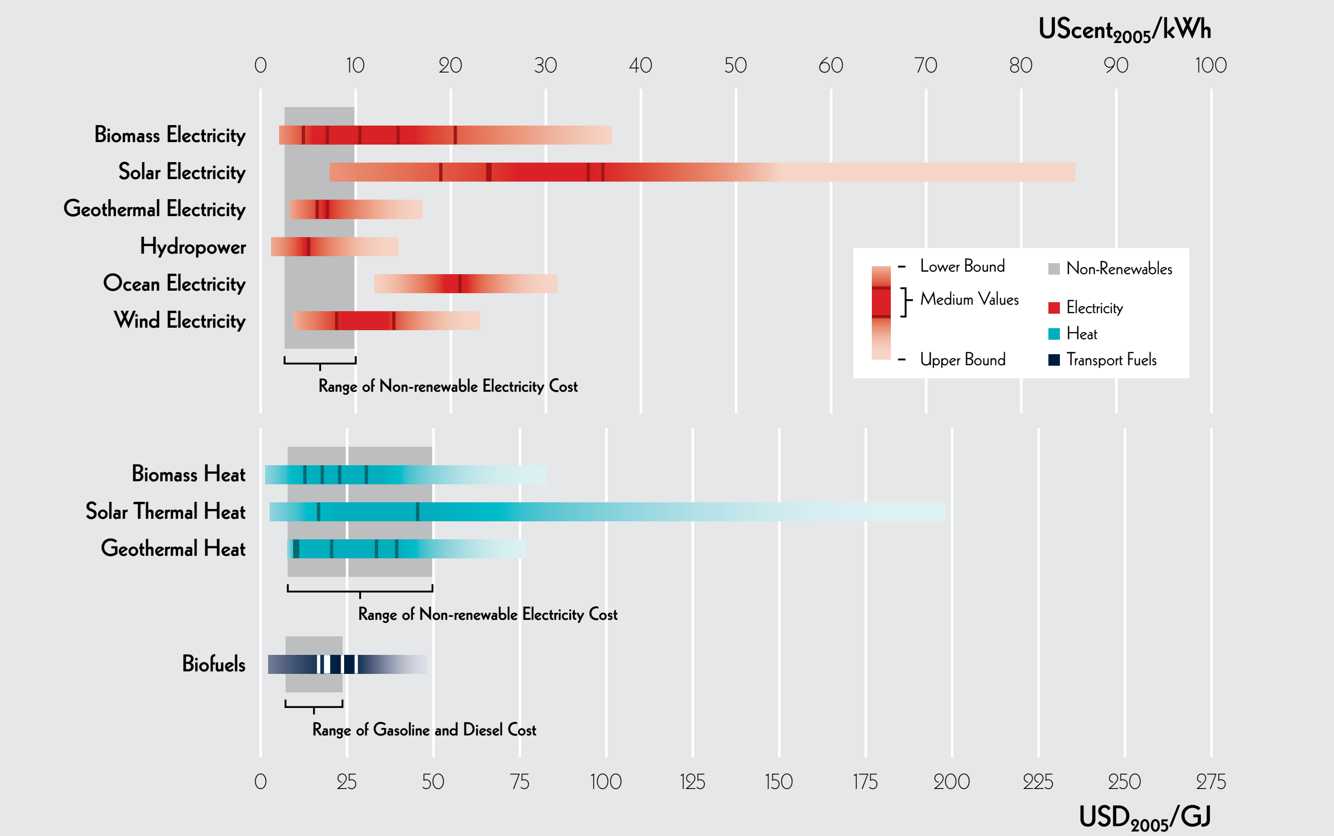
19 Moomaw et al. (2011: 188) explain the factors used: "The lower bound of the levelized cost range is based on a 3 percent discount rate applied to the low ends of the ranges of investment, operations and maintenance (O&M), and (if applicable) feedstock cost and the high ends of the ranges of capacity factors and lifetimes as well as (if applicable) the high ends of the ranges of conversion efficiencies and by-product revenue. The higher bound of the levelized cost range is accordingly based on a 10 percent discount rate applied to the high end of the ranges of investment, O&M and (if applicable) feedstock costs and the low end of the ranges of capacity factors and lifetimes as well as (if applicable) the low ends of the ranges of conversion efficiencies and by-product revenue. Note that conversion efficiencies, by-product revenue and lifetimes were in some cases set to standard or average values."

Table 5.6: Renewable Energy Potentials Across the African Regions

Region	Wind (TWh/yr)	Solar (TWh/yr)	Biomass (EJ/yr)	Geothermal (TWh/yr)	Hydro (TWh/yr)
East	2,000-3,000	30,000	20-74	1-16	578
Central	-	-	49-86	-	1,057
North	3,000-4,000	50,000-60,000	8-15	-	78
South	16	25,000-30,000	3-101	-	26
West	0-7	50,000	2-96	-	105
Total Africa	**5,000-7,000**	**155,000-170,000**	**82-372**	**1-16**	**1,844**

Source: IRENA (2011), based on a compilation of various sources.

Figure 5.11: Renewable Energy Technology Detailed Cost Ranges



Notes: Medium values are shown for the following subcategories, sorted in the order as they appear in the respective ranges (from left to right):

Electricity

Biomass:
1. Cofiring
2. Small scale combined heat and power, CHP (Gasification internal combustion engine)
3. Direct dedicated stoker & CHP
4. Small scale CHP (steam turbine)
5. Small scale CHP (organic Rankine cycle)

Solar Electricity:
1. Concentrating solar power
2. Utility-scale PV (1-axis and fixed tilt)
3. Commercial rooftop PV
4. Residential rooftop PV

Geothermal Electricity:
1. Condensing flash plant
2. Binary cycle plant

Hydropower:
1. All types

Ocean Electricity:
1. Tidal barrage

Wind Electricity:
1. Onshore
2. Offshore

Heat

Biomass Heat:
1. Municipal solid waste based CHP
2. Anaerobic digestion based CHP
3. Steam turbine CHP
4. Domestic pellet heating system

Solar Thermal Heat:
1. Domestic hot water systems in China
2. Water and space heating

Geothermal Heat:
1. Greenhouses
2. Uncovered aquaculture ponds
3. District heating
4. Geothermal heat pumps
5. Geothermal building heating

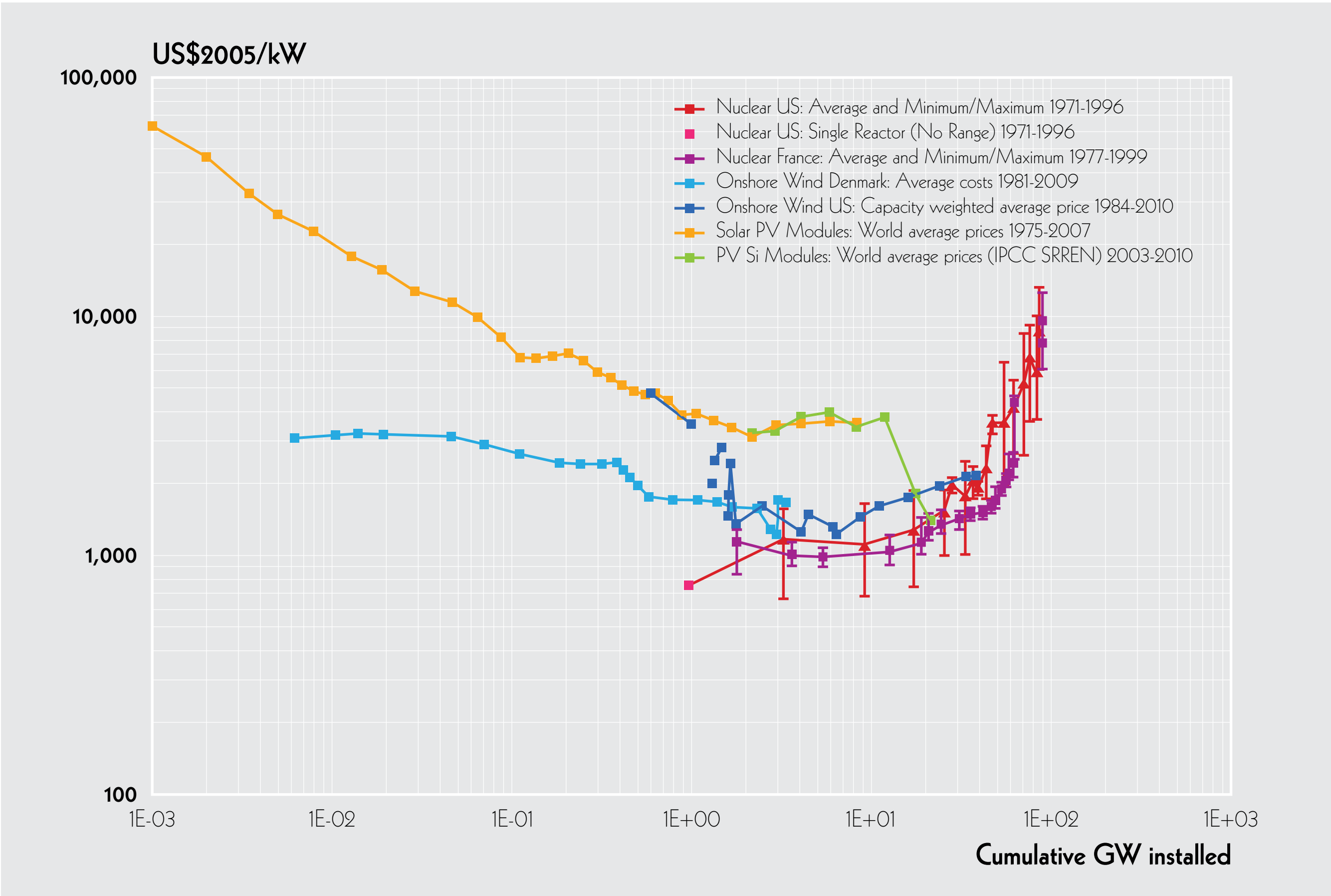
Transport Fuels

Biofuels:
1. Corn ethanol
2. Soy biodiesel
3. Wheat ethanol
4. Sugarcane ethanol
5. Palm oil biodiesel

The lower range of the levelized cost of energy for each RE technology is based on a combination of the most favourable input-values, whereas the upper range is based on a combination of the least favourable input values. Reference ranges in the figure background for non-renewable electricity options are indicative of the levelized cost of centralized non-renewable electricity generation. Reference ranges for heat are indicative of recent costs for oil and gas based heat supply options. Reference ranges for transport fuels are based on recent crude oil spot prices of USD 40 to 130/barrel and corresponding diesel and gasoline costs, excluding taxes.

Source: Arvizu et al. (2011).

Figure 5.12: Cost Trends of Selected Non-Fossil Energy Technologies in US$ 2005 per kW Installed Versus Cumulative Deployment in GW Installed



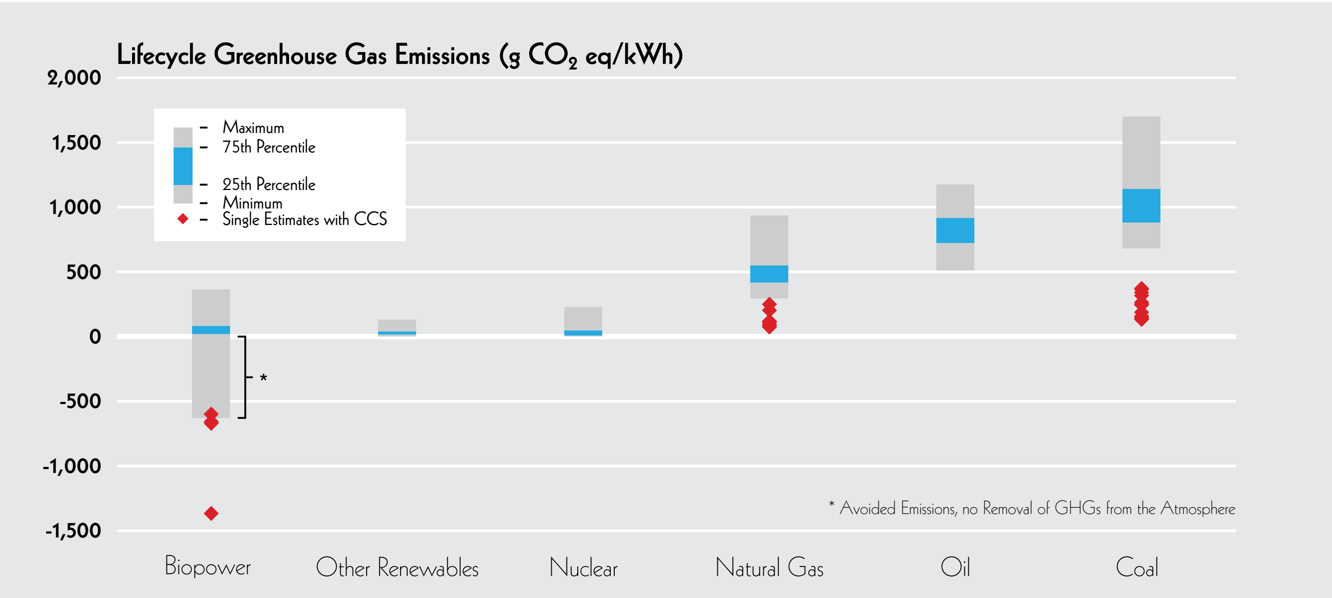
Source: Johansson et al. (2012).
Note: Both scales are logarithmic.

give an indication of the extent to which the upper or lower bounds represent any significance[20]. The figure suggests that onshore wind, hydropower, geothermal and biomass electricity all have median values of levelized cost within the range of non-renewable energy carriers. Only ocean and solar electricity have higher median values. For heat, all three technology groups (biomass, solar and geothermal) have levelized costs within the range of oil and gas based heating costs. For transport fuels, only palm oil biodiesel has a higher median levelized cost than the range of gasoline and diesel.

There has been a general downward trend in the costs for RETs. Figure 5.12 shows a general downward trend in costs as more capacity has been deployed. Nuclear technologies, in contrast, have risen in cost significantly. The most striking downward trend is for PV, the cost of which has plummeted in recent years. However, for wind power, there has been a recent upward trend in the cost of US onshore technology. Johansson et al. (2012) suggest

20 Where more than one median value is shown for a technology group, the leftmost value corresponds to the first technology listed under the group in the bottom part of the figure. For example, for biomass, cofiring has the lowest median value at approximately 3-4 US2005 cents per kWh. Small scale combined heat and power (CHP) (organic Rankine cycle) has the highest median value at just over 20 US_{2005} cents per kWh.

Figure 5.13: Lifecycle GHG Emissions of Renewable Energy, Nuclear Energy and Fossil Fuels



Source: Moomaw et al. (2012).

that this rise in costs of US wind power is the result of a combination of factors. Ambitious demand-pull policies designed to stimulate additional manufacturing capacity, rising profit margins, and rising commodity and raw materials prices may have been the multiple causes.

5.6.2 Benefits of Renewable Energy Technologies

Deployment of RETs leads to reduction in GHG emissions. Figure 4.13 gives a summary overview of lifecycle GHG emissions from a selection of technology groups. Once again, there is a range to report, particularly in regard to bioenergy. This has partly to do with the way lifecycle assessments are conducted but also to the range of technologies within each group.

Even allowing for these ranges, there is little overlap between the worst performing biofuels and the fossil energy sources, all of which produce much higher levels of GHG emissions than the "other renewables," except when carbon capture and storage (CCS) is used as well.

The RETs also result in the reduction of local pollutants, especially particulates, which, according to Johansson et al. (2012), could mean "a saving of 20 million disability adjusted life years (DALYs) from outdoor air pollution and more than 24 million DALYs from household air pollution," compared with just the introduction of air quality legislation that is currently planned. The authors also suggest that these positive health impacts could help to persuade individuals to adopt RETs, more so than asking them to make changes to achieve global benefits such as the mitigation of climate change.

The RETs can also help with job creation. IRENA (2012b) provides some data on this, albeit based on non-Africa specific data[21]. Table 5.7 has this information for solar, small hydro, biomass and wind. This suggests that solar offers the highest job intensity, at 30 jobs per MW, and small hydro the lowest, at 4 per MW. There are some other important nuances about job creation with respect to RETs, particularly small-scale RETs and their use in

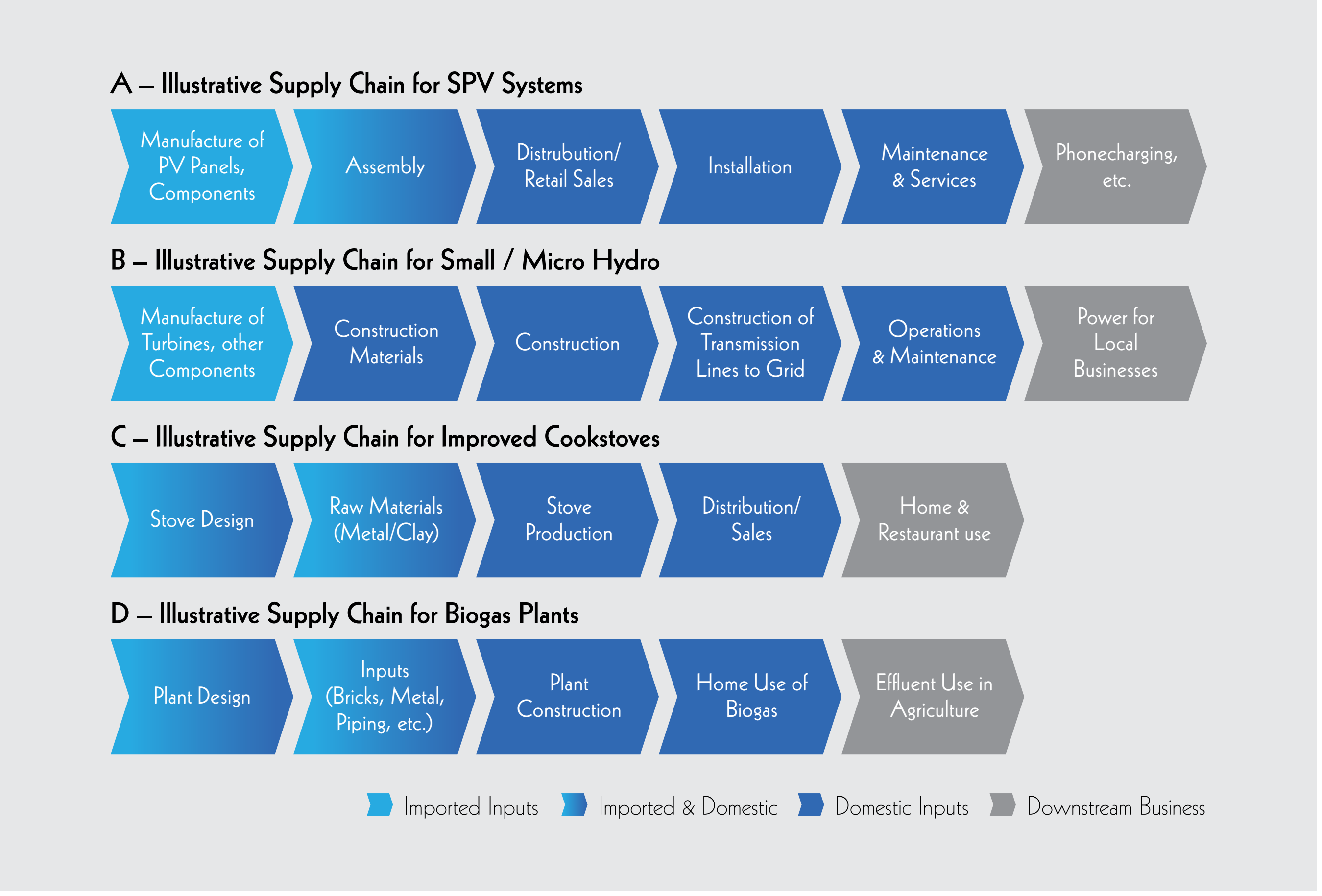
21 The data is based on information on such jobs in India.

Table 5.7: Potential Employment Creation through Off-grid RET-generated Electricity

Energy use (TWh)	Energy use (TWh)	Load Factor(%)	Capacity(MW)	Job Factor (Jobs per MW)	Employment (Thousands)
Solar	169.2	25	77,260	30	2,318
Small Hydro	37.6	70	6,132	4	31
Biomass	98.7	80	14,084	15	211
Wind	131.6	30	50,076	22	1,102
Total	**437.1**		**147,552**		**3,661**

Source: IRENA (2012b) estimates based on data from outside Africa.
Note: Given that the table offers a very rough sketch of potential job creation, the employment figures in the final column have been rounded to the nearest thousand.

Figure 5.14: Illustrative Supply Chains for Various Renewable Energy Technologies in Developing Countries



Source: IRENA (2012b).

rural areas of poorer developing countries. Many of the jobs are in the service end of the supply chain and include distribution and sales, installation, maintenance, and so on (see Figure 5.14). For some RETs (e.g., biogas plants and improved cook stoves), there are opportunities for manufacturing or construction jobs, which, by contrast, are unlikely in the case of PV modules in Africa in the short term because of the high level of skills required. Having said this, over time and with appropriate policy interventions, there may be possibilities to develop local skills to manufacture technologies such as PV modules and to move to more lucrative parts of the value chain, while building the capabilities to realize more self-directed development. For more on this, see Chapter 5 on technology transfer.

5.6.3 Summary of Renewable Energy Opportunities

In sum, Africa has abundant but largely untapped renewable energy resources. The use of RETs to tap these resources offers a number of environmental, social and economic benefits that align well with aspirations of a green growth strategy, and that are not easily achieved with fossil energy technologies. While RETs are in general still more expensive than fossil energy technologies, their costs are falling, whilst those for fossil energy technologies are increasing. In some cases – perhaps in many – RETs already offer cheaper ways to access energy services than fossil energy options.

A further opportunity available to many African countries, especially those that have not yet established much in the way of energy infrastructure, is the prospect of avoiding lock-in to high-carbon fossil energy pathways for decades into the future (Doig and Adow, 2011; Byrne et al., 2012a). Locking into such systems will simply store up expensive problems for later, as industrialized (and a number of middle-income) countries are discovering. It is a complex challenge to shift interdependent high-carbon energy systems to new low-carbon alternatives.

African countries can address their critical energy infrastructure challenges by making use of this confluence of conditions. But this will take time and will need international assistance (in the manner discussed in Chapters 6 and 7) in strategic combination with regional, national and sub-national efforts. Specific low-carbon pathways will be different for different countries, but this diversity of pathways will help Africa move toward broader sustainability objectives such as energy security and resilience.

5.7 Relevance of Efficiency Gains for Energy Security and Low-carbon Development

Energy efficiency (EE) is an important supplement to RETs in the process of creating low-carbon pathways. There are numerous opportunities for improving the efficiency of end-use technologies and processes and the systems in which they are used. These exist in all spheres of activity, from the industrial to the household. By lowering the demand for energy, supply-side investments can be reduced and investment capital can be released for other purposes. For consumers, lower energy demand means lower expenditures. For producers, lower energy costs can translate into more competitive products.

Significant EE gains are possible in Africa, and could lead to important CO_2 emissions reductions. According to Farrell and Remes (2008), there are opportunities to reduce energy demand worldwide by 20 percent compared with projections by 2020. The results of a further study are given in Table 5.8, showing the economically feasible EE improvements in Africa in a range of sectors for the year 2020, based on various country-specific studies.

Although a range of countries is represented in Table 5.8, it should be noted that many countries are missing. This suggests that there may be an information deficit in regard to the potential for EE improvements and that more work may be needed to assess the full extent of such potential in Africa. To this end, a recent study for the World Bank of EE potential in the African cement industry demonstrated that the implementation of five processes across African cement facilities, to bring them closer to the technological frontier, could result in annual savings of more than 5 million tons of CO_2 emissions (Energy Institute, 2009).

Thorough appraisals are necessary to maximize EE improvements. Energy efficiency gains in particular are susceptible to the "rebound effect," where the lower

Table 5.8: Economic Energy Efficiency Potential in Africa for 2020

Sector and area	Economic potential (percent)	Country	Energy price level assumed	Base year	Source
Industry					
Total industry	15	Zimbabwe		1990	Tau, 1991
	about 30	Zambia		1995	SADC, 1996
	32	Ghana		1991	Davidson and Karekezi, 1991; Adegbulugbe, 1992a
	25	Nigeria		1985	Davidson and Karekezi, 1991; SADC,1997
	>20	Sierra Leone		1997	Adegbulugbe, 1993
	20	Mozambique			
Iron and Steel Cement	7.2	Kenya			Nyoike, 1993
	11.3	Kenya			Nyoike, 1993
	15.4	Ghana		1988	Opam, 1992
	9.8	Kenya			Nyoike, 1993
Aluminium (sec)	44.8	Kenya			Nyoike, 1993
Refineries	6.3	Kenya			Nyoike, 1993
Inorganic chemicls	19	Kenya			Nyoike, 1993
Consumer goods	25	Kenya			Nyoike, 1993
Food	16-24	Mozambique		1993	SADC, 1997
	1--30	Ghana		1988	Opam, 1992
Cogeneration	600MW	Egypt		1998	Alnakeeb, 1998
Residential					
Electric appliances	20-25	Mozambique	1993	1991	SADC, 1997
	11	South Africa		1995	Energy Efficiency News, 1996
Transportation					
Cars, road system	30	Nigeria		1985	Adegbulugbe, 1992a
Total transport	30	Ethiopia		1995	Mengistu,1995

Source: UNDP (2000).

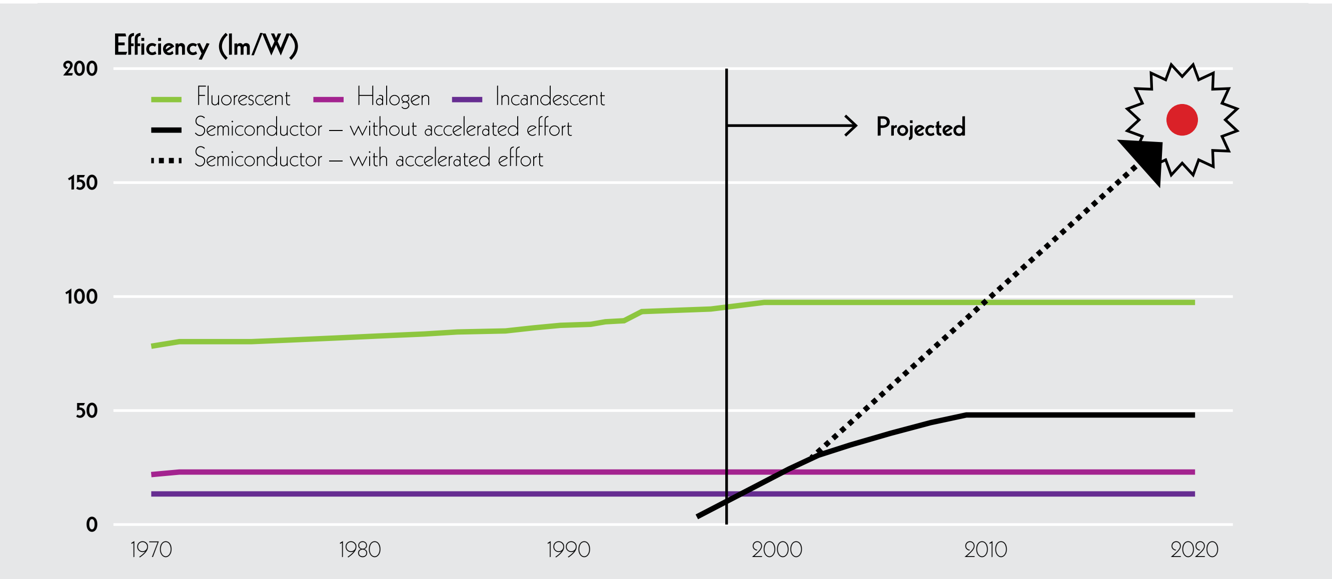
effective price of energy following the efficiency improvement may lead to (some) increases in energy consumption (Sorrell, 2007). The rebound effect could erode the gains from EE improvements, and might even reverse them in some cases. This is not to say that EE should be discounted; rather, it is to caution against over-optimistic assumptions about EE and to suggest that costly outcomes should be anticipated in order to mitigate their effects.

The rest of this section will consider EE opportunities in some end-use technologies and those involving behavioral change. These include efficient lights and cook stoves, as well as behavioral change through education, training, the provision of information, and raising awareness.

5.7.1 Energy Efficient Lighting

Compact fluorescent lamps (CFLs) and light emitting diodes (LEDs) offer energy efficient solutions for households or individual consumers. According to POST (2010), global CO_2 emissions from lighting are three times those of aviation, accounting for one-fifth of global emissions, and the demand for lighting is set to increase 80 percent by 2030. Two main types of electric lighting technology are currently attracting interest because they are more energy efficient than traditional incandescent lamps: compact fluorescent lamps (CFLs) and light emitting diodes (LEDs). A CFL uses about 20 percent of the power of an incandescent lamp to produce the same light level, where this efficiency is measured in lumens per watt (lm/W). CFLs have been growing in use for many years, and have improved in a number of their technical characteristics. The prices of CFLs have also been falling, although the initial price is still too high for many of the world's poorest people. LED efficiency is similar to or greater than that of CFLs but, although they have been in use for many years, it is only relatively recently that they have become serious alternatives for space lighting. As Figure 5.15 shows, CFLs are thought to have reached their maximum efficiency, while LEDs are expected to become much more efficient following further research and development (Sekyere et al., 2012). Furthermore, LEDs have much longer operational lifetimes than CFLs. Current efficiency values and operational lifetimes for different lighting technologies are given in Table 5.9.

Figure 5.15: Comparison of Achieved and Projected Efficiencies of White LEDs with Other White Light Sources



Source: Sekyere et al. (2012).

Table 5.9: Energy Efficiencies and Lifetimes of Lamps*

Lamp Technology	Energy Efficiency (lumens per watt)	Typical Lifetime (hours)
Incandescent	8-14	400-2,000
Halogen Incandescent	15-25	1,500-5,000
Fluorescent (tube)	45-100	6,000-70,000
Fluorescent (CFL)	50-70	3,000-15,000
LED	50-100	20,000-50,000
Discharge	60-130	15,000-20,000
Induction	50-70	>60,000

Source: POST (2010).

* Note that the table introduces the lamp technologies of discharge and induction that were not covered in the text. These technologies provide other energy efficient solutions for the future.

Two experiences with CFL dissemination in African countries are instructive. The Ghanaian experience (see Edjekumhene and Cobson-Cobbold 2011) demonstrates the impact of different approaches implemented over time and the role of complementary policies. The Rwandan experience (see Okereke and Tyldesley, 2011) illustrates the possibilities of using carbon finance to promote EE lighting.

Ghana's CFL exchange program began in the mid-1990s, with a simple subsidy program. Initially, US$ 1 million worth of CFLs were imported and sold at highly subsidized rates through the customer service points of two utilities. The program was unsuccessful for a number of reasons, including low electricity tariffs, a lack of consumer awareness of the benefits of CFLs, poor marketing, and poor lamp quality. Consequently, the highly subsidized lamps were smuggled to Cote d'Ivoire, where tariffs were higher and consumers were more aware of the benefits. By contrast, a later program, beginning in 2007, achieved significantly more success. By this time, power sector reforms had led to tariff increases - enough to make the use of CFLs more attractive. The Ghanaian government imported 6 million CFLs, costing US$ 13 million, and distributed them free to households. Crucially, each household was visited and all the incandescent lamps were removed and replaced with the CFLs. Furthermore, as of January 2011, incandescent lamps were banned. The impact of this second program was dramatic, with demand for electricity dropping by more than 124 MW, saving an estimated US$ 38 million per annum and reducing emissions by 105,000 tons of CO_2 annually.

The Rwanda CFL Distribution Project, starting in 2007, had four aims: to reduce electricity demand, which would enable the utility to widen electricity access; to lower bills for customers; to raise awareness of energy efficiency among households; and to reduce carbon emissions by reducing electricity use. The financial resources for the program came through the Clean Development Mechanism. In the first phase of the project, existing customers were offered an exchange of incandescent lamps for up to two CFLs and new customers were given CFLs when they were connected to the grid. In a second phase, customers were offered up to five CFLs for just US$ 0.37 per lamp in exchange for incandescents. A further two phases of distribution took place up to mid-2010. Awareness campaigns were conducted before the project started and during its implementation. By the end of the project, a study suggested that interest in CFLs had increased, although this had been somewhat undermined by much cheaper and lower quality CFLs on the market. Still, the project is estimated to have helped reduce energy demand by 46,000 MWh annually, which is equivalent to the energy demand of 18,000 customers. The CDM finance was critical to the financial success of the project. Without it, the utility would have lost about US$ 1.2 million.

These two cases provide some useful lessons but also raise questions. The Ghanaian case shows how policies can interact to facilitate change. The combination of rising electricity prices and free availability of CFLs was more effective than simply supplying highly subsidized lamps. Perhaps more importantly, the forced exchange of lamps meant that CFLs were more likely to be used in the intended context. Whether this kind of approach could be implemented in other countries is an open question, as imposing lamp exchanges might create resistance in some contexts. The Rwandan case seems to have been successful without any imposition of CFLs. However, it may be that electricity tariffs were sufficiently high to make CFLs attractive from the outset.

What is not addressed in either case is the issue of capacity to develop further from the initial adoption of CFLs. As will be discussed in Chapter 8, the capacity to innovate beyond initial adoption could be crucial to the long-term success of CFLs in either country. The reduction in energy demand is clearly a helpful immediate achievement, but important development benefits may be missed if local manufacture of CFLs, or other lighting system components, is not pursued.

5.7.2 Cooking Stoves

Biomass remains the most important energy carrier for cooking in Africa. IEA (2011b) estimates that 80 percent of people in sub-Saharan Africa (SSA) rely on traditional biomass as their primary cooking fuel. At present, only

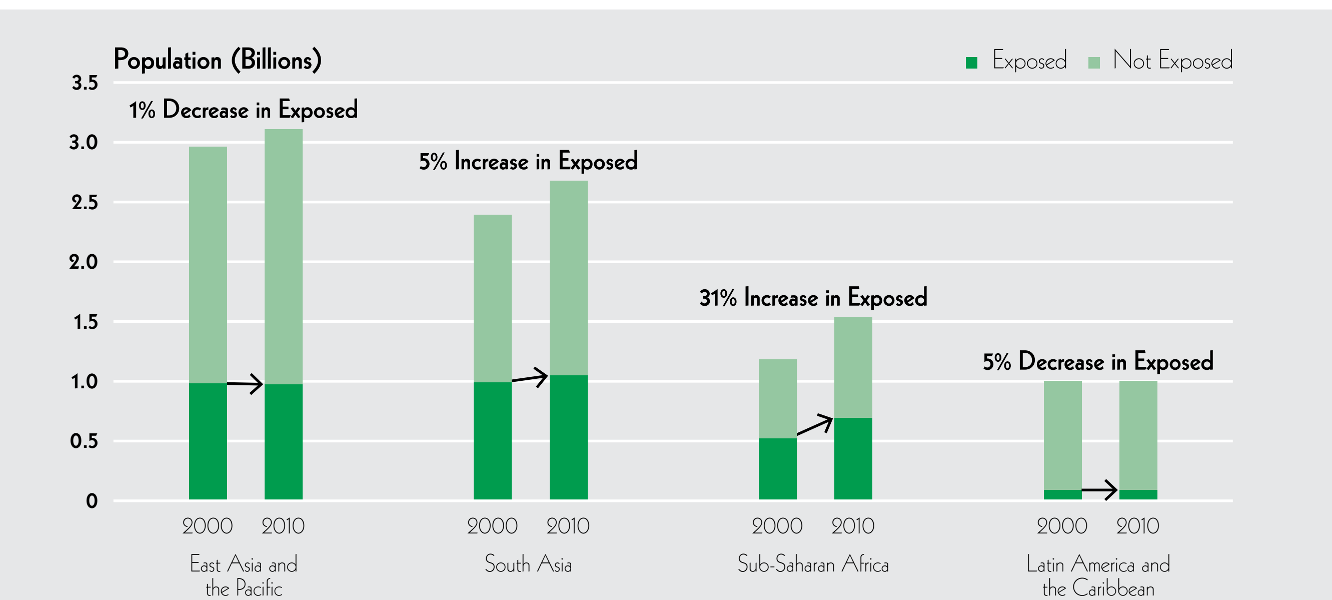
6 percent make use of improved cook stoves (Practical Action, 2010). According to UNDP-WHO (2009), 551,000 deaths per year in SSA are attributable to indoor air pollution, which is also the highest rate per million of any world region (see Table 5.10). Even more concerning is that exposure to indoor air pollution in SSA is increasing rapidly. Polsky and Ly (2012) state that there was a 31 percent increase in exposure over the period 2000 to 2010 (see Figure 5.16).

Table 5.10: Mortality and Morbidity Attributable to Indoor Air Pollution from Solid Fuel Use, by Global Region, 2004

	Attributable deaths per year		Attributable DALYs per year	
	Number ('000)	Per 1 million population	Number (in millions)	Per 1 million population
Developing Countries	1,944	378	40.5	7,878
LDCs	577	771	18.4	24,606
Sub-Saharan Africa	551	781	18	25,590
South Asia	662	423	14.2	9,075
Arab States	35	114	1.1	3,489
East Asia and Pacific	665	341	6.5	3,308
Latin America and Caribbean	29	54	0.7	1,334
World	1,961	305	41	6,374

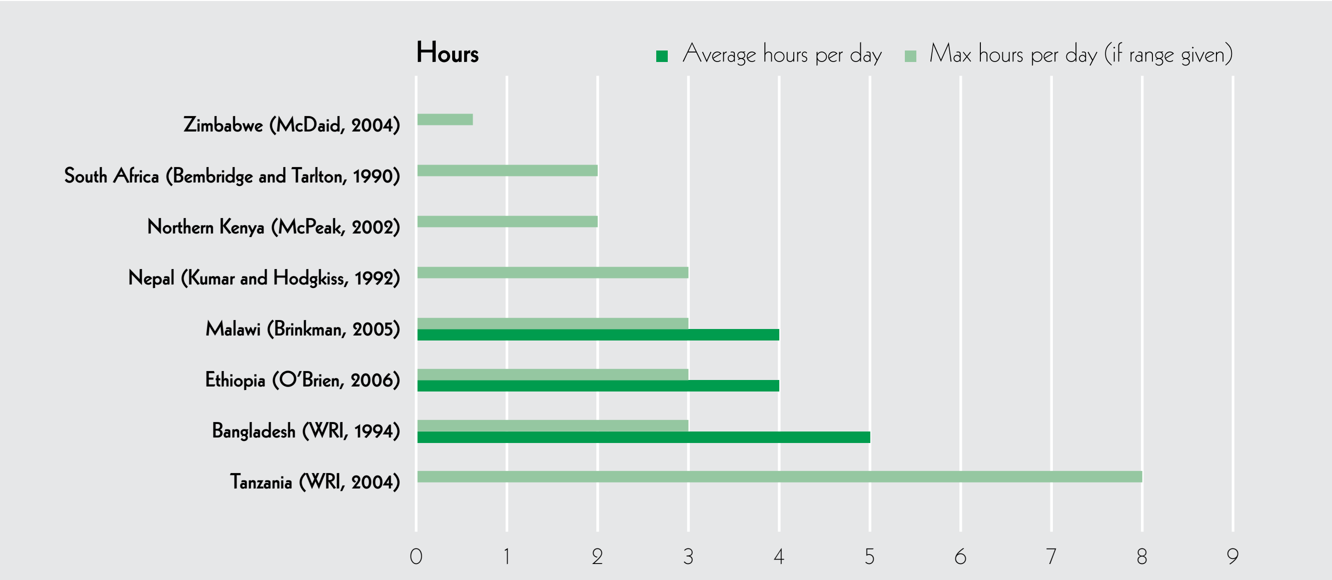
Source: UNDP-WHO (2009).
Note: Numbers and rates of death and disability-adjusted life years (DALYs) for all causes - i.e., Child pneumonia, adult COPD, and adult lung cancer.

Figure 5.16: Change in Regional Solid Fuel Use



Source: Polsky and Ly (2012).

Figure 5.17: Selected Data on Time Spent in Wood Collection



Source: Practical Action (2010).

It is increasingly difficult to collect biomass. Figure 5.17 shows hours spent collecting wood in a selection of countries. According to these figures, some Tanzanians could be spending eight hours per day at this task. Clearly, such work is burdensome and likely to be economically unproductive, unless the wood is being collected for later sale. And, of course, the gathering of this type of biomass may have negative environmental impacts. Even if this activity does not cause deforestation, the burning of biomass contributes significant GHG emissions that further threaten vulnerable populations.

So, it is clear that the inefficient burning of traditional biomass is unsustainable at many levels. This observation is not new, of course. The "other energy crisis" – increasing constraints on biomass supplies in developing countries – was identified in the mid-1970s (Eckholm, 1975). Attempts to use technology to address the problem have been underway for decades. Some of the improved stoves that have been introduced as a result have been successful (e.g., the Kenya ceramic jiko) but many have failed. Efforts to develop improved cook stoves continue today. But, in an important difference with many of the past failed attempts, there are now international and local networks engaged in these efforts (e.g., the Global Alliance for Clean Cook Stoves, Household Energy Network (HEDON), and International Network on Gender and Sustainable Energy (ENERGIA)). HEDON (2012) provides a classification system for improved stoves so that the wide variety of designs can be categorized for ease of assessment and planning.

Successful diffusion and adoption of improved cook stoves is a complex and challenging task, as illustrated by the history of failed projects and low adoption rates in Africa. Nevertheless, the literature points to successes from which lessons can be learned and strategies derived that can help these efforts. Rai (2009), for example, identifies key lessons from the experiences of practitioners, observing that, first of all, the stove in question needs to be "absolutely right." That is, the design should be in line with the context-specific needs and preferences of the customer. Second, there should be strong partnerships among state institutions, the private sector, and ordinary citizens. Third, donors can also be important for providing subsidies to support market development, including experimenting to find the right stove design, facilitating capacity building, raising awareness and promoting stoves. Fourth, as the "bottom of the pyramid" cook stove market is generally unattractive to larger companies, it takes more socially conscious entrepreneurs to drive market development. Other literature has emphasized the importance of sufficient engagement with users. Slaski and Thurber (2009) elaborate this last point, arguing that adopting an improved cook stove could mean significant lifestyle changes, and that, without training in how to use the stove effectively, the adoption of what may be seen as a disruptive technology is unlikely to occur.

Many of the lessons outlined by Rai (2009) align closely with strategies for creating low-carbon pathways with RETs. Any solution must be responsive to the context into which it will be deployed, and broad networks of stakeholders are essential for generating the learning required to get the product right in that context. Although Rai (2009) does not discuss policy explicitly, the recommendation for a strong partnership with state institutions at least implies the relevance of policy-makers to the process. Drawing this together with the principle of user engagement, Rai's argument also chimes with the earlier argument that learning is best achieved when it is participatory. In the case of cooking practices in Africa, it is clear that they will continue to rely on biomass for a long time.

Accepting this reality does not mean that the transition to low-carbon cooking alternatives should be abandoned. Rather, the focus can start with improved cook stoves that will avoid some of the health problems of the most inefficient technologies, based on introducing cleaner technologies that are designed with the user center stage. Improved health outcomes will, in turn, contribute to alleviating poverty, in tandem with other appropriate policies, including potentially facilitating local manufacturing of improved cook stoves, and building indigenous innovation capacities. This will help generate economic gains such that, as people work themselves out of poverty, they can afford higher quality cooking technologies, perhaps technologies created as a result of the enhanced innovation capacities initiated with earlier improved cook stoves. In the meantime, the use of cleaner stoves can mitigate GHG emissions, with the associated benefits to the global and local environment.

5.8 Behavioral Changes Through Sensitization

The discussion has so far centered on technologies. Behavior changes are also very important, as they could generate large gains at little, if any, cost. Understanding behaviors, and how they can be influenced by external constraints and opportunities, can present opportunities to encourage certain choices over others – for example, energy saving rather than energy consuming behaviors. The context is once again important: cultural practices are highly context-specific. These ideas have implications for how behavior change might have a positive impact on creating low-carbon pathways.

This logic might suggest that it should be relatively straightforward to change conscious "bad" behavior by, for instance, providing information that it is damaging. However, in practice, encouraging "good" behavior does not always seem to be so simple (Owen and Driffill, 2008). Simply supplying information, with or without deeper sensitization, may not be enough to persuade consumers to change their behavior. Owen and Driffill (2008) argue that behavior is influenced by a much broader set of factors, pointing to the context in which behaviors are formed.

This analysis is broadly aligned with the argument of Griskevicius et al. (2008) that "descriptive" social norms – that is, clear displays of a particular behavior that is expected from others – influence the behavior of those who are exposed to the descriptive norm. An example, tested by the authors, shows this effect. The authors counted the number of passersby who gave money to a street musician. Later, they counted the number of passersby who gave money to the same street musician, except that every time someone was approaching, they had someone else donate money in the musician's hat first (and so perform a descriptive social norm). The result was that the passersby who saw money being donated were eight times more likely to give than those who did not see money donated.

When those who donated were interviewed, they denied that they gave money because of the influence of the other donation; rather, they believed they had donated for some other reason.

This suggests that campaigns to raise awareness must consider social norms. If the norms and other contextual factors within which behaviors developed work in opposition to the "desired" behavior, then the desired behavior is unlikely to be adopted. For example, energy efficiency measures may not be adopted by consumers, even if they would benefit quickly from cost savings, if they are in conflict with the particular cultural norms – such as cleanliness – of the context in which they live. Although it is unlikely that policy can change norms, Owen and Driffill (2008) do offer some ideas for how to move beyond this constraint. They suggest that research points to "more interactive, deliberative" engagement between stakeholders, including the public. Once again, this is reminiscent of the argument earlier to include a broad range of actors to generate learning.

The way in which information is provided can also be crucial. Fischer (2008), investigating feedback methods for electricity meters in several industrialized countries, finds that successful feedback combines a number of features. It should be provided frequently and over a long period. It should give specific appliance information. And it should be presented in a clear, attractive and interactive form. To underline this point in a different context, van der Plas and Hankins (1998) found in their survey of Kenyan households which owned solar home systems (SHSs) that those owners who were trained in how to maintain their systems were more likely to have working systems than those who received no training. Here, again, the users had information that was specific and could be acted upon when needed.

5.9 Sustainable Transport and Cities

Sustainable changes in transport systems, combined with exploring RETs and changes in EE, is one way of moving towards green growth. Transport is a vital component of development, with transport networks enabling people to access employment, markets, education, information and a variety of other resources and assets that can enhance their well-being. Many existing road transport systems in African cities are relics of the colonial era, and under increasing pressure from growth in population and mobility. They are also typically fossil fuel-dependent and thus carbon intensive, thereby contributing to levels of greenhouse gas emissions.

African cities are currently set to develop in ways that encourage and lock in private motorized vehicle use, with implications for emissions (and also for considerations such as air quality and public safety). Africa is in line with global trends, which show that road transport is the largest source of emissions (OECD and ITF, 2010). Of particular concern is evidence that there is a positive correlation between GDP and the number of trips or percentage of travelers (known as the modal share) using private motorized vehicles (see Figure 5.18).

Below per capita income of about US $20,000, this modal share tends to increase with GDP. Above US $20,000, the picture is more complex. The red line shows the North American trend, in which the modal share increases relatively steeply with GDP, up to around US$ 30,000 per capita. The yellow line shows the "European" pattern, in which the modal share increases less steeply than in the North American case, up to around US$ 25,000, reflecting higher urban densities and different policies, for example, those encouraging effective public transport networks. From around US$ 25,000 to US$ 55,000 per capita, the "European" model is associated with a decline in the modal share of private motorized vehicle use, which actually declines with increasing GDP per capita. The blue line shows the most efficient pattern, as represented by cities such as Madrid, Hong Kong, Amsterdam and Tokyo, where, even with high GDP, the modal share of private vehicle use remains below 30 percent, due to a combination of high urban density and policies and planning that favor public and non-motorized private transport.

Only five African cities are plotted in Figure 5.18, but all fit within the European (Casablanca, Johannesburg) and

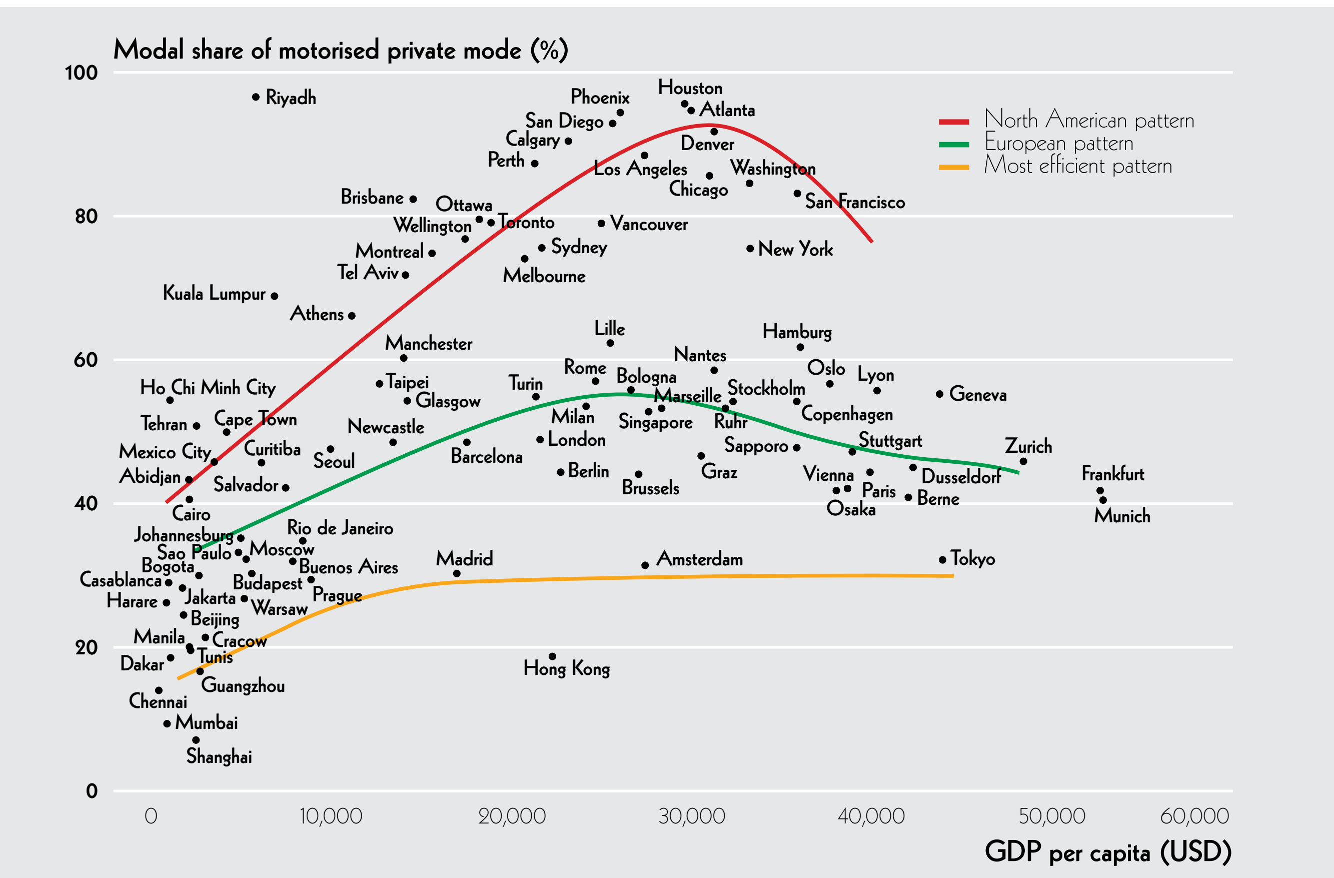
North American (Cairo, Abidjan, Cape Town) patterns. This suggests that African cities, at least as represented by these examples, are currently set to develop in ways that encourage and lock in private motorized vehicle use. If African countries follow similar development pathways and transport policies as those that have been pursued by industrialized countries, emissions from transport will increase dramatically, with the bulk of these emissions coming from road transport. Emphasis on RETs and EE in the transport sector offers the opportunity to change to a low-carbon development pathway.

5.9.1 Encouraging Green Growth in the Transport Sector in Africa

Several options exist to encourage green growth in Africa's transport sector, which will help create sustainable cities. As already discussed, there is an opportunity to use biomass fuels as RETs to power transportation. Second generation biofuels aim to address some of the criticisms of their first generation counterparts, by using crop waste as opposed to the edible parts of crops. Another RET option is the linking of transport systems to decarbonized energy grids, for example, through the use of electric vehicles. Given the poor quality of existing energy grids in Africa today, this option is a longer-term solution that would require significant investment in infrastructure to distribute energy to power vehicles from appropriate RETs (e.g., wind, solar, geothermal or hydro).

A reduction in the use of motorized vehicles will contribute to the social dimension of green growth. Energy efficiency can be encouraged, both separately and in conjunction with

Figure 5.18: Relationship between GDP per Capita and Modal Share of Private Vehicles



Source: http://climatetechwiki.org.

a switch to RETs. Urban planning and transport policies can facilitate the promotion of sustainable transport, with effective public transport networks and safe options for non-motorized transport (such as walkways and cycle lanes). Any reduction in the use of motorized vehicles will bring concomitant benefits that contribute to green growth in its social dimension – such as air quality improvement, reduced congestion, better health due to exercise, increased social equality through more equitable access to transport, better public safety through reduced accident rates, noise reduction, economic efficiency gains through a reduction in journey times and productive time lost as a result of traffic congestion, and more attractive urban environments for investors and tourists as well as residents.

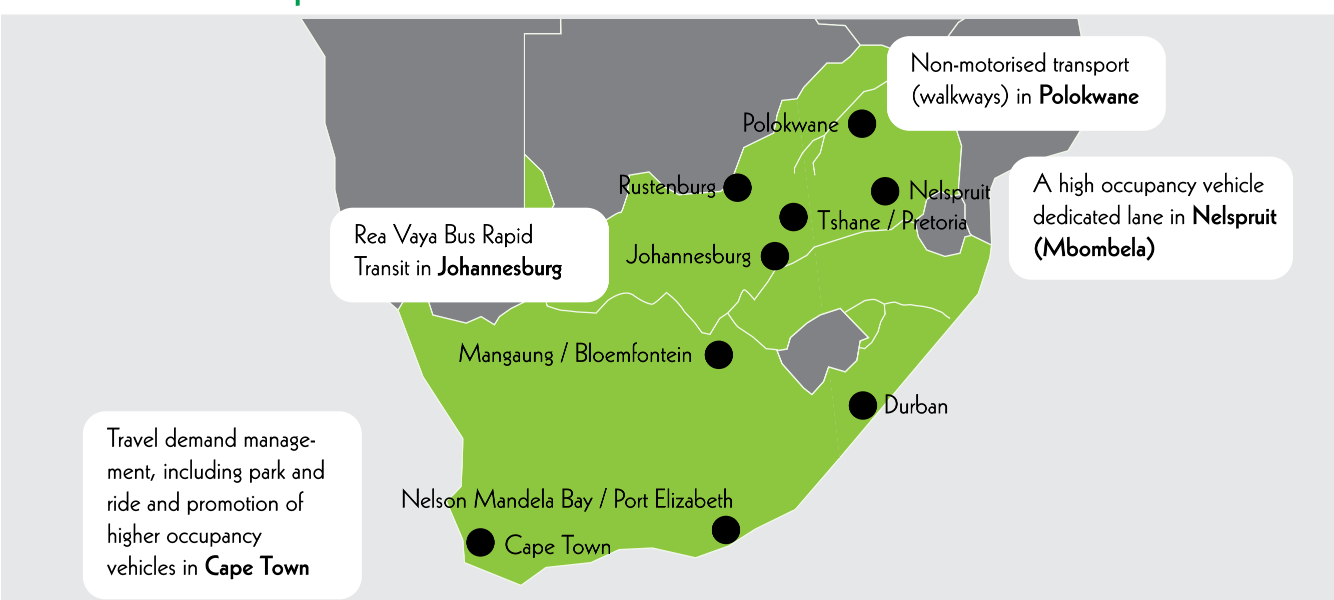
5.9.2 Current Sustainable Transport Initiatives in Africa

Transportation issues are illustrated with one project in South Africa and another in East Africa.

Two South African cities – Johannesburg and Cape Town – feature prominently in Figure 4.19 as having a significant modal share of private vehicle use. In the run-up to the 2010 FIFA World Cup, a UNDP/GEF project was implemented in order to promote sustainable urban passenger transportation in the venue cities. This US$ 340 million project aimed to increase transport availability and choice to previously disadvantaged groups, and, by improving availability, to encourage modal shift away from private cars. Figure 5.19 shows the range of different instruments that were introduced in different host cities.

A similar initiative to promote sustainable urban transport has been introduced in East Africa, covering the cities of Addis Ababa, Kampala and Nairobi. This project is implemented by UNEP and UN-HABITAT with US$ 7 million of GEF funding (including co-financing). This project will introduce low-cost public transport and non-motorized public transport to alleviate poverty (UN-HABITAT, 2011). It is projected to result in direct greenhouse gas emission reductions of 2.5 million tons by 2035 (with the potential to leverage an additional 9 megatons once the whole network is operational).

Figure 5.19: Sustainable Transportation Projects in Various FIFA 2010 World Cup Host Cities



Source: GEF (2011).

5.10 Conclusion

Africa faces difficult challenges in relation to green growth in the energy sector. On the one hand, tapping its huge endowment in fossil fuels improves Africa's access to energy and increases growth. On the other hand, climate change is projected to affect Africa more than any other region. Therefore, although African countries are exempt from emission reduction requirements, and Africa is currently a small contributor to the problem of greenhouse gas emissions, it is in the region's interest to contribute to the solution. On this basis, the chapter discussed opportunities for low-carbon development in the energy sector.

The continued subsidization of fossil fuel energy is an inadequate policy which imposes severe fiscal burdens on African economies as well as aggravating total carbon emissions. With the trend of rising prices of fossil fuels, subsidization does not send the right price signals to producers and consumers and artificially makes fossil fuel energy generation more competitive compared to renewable counterparts. The chapter therefore outlined policy instruments, such as targeted subsidies or their appropriate removal, as an opportunity for low-carbon development. This would free up a big portion of the state budget to be used for more efficient policies. However, not all subsidies are necessarily inefficient. Subsidies to fossil fuels could be limited to "cleaner" fuels such as LPG.

Targeted subsidies to the poorest part of the population could also be used, not only to reduce energy poverty, but also to reduce deforestation and protect the environment in many African countries. As mentioned previously, in SSA countries, about 85 percent of all energy is produced from biomass and this has contributed to accelerated deforestation, soil degradation and erosion. When fossil fuel prices increase, households, especially the poor, tend to switch to biomass (wood, charcoal etc.), so removing fossil fuel subsidies could increase the pressure on these resources. Governments should therefore be cautious so that the goal of removing fossil fuel subsidies will not have adverse effects on the goal of reducing the pace of deforestation.

This chapter has shown that a range of renewable energy resources already exist in Africa. The feasibility of many of them depends on prevailing weather patterns, and, since these are not always known, it is difficult to quantify the exact potential. Even so, it seems that there are many places on the continent where it is indeed more feasible to exploit the renewable resources than the fossil-based ones. Current rates of exploitation are affected by fossil fuel subsidies, as well as the state of technological development. While on aggregate there is great potential for Africa to switch to low-carbon pathways and promote green growth, the implementation of any particular RET will depend on context-specific features. Each African nation is endowed with its own particular pattern of renewable resources and so each will choose its own low-carbon pathway. However, the diversity of renewable resources is positive for Africa, provided there is cross-border cooperation, because it builds resilience into the energy supply systems, which can help realize sustainability. African countries have a unique opportunity to exploit such a diversity of resources.

A complement to renewable energy supply, analyzed in this chapter, is EE. A variety of options exist to exploit EE in Africa, although caution is needed because of potential rebound effects. In particular, bringing about behavioral change is not straightforward and cannot be assumed to directly follow from increased information and awareness. The literature suggests that more participatory approaches could be fruitful. Sustainable transport options in cities offer the opportunity for introducing both RETs and EE, and various initiatives have been implemented to date.

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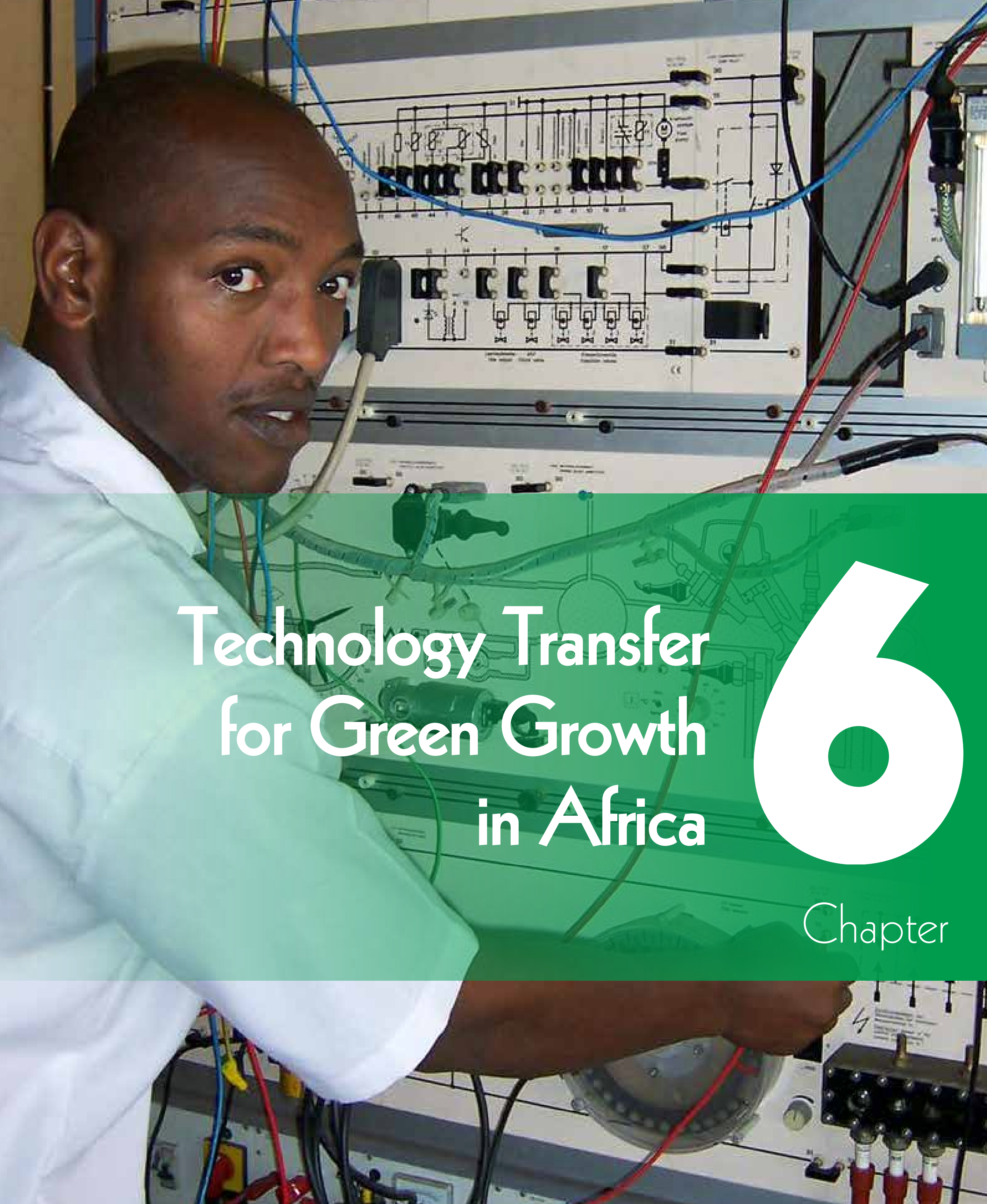


Chapter 6

Technology Transfer for Green Growth in Africa

6 Technology Transfer for Green Growth in Africa

6.1 Introduction

Access to technology is directly correlated with economic productivity in nearly all sectors of the economy. For this reason, there has been an increasing attention in recent years towards transfer of green technologies to developing countries. However, technology ownership is still skewed towards the North (IPCC, 2000). Despite this, facilitating access to green technology can play a crucial role in Africa's development process.

This chapter highlights the flaws of traditional understandings of, and policy approaches towards, green Technology Transfer (hereafter abbreviated as "TT"). It also describes how a new understanding, subject to building of indigenous innovation capacities, could position Africa to capitalize on opportunities presented by green technologies in fostering long-term green growth and human development. This is buttressed by some country case studies on sectors that could benefit from TT and why green TT is uniquely superior to conventional TT. The discussion also highlights some areas of controversy surrounding the use of Intellectual Property Rights (IPRs) and how these might constrain green TT to Africa. Green TT should reflect local contexts of African countries, such as the needs of poor people, and how Africa can leverage on existing international policy instruments and green TT financing instruments. These issues and Africa's ability take a strategic approach to benefit from green TT are considered in the ensuing discussion[22].

22 For more detailed coverage, readers are encouraged to consult Ockwell and Mallett (2012). The insights in this section reflect years of collaborative research at the Sussex Energy Group, University of Sussex, also involving researchers at Carleton University, Canada, TERI and IIT in India and ECN in the Netherlands.

6.2 Opportunities for TT in Africa

While it might be possible to identify green technologies that could benefit Africa, facilitating their transfer rests on a revised understanding of what TT is and how it can be facilitated. Therefore, a proper assessment of appropriate technology needs in Africa, as part of a broader green growth strategy, should be facilitated by nationally located Climate Innovation Centers. Cross country variations and multiple context-specific considerations would normally translate into very different technology needs and interventions.

Technology transfer can help sustain natural resources and improve the livelihoods of people who depend on those resources. Increasing water scarcity and the attendant unreliability of water supply coupled with competition for land arising from other non-agricultural demands necessitate the need for TT. Thus, when properly sourced and managed, TT can enhance land productivity and tackle problems of food and water insecurity. For example, Moussa (2002) argues that biotechnological approaches and technologies that promote decreased inputs of water, energy, fertilizer and pesticides have immense potential to increase crop yields. The same applies to appropriate agricultural practices, such as improved irrigation and soil management techniques. These 'soft' technologies could have similar effect with physical machinery or high-yielding, drought resistant strains of seeds.

Thus, whilst the need to finance investment in hard technologies is crucial, capacity building initiatives and other institutional technologies also deserve equal attention as forms of facilitating TT. These 'soft' technologies include, inter alia, training; effective linkages between markets, storage and distribution systems; availability and access to rural micro-finance; and improved networking between research institutions, rural infrastructure providers, and the private sector.

Forest management and biodiversity conservation could also benefit from TT, especially in light of new funding streams such as REDD+ and other emerging international financing mechanisms. Green TT could be used to increase sustainability and productivity of forests, enhancing biodiversity conservation and profitability at the level of forest stand through to broader socioeconomic levels (IPCC, 2000; 2007). Other areas green TT can make a discerning impact include silvicultural practices for afforestation and reforestation programs; genetically superior planting material; efficient harvesting and processing, and end use technologies. Technology transfer would be particularly effective if blended with indigenous knowledge of forest conservation practices and methods.

In many coastal areas of Africa, the fisheries sector contributes substantially to socioeconomic conditions of the people. Thus, by enhancing sustainable fisheries management, green TT can play an important role in improving people's livelihoods. A range of equipment and techniques designed to improve stock assessment continue to evolve. Similarly, technological innovations meant to improve efficiency of the supply and value chain of aquatic resources and products are being explored across the world (FAO, 2012). For example, fishing vessels which promote efficient fuel consumption could be explored to increase profitability of Africa's fishing industry.

In addition, TT might overcome technological constraints local communities face in accessing offshore fish stocks, often perceived as misappropriated by large foreign fleets. New equipment and techniques can also yield huge environmental benefits for fisheries by increasing selectivity of the catch, reducing by-catch (marine life caught accidentally) and waste (e.g., through use of ice) and utilizing previously underutilized resources (FAO, 2012). However, it is essential that the transfer and use of more efficient equipment and techniques is accompanied by knowledge transfer on usage and maintenance in order to foster ownership.

In the energy sector, TT can improve energy access and enhance resilience to effects of climate change across Africa. Green, low carbon energy technologies, whether for energy generation (e.g., biomass, wind, solar, hydro, geothermal and marine energy) or increasing the efficiency of energy production and consumption (e.g., energy efficient boiler technologies, energy efficient light bulbs and other electrical goods, and energy efficient vehicles), can contribute to better energy access. This is particularly the case in areas where grid extension is prohibitively expensive and/or presents technological challenges which result in efficiency losses over long distances, or institutional problems which prevent effective payment enforcement for electricity in remote areas. Droughts are a common phenomenon in African countries and often impact the supply of hydroelectricity by limiting generation capacity while floods cause damage to electricity grid infrastructure. Therefore, green energy technologies that improve resilience of hydro power to droughts and floods can significantly contribute to improving energy security.

Multiple opportunities exist for both hardware and knowledge TT in developing transport infrastructure across Africa. Examples include urban transport planning and increased use of biofuels, as well as the adoption of more energy efficient vehicles with subsequent resource savings and related economic benefits. As discussed in Section 5.9, South Africa has recently showcased a range of sustainable transport initiatives during the hosting of the Fédération Internationale de Football Association (FIFA) World Cup 2010. These include non-motorized walkways in Polokwane, Rea Veya Bus Rapid Mass Transit in Johannesburg, and travel demand management in Cape Town. These examples highlight existing potential opportunities for intra-Africa sharing of learning from these initiatives as well as TT from outside Africa.

The development of efficient rural and urban infrastructure, just like in transportation, can benefit from TT. Developing economically and environmentally efficient rural and urban infrastructure requires careful consideration of appropriate technological needs. These might relate to technologies and techniques for efficient water supply and use, urban planning, energy efficient commercial and domestic housing, or state of the art heating and cooling solutions.

6.3 TT and Green Growth: the Need for a New Understanding

While all the sectors mentioned in the previous section could potentially benefit from access to new, green technology, understanding how this might be facilitated requires careful consideration of the unique characteristics of green TT relative to conventional TT, as well as the nature of "technology" itself. To date, TT policy has failed to achieve the scale or pace required to deliver significant economic and human development benefits to developing countries, or to address global environmental problems like climate change. The principal focus has been on providing additional funding to incentivize investment in green technological hardware in developing countries, such as the provision of carbon credits under the CDM. But this "hardware financing" approach fails to recognize the critical role that innovation capacities play in both facilitating technology uptake and ensuring connections with long-term development processes.

High-income countries generally have greater access to technologies than their low-income counterparts. However, there are multiple examples where countries in the same income bracket exhibit very different levels of technological diffusion across their economies (World Bank, 2008; Tomlinson et al., 2008). For example, technology diffusion in countries of the former Soviet Union tends to be higher than in other countries in the same income bracket. Similarly, upper-middle and lower-middle income countries in Latin America and the Caribbean exhibit lower levels of technology diffusion than other countries in the same income bracket. The implication is that "... *although ability to pay is clearly an important issue for technology diffusion, it may not be sufficient in isolation*" (Tomlinson et al., 2008).

Therefore, it is important to understand what factors influence technology diffusion, beyond the current model of finance flows for hardware. This points to a revised understanding of TT as a process which can best be facilitated by efforts to develop innovation capacities and systems through knowledge flows and integration of relevant actors within and across developing countries. If Africa is to be successful in realizing green growth, it is not enough for a new green technology to be in use by one national firm or one large project. The key concern should be for green technologies to diffuse across a country, becoming widespread in use and underpinning broader national productivity gains and environmental and development benefits. To properly understand how this might be achieved in relation to green technologies, it is important first to be aware of the unique challenges green technologies raise relative to conventional technologies.

6.3.1 Unique Considerations for Green TT

There are a number of ways in which green TT is different from conventional TT. The first, recognized by "hardware financing" policy mechanisms like the CDM, is that green technologies yield benefits to society which are of a public good nature and therefore not captured by the market. This includes technologies that reduce costs to society from GHG emissions or negative impacts on biodiversity. To a large extent, this is what justifies public support for green TT.

Another unique characteristic of green TT is that it is both "horizontal" and "vertical", and could contribute to higher costs. Horizontal transfer refers to technology diffusion from one country to another. Green technologies are often at early stages of technological development and/or commercial maturity. Even when fully developed and mature, they often require testing and revising to be effectively operational under different environmental, economic and social conditions. This means green TT also often involves "vertical transfer" – the transfer of a technology along the innovation chain, from early research and development (R&D) through demonstration and commercial viability.

Technologies at earlier stages of development are subject to far more risks and uncertainties than conventional, already commercially viable ones. From an investment perspective, this would include working with new, unfamiliar finance models; from an end user perspective, it would involve adopting, operating and maintaining unfamiliar technologies; from a policy perspective, incentivizing development and uptake of non-conventional technologies not yet commercially tested and from a technology developer perspective, developing new technologies in uncertain funding and investment contexts. This entails dealing with the widely referred to "valley of death" (see Figure 6.1), where limited funding is available for the critical middle stages of the technology development/innovation process, which leads to many promising green technologies never becoming commercially viable.

Even when considering conventional horizontal transfer (devoid of the risks associated with vertical transfer), green technologies are now widely observed to follow a wider range of trajectories than has been observed with conventional technologies in the past. Following in the pattern of traditional north-south flows, south-south green technology flows are also becoming increasingly common (e.g., exports of solar technologies from China). South-north flows are also gaining prominence. Examples include exports of wind technologies from India and China (Brewer, 2008).

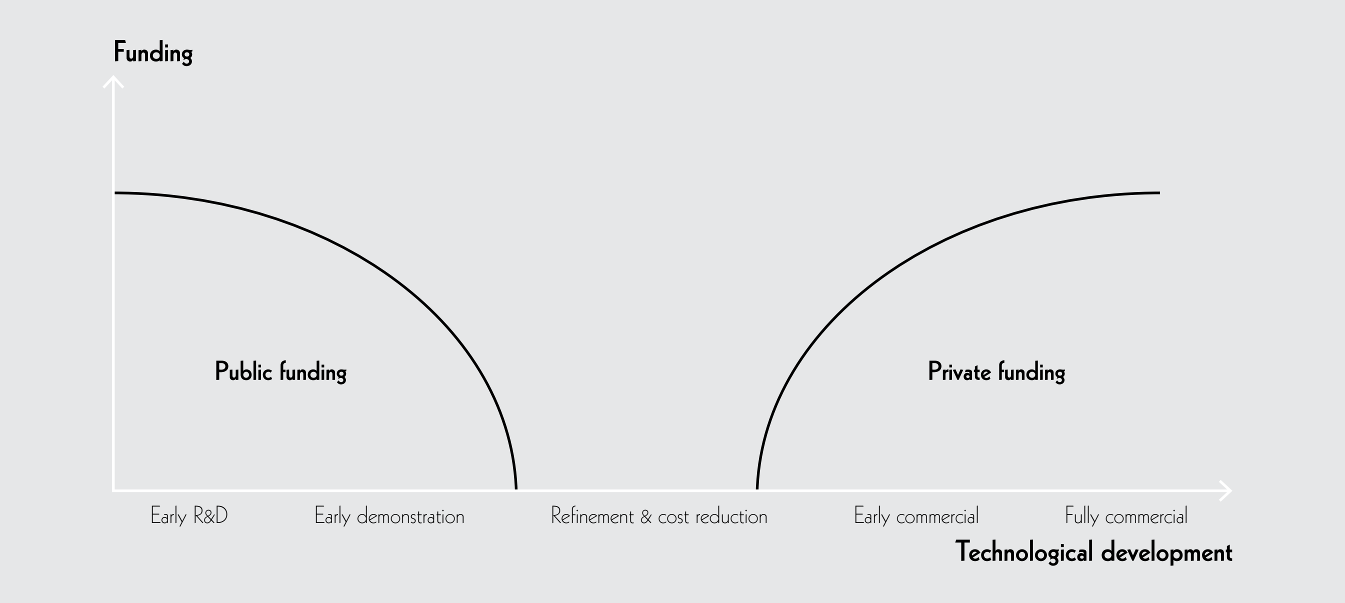
All these unique characteristics suggest a need for strategic policy intervention to facilitate the transfer and uptake of green technologies in Africa. But to date, hardware financing policy mechanisms like the CDM have yielded little benefits for Africa. Around 83 percent of cumulative investment under the CDM has been in the BRICs – Brazil, Russia, India and China (Byrne et al., 2012b). In contrast, sub-Saharan Africa is estimated to have received just over 1 percent of cumulative investment[23] under the CDM, with actual certified emission reductions pegged as low as 0.2 percent from the LDCs - Least Developed Countries (De Lopez et al., 2009).

6.3.2 Beyond Hardware Financing: Knowledge Flows and Innovation Capacity Building for Green Growth

The starting point for understanding the failure of hardware financing policy mechanisms in facilitating widespread green TT to Africa is the appreciation of the fact

23 Figure from author's personal correspondence with Dr. Rob Byrne, University of Sussex, based on analysis of data from the UNEP Risoe website.

Figure 6.1. The "Valley of Death" Between Public and Private Funding

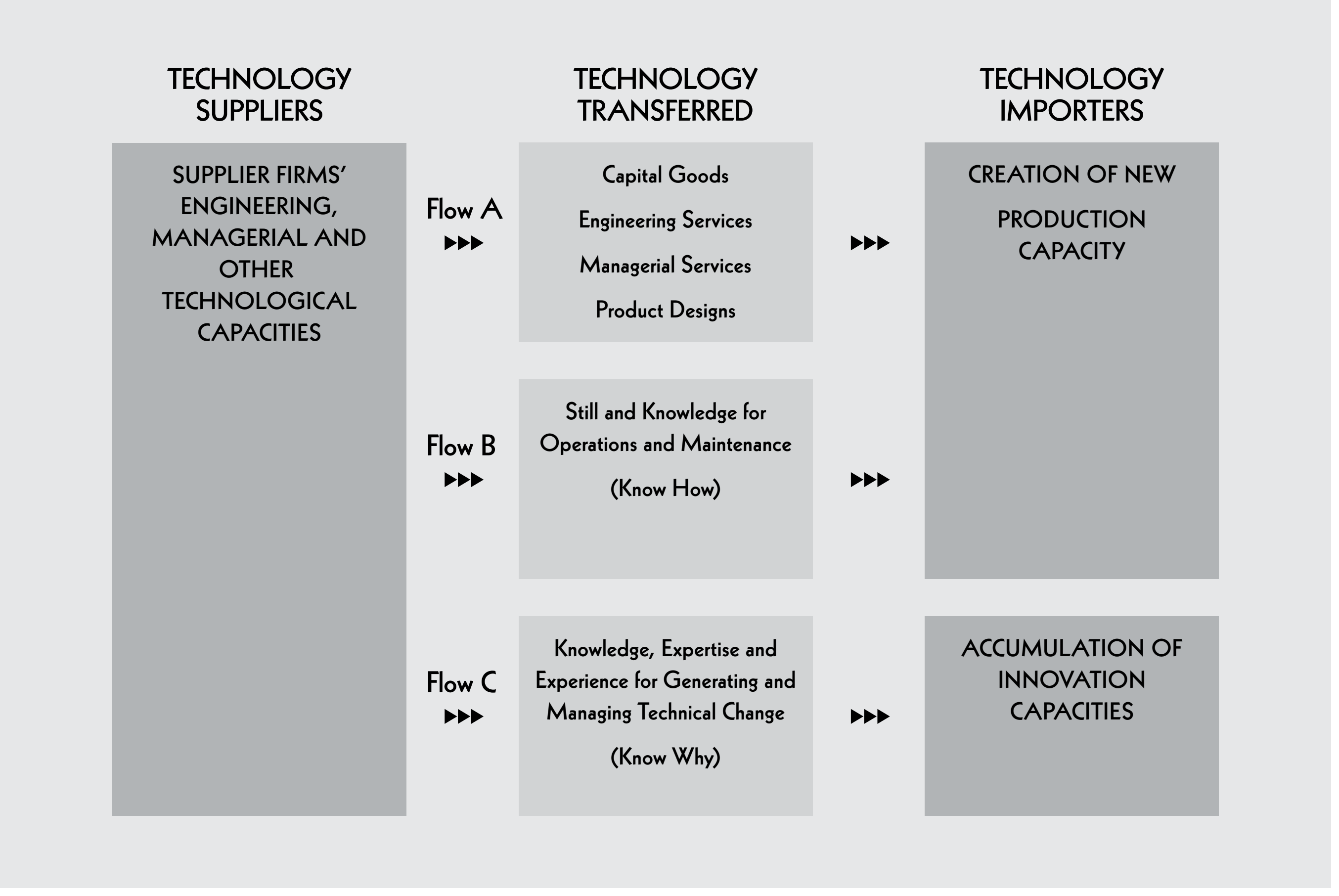


Source: Adapted from Murphy and Edwards (2003).

that technology is not just hardware. It also fundamentally encompasses knowledge. Knowledge, expertise and experience for generating and managing technical change are critical in facilitating green TT in Africa. And TT involves qualitatively different flows of knowledge, which have critical implications for the types of new capacity that TT can contribute in a country and whether this is enough to underpin economic growth and development. This is best illustrated by Martin Bell's diagram in Figure 6.2, depicting three flows of technology.

Flows A and B consist of the hardware, services or designs that are being transferred (Flow A) and the knowledge (skills and know-how) to operate and/or maintain (Flow B). These flows create new production capacity in the recipient country (or firm, farm, or household). But this in itself is unlikely to underpin any kind of long-term, sustained process of green growth and development. This is because neither Flow A nor B is likely to be channeled into African nations at any significant scale unless these nations are also in receipt of Flow C. Flow C therefore represents the knowledge, expertise and experience for generating and managing technical change – knowledge about how and why a new, green technology works and the process of innovation that underpinned it. Therefore Flow C leads to the development of new, green innovation

Figure 6.2. Qualitatively Different Flows of Hardware and Knowledge in the TT Process and Their Contribution to Different Types of New Capacity



Source: Adapted from Bell, 1990.

capacities in recipient countries (firms, farms, households etc.). These innovation capacities determine where international flows of Types A and B tend to be directed, and whether TT is likely to result in long-term economic growth and development in a recipient country (Bell, 1990; 2009; Bell and Pavitt, 1993).

This point might seem strange on the face of it. After all, why should LDCs be concerned about innovation capacities, rather than focusing on increasing their industrial base by importing existing technologies? However, this is based on an incomplete understanding of the necessity of innovation and the direct relationship between innovation capacities and the flow of technologies (see UNCTAD, 2007).

In a development context, innovation is largely "incremental" where small efficiency gains accumulate over time, or adaptive innovation, where existing technologies are adapted to work in new countries, industries, firms, farms or households. Thus, a proper understanding of innovation goes beyond the common assumption of inventing technologies that are new to the world, i.e., radical innovations. As espoused in the Oslo Manual (OECD et al., 2005) and amplified by Bell (2007), it is equally innovative when a firm, farm or household is the first to introduce a new piece of hardware, or a new technique, or does so itself for the first time, even when others have already been doing/using it. For example, incremental efficiency improvements which characterized the Korean steel industry eventually moved to the international technology frontier (D'Costa, 1998; Gallagher, 2006), and the adaptive innovation of the internal combustion engine facilitated Brazil's international leading role in transport related biofuels. This could equally apply to Africa. For example, a farmer in Sudan adopting water efficient farming techniques and adapting them to specific environmental conditions, or an entrepreneur in Kenya configuring small waste solar panel parts to create a business in supplying mobile phone solar charging modules (see Byrne, 2011).

Green innovation capacities entail the capacity to adopt, adapt, work with and develop green technologies within the specific context of a particular country, industry, firm, farm or household. A critical component of innovation capacities is the presence of well-functioning innovation systems made up of *"...interconnected firms, (research) organizations and users all operating within an institutional environment that supports the building and strengthening of skills, knowledge and experience, and further enhances the interconnectedness of such players"* (Byrne et al., 2012a). The emphasis on an appropriate institutional environment highlights the role that policy can play in fostering interconnectedness and promoting the components of successful innovation systems, such as skills development through tertiary education and international links between indigenous companies, universities, and overseas technology experts.

The divergence in technology diffusion across countries within similar income brackets, discussed above, may be explained by differences in innovation capacities. In explaining this divergence, Tomlinson et al. (2008) and the World Bank (2008) highlight factors such as foreign direct investment (FDI), openness to and ease of doing trade, the presence of well-functioning markets, legal and regulatory frameworks, diaspora communities, and levels of tertiary education, as having more relevance to the diffusion of technologies within countries than relative income levels. These are all elements of well-functioning innovation systems. This perspective facilitates a systematic way of thinking about these individual elements and how technology diffusion is facilitated when they function together. This helps to explain why hardware financing flows, such as those under the CDM, have generally gone to rapidly emerging countries like the BRICs, which already have a certain degree of innovation capacity – especially China, which accounts for a lion's share of the funding flows and existing innovation capacities[24].

The main goal for Africa should therefore be to ensure that green TT processes have the maximum possible impact on building new innovation capacities. The continent needs to take advantage of the available opportunities to put in

24 Lack of institutional capacity to administer CDM finance is also a major barrier to many LDCs in accessing CDM investment.

place specific measures to develop innovation capacities and systems. This will galvanize widespread diffusion and penetration of green technologies across Africa.

6.3.3 Capacity Building and Hardware Finance: Case Studies from Africa

The landscape for Africa's technological transfer is slowly changing, and some countries have moved ahead to embrace these changes. Here we illustrate with two case studies the contrasting policy approaches to facilitating the uptake of solar home systems in Africa. This comparison illustrates the importance of building innovation capacity to benefit from technology transfer. These studies are based on Byrne (2011) and depict examples of Global Environment Facility (GEF) funded projects for the diffusion of Solar Home Systems (SHSs).

One project based in Kenya was initiated in 1998 was part of the Photovoltaic Market Transformation Initiative (PVMTI). It involved the GEF working through the International Finance Corporation (IFC). This initiative adopted a hardware financing approach. The other project was initiated in 2004 in Tanzania, bringing together the GEF and the UN Development Program (UNDP), focusing more on market creation and capacity building. Unlike the Kenyan project, the Tanzanian undertaking achieved far greater success in terms of TT and diffusion.

In Kenya, despite making an investment of US$ 5 million to address a perceived finance bottleneck on both the supply and demand sides of the SHS market, negotiations on finance deals with local supply consortiums and financial institutions were generally unsuccessful. As a result, only 170 SHSs capacity was installed by the early 2000s, causing a high degree of frustration among local PV actors. There are several factors that contributed to the failure to broker finance deals for SHSs through the scheme. These include:

» The minimum deal size was too large for the Kenyan market. The minimum counterpart investment from a local consortium was set at US$ 0.5 million and had to be matched by PVMTI. However, few local suppliers had the capacity to mobilize such level of investment on their own.

» Misalignment between the IFC and local banking rules, which made it impossible for either party to finalize deals.

» High transaction costs for mainstream banks, despite some interest in bundling deals for on-lending to micro-finance institutions (MFIs). The deal flows ended up being too small relative to the costs of managing them.

These issues highlight the need for policy mechanisms that respond to local contexts and needs if TT is to be successful.

In response to their frustration with the PVMTI, Kenyan PV stakeholders lobbied for an increase in funding to support capacity building as opposed to direct funding for technology uptake. This proved successful, resulting in increased funding, channeled into the development of a Kenyan PV training curriculum, introduction of technical standards for the industry, and courses for vendors and technicians, accompanied by printed manuals for these groups and their customers. These are fundamental building blocks for developing innovation capacities and creating the networks necessary for effective innovation systems, with high potential for lasting impacts on the ability of Kenyan stakeholders to adopt and adapt low-carbon energy technologies to meet their economic and development needs.

The Tanzanian case study provides an insight into the potential success of schemes which choose to focus on capacity building from the outset. Based in Mwanza Region, near Lake Victoria, the US$ 2.5 million project focused at the level of government energy policy, and aimed at building capacity and creating markets around SHSs. There were five main elements: policy influence (technical standards, lower duties and taxes); private sector capacity building (technical and sales); raising awareness (demonstrations, advertising); enhancing affordability; and replication in nearby regions.

This approach was one of the factors contributing to the successful building of regional innovation capacities around SHSs, establishment of standards-setting institutional framework and process, as well as in galvanizing broader policy influence. In addition, the local population became increasingly aware of the project and enhanced potential for sustained uptake amongst technology users. Within few years, the market for SHSs had expanded to other parts of Tanzania. Between 2006 and 2007, 14,000 solar modules had been sold and by 2008, the annual market for solar modules was estimated to be worth US$ 2 million.

The main shortcoming of the Tanzanian project was the inability to tap into micro-finance to increase affordability of SHSs. This has been attributed to difficulties in securing high-level management support within the banks for SHS loan products, and high risks associated with lending to dispersed rural customers (Byrne, 2011).

The two case studies provide an illustration of how a well-designed and focused capacity building policy can be successful in fostering green TT and diffusion. For example, once the Kenyan PVMTI refocused efforts towards capacity building, confidence in the market for SHSs increased. This reversed the previous negative perception of the technology, which had resulted from poor quality components, scarcity of independent information about SHSs, and lack of supporting capacity such as skilled technicians (Byrne, 2011). It is therefore important to consider long term benefits from capacity building efforts beyond the lifetime of projects.

6.3.4 A Note on Intellectual Property Rights

Intellectual property rights (IPRs) have sparked a lot of controversy in relation to TT in Africa and elsewhere. Some commentators claim that inadequate IPR protection is a barrier to the transfer of new green technologies, as firms that own them fear that lack of protection of their commercial knowledge could stifle technological innovations. Thus, proponents of IPRs advocate for policies to strengthen IPR protection. This led to the agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS)[25]. However, critics argue that IPR protection is a barrier to green TT by limiting access to technologies, especially for developing countries. Instead, they advocate for alternative options, such as establishment of a fund to buy up and make publicly available IPRs for climate technologies, similar to approaches applied on antiretroviral drugs.

Researchers are gradually increasing the evidence to assess the validity of claims that IPRs undermine access to TT (see, for example, Barton, 2007; ICTSD and UNCTAD, 2003; Lewis, 2007; Harvey, 2008; Mallett et al., 2009; Abdel Latif, 2012; Srinivas, 2012). A recent assessment of this evidence shows a mixed picture (Ockwell et al., 2010a). Much of the evidence is biased towards certain technologies (wind and solar photovoltaics, in particular) and mainly in rapidly emerging economies (especially China and India). Generally the evidence suggests that IPRs have not acted as a barrier to TT although several firms regularly express concerns that IPRs might prevent them from reaching the technological frontier for some technologies such as thin film solar PV.

Lack of conclusive empirical evidence makes it difficult to design appropriate policies for treatment of IPRs in relation to green TT. As Ockwell et al. (2010a) assert, the more nuanced understanding of technology and innovation capacities described above makes it difficult to conclude that IPR access will be sufficient in itself to facilitate widespread green TT. What is far more important is the development of indigenous innovation capacities and related systems in African countries. Without careful capacity building strategies to facilitate tacit knowledge flows, education, training and strong networks between research institutions and the private sector, access to IPRs is likely to achieve little in promoting TT. Moreover, a fund to buy up IPRs for new green technological innovations

25 TRIPS, the agreement on Trade Related Aspects of Intellectual Property Rights, aims at creating uniform IPR protection across developed and developing countries. It is administered by the WTO and has brought IPRs into international trade negotiations for the first time. Developing countries were given a longer period to conform to the agreement than their developed counterparts and have until 2016 to conform.

without building human capacity to manage it would equally be less effective in increasing access to TT.

6.3.5 Pro-poor TT: A Context-Specific Needs-Based Approach for Africa

It is vital for policy mechanisms and other initiatives to respond to context specificities of green technologies, the locations where they will be used, and the needs of local actors. There are multiple levels at which context specificities come into play.

Green technology initiatives need to be aligned with countries' development needs – including a focus on poverty alleviation. For example, a critical component of realizing green growth in Africa is the need to increase access to modern energy services by ensuring "socio-technical fit" (Rip and Kemp, 1998; Geels, 2002; Smith et al., 2010). Socio-technical fit refers to technologies designed to fit with the socioeconomic characteristics of countries, firms, regulatory structures and communities where they are to be used.

As noted earlier, there are well-documented case studies where projects introducing energy efficient cook stoves have failed because the technology was not consistent with local cooking practices. On the other hand, there are also many examples of successful energy efficient cook stoves mainly because projects engaged with local end users in the design of stoves, used local materials to construct them, and trained end users to maintain them and educate others in their use and maintenance (see Agarwal 1986 for a more comprehensive discussion of considerations relating to fuel-efficient wood stoves).

Technologies are embedded interdependently in social practices and reflect knowledge of these practices as much as technical principles (Byrne et al., 2012b). The important insight is that technologies will be widely adopted if they successfully harness technical principles and their form and function are aligned with dominant social practices, or provide opportunities to realize new practices that are attractive in specific contexts. Thus, while energy infrastructure in Africa is currently defined by fossil-based infrastructure, there is an opportunity to build on the continent's relatively low level of existing energy infrastructure with new, green energy technologies that are well aligned with local needs and characteristics.

Some of the most relevant context specificities are discussed below:

- *Rural Versus Urban:* Rapid urbanization makes cities key areas for low-carbon infrastructure development. Therefore, it is essential that factors specific to the urban setting such as transportation, building designs, water supply, electricity and heat are integrated into urban planning. In rural areas, energy supply often requires long-term investments with low levels of immediate financial return, despite the transformative aggregate impacts of energy access. This creates a need for governments and utility companies to put in place fiscal incentives and regulatory requirements to encourage such investment (Parthan et al., 2010).

- *Environmental Context:* Some areas might be more suited to wind energy technologies, others to geothermal. Contexts can also differ at the national level, such as the BRICS relative to LDCs or Small Island Developing States (SIDS). There also are differing needs of households, farms, firms and industries.

- *Innovation Capacity:* Careful assessment and analysis of existing innovation systems (e.g., the range of, and connectivity between, relevant actors, regulations, training opportunities, etc.) is critical to assessing the nature of TT initiatives most likely to meet with success in a particular country. This approach has a greater chance to yield maximum benefits from available investments if capacity development targets areas that would most benefit from further development – whether by strengthening existing capacities or building new capacities.

6.3.6 Climate Innovation Centers (CICs) as International Opportunities for Funding and Capacity Building

A range of opportunities exist for leveraging funding support and capacity building to facilitate green TT. This section discusses how Africa might take a strategic approach to building on these opportunities. The need for more effective approaches to facilitating the transfer and uptake of climate technologies in developing countries has been a key issue in recent years and initiatives have emerged in international climate policy negotiations to facilitate this process. Transfer of technology is enshrined in the United Nations Framework Convention on Climate Change (UNFCCC) in several articles and under the Kyoto Protocol. Increasing emphasis on "climate compatible development" in other funding streams (e.g., bilateral aid), creates opportunities for African nations to exploit funding and related activities to gain access to, and uptake of, climate technologies.

African countries need to focus explicitly on building indigenous innovation capacities through a network of CICs across developing countries (Sagar et al., 2009; Sagar, 2010). The idea is to create centers that can coordinate activities around climate technology innovation and transfer, including essential capacity building activities. Essentially, CICs could provide a catalyst for climate TT, innovation and capacity building in developing countries by shifting focus from short-term hardware financing towards enhanced capacity building.

The use of CIC is currently being pursued under two separate initiatives. The first, with particular relevance to Africa, is implemented by DFID and InfoDev under the Climate Technology Program[26]. This includes pilot CICs in Kenya, Ethiopia, India and Vietnam.

26 See http://www.infodev.org/en/Topic.19.html

The second CIC-related initiative forms part of the broader Technology Mechanism[27] developed under the UNFCCC. This "Climate Technology Center and Network" is implemented around a central "Center" hosted in one developing country and linked to a network of other centers (or "Nationally Designated Entities") distributed across developing countries where impetus exists to participate. To strengthen capacity and enhance access, this initiative will be run by a consortium led by the United Nations Environment Program[28]. However, details about actual implementation are yet to be firmed up.

6.4 Leveraging Opportunities for Green TT in Africa: A Strategic Approach

A coordinated and strategic approach to green TT development can maximize the leverage of international funding and maximize the potential of green technology to increase economic productivity and leverage human development gains. Building on the most promising emerging international policy practices and the head start made in Kenya and Ethiopia, it would be beneficial to galvanize a pan-African initiative to establish a network of CICs across the continent. This initiative should engage existing international efforts in Africa, and the Climate Technology Center and Network under the UNFCCC. Coordination of this approach could be facilitated by the African Development Bank. Consideration should also be given to the benefits of an African central coordinating body or central African coordinating CIC to catalyze development of, and coordinate networking between, national CICs across Africa.

Activities of national CICs and any continental-level coordinating body must be guided by a number of key considerations. It is important that the CICs avoid the pitfalls of some past African center-based initiatives,

27 This is the central pillar being negotiated for delivery of TT under a post-Kyoto agreement. Pilot CICs are currently under development in Kenya and India with funding and coordination coming from DFID in the UK in partnership with infoDev.

28 See http://unfccc.int/files/cooperation_and_support/technology/application/pdf/main_proposal_unep.pdf

such as efforts around centers for science and innovation, which historically failed to deliver needs-driven, capacity building opportunities beyond the elite actors involved in the centers (Leach and Waldman, 2009). To achieve this, a number of key considerations are important to ensure that meaningful benefits are delivered across Africa and to respond to the context-specific needs of individual nations and communities. These are discussed next.

Technology Needs Assessments

Initial activities under CICs should include completion of stakeholder led assessments of existing opportunities for TT based on careful consideration of country-specific needs and opportunities. These can borrow from some of the guidance for preparing Technology Needs Assessment (TNA) under the UNFCCC (UNDP, 2010). In particular, it is critical that emphasis is placed on an engaged approach with national stakeholders in order to avoid the tendency of past TNAs under the UNFCCC to produce a "wish list" of available technologies.

Instead, assessments must aim at producing a carefully prepared list of priority areas that match the context-specific needs of the country, map the existing innovation capacities and system components, and identify the key areas and ways in which these will benefit from TT at different points from innovation to production and consumption.

Building Indigenous Innovation Capacities and Systems

To be effective, CICs should focus on nationally and locally appropriate facilitation and capacity building in order to understand existing capacities and improve the coordination of networks. Activities should span a range of areas, including, but not limited to:

- Facilitating networks between relevant actors;
- Undertaking training programs;
- Developing and implementing technology standards and certification schemes;
- Brokering personnel exchanges, seminars and knowledge sharing with international technology leading firms;
- Identifying relevant international innovations whose transfer might be beneficial nationally;
- Undertaking applied research, development and demonstration activities (including at the end user level);
- Providing business incubator services;
- Supporting enterprise creation;
- Granting early stage funding for climate technology ventures;
- Supporting projects to deploy existing climate technologies and energy efficiency measures; and
- Assessing and engaging with revision of national policy and regulatory regimes (see below).

Guidance could be sought on best practices from existing center-based institutions, such as the Consultative Group for International Agricultural Research (CGIAR) or the Chilean based Fundacion Chile, which has been successful across a range of industries in leveraging international innovations to the benefit of national economic productivity (see Ockwell et al., 2010b for a description of Fundacion Chile's approach to technology transfer and innovation).

Leveraging Finance

The CICs should provide a national focus point for identifying appropriate international and national financing opportunities and engaging with national stakeholders to develop indigenous capacities.

National Policy Assessment and Realignment

National policy and regulatory environments form a critical part of effective innovation systems. It is therefore essential that CICs conduct assessments of national policy environments and engage with the government to help develop an enabling environment for green TT and innovation.

International assistance should be sought to assist with countries' strategy development in partnership with national actors and institutions to maximize opportunities for learning and capacity building. This could include engagement with initiatives under IRENA. Bilateral support from developed countries may also be explored. For example, the UK Foreign and Commonwealth Office (FCO) provided financial assistance to meet costs of providing UK expert input into some developing countries' climate TNAs as part of country engagement under the UNFCCC.

A range of national financing options to address cost barriers to green technologies could also be considered. These may include:

» Rebates for green technology investments as part of a project development subsidy. These should be enacted on a flexible basis with a defined phase-out time accompanied by technology standards and monitoring programs. Finance could be leveraged through capital investment support from international grants and aid programs (van Alphen et al., 2008). Results-based financing and/or advance market commitment approaches to addressing cost barriers could also be considered, including multilateral development banks and the Program on Scaling-Up Renewable Energy in Low Income Countries (SREP)[29].

» Long-term, low-interest loans might also be considered. The Maldives provides an excellent example of such instruments (van Alphen et al., 2008). Loan guarantees for small and medium enterprises developing green technology based businesses could also be beneficial (Parthan et al., 2010).

» Micro-finance and hire purchase (installment payment plans) facilities to assist farmers, households and communities to implement green technology initiatives can also be great value. However, attention must be paid to context-specific considerations. Micro-finance schemes seem to have worked well in parts of Asia (Yadoo and Cruickshank, 2010), and Latin America (Allderdice et al., 2007), but their success is less clear in Africa (Krause and Nordström, 2004). Instead, hire purchase seems to be a more successful financing model although it may be restrictive for the poorest people who may not be in salaried employment (Hankins, 2004).

Encouraging Strategic Private Sector Behavior
By taking a strategic approach to international engagement around technology, it is possible for firms to maximize opportunities to increase their own innovation capacities, say through deliberate engagement with international technology owners and careful in-house knowledge management such as production of manuals and standards, project management procedures. In the long run, this is likely to translate into demonstrable competitive advantages. National level CICs (and continental networks thereof) should make efforts to communicate these opportunities and ways of realizing them to African firms.

Ensuring Context-Specific, Needs Based Approaches
All activities under CICs should be based on a careful assessment of national context specificities and needs, facilitated by assessments. This applies to the industry level as well individual firms and farms, communities and households. An important starting point for CICs would be a comprehensive assessment of existing continental and national level innovation capacities, as well as an assessment of the type of international green innovations best suited to African contexts and needs.

Regional and International Engagements
The CICs should be outward looking, seeking to learn from international best practices and in particular to benefit from and share insights with CICs in other

29 See http://www.climateinvestmentfunds.org/cif/srep

developing countries and international hubs. International initiatives such as IREDA (Indian Renewable Energy Development Agency) and REEEP (Renewable Energy and Energy Efficiency Partnership) should be explored as potential innovative business models and regulatory tools. Consideration should also be given to opportunities for regional cooperation around green technology and knowledge-based initiatives. For example, in 2006 the Economic Community of West African States (ECOWAS) launched a Regional Energy Access Policy aimed at building regional cooperation on energy access, development of strategy and enabling policy and institutional frameworks (UNDP, 2007).

6.5 Conclusion

Green TT, as part of a broader green growth strategy in Africa, should go beyond traditional hardware financing efforts, such as the CDM, which have failed to yield widespread benefits for Africa. Instead, a more holistic emphasis on building innovation capacities and systems can be developed through CICs. By taking a strategic approach to implementing networks of CICs, Africa has the potential to leverage finance and pursue related capacity building activities across the continent.

This broad emphasis on capacity building has long-term green growth and related human development benefits. They could unlock Africa's economic productivity which has been elusive for a long time, allowing it to leapfrog forward to a cleaner, more efficient and economically productive future based on green technology adoption and innovation.

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Financing Green Growth in Africa

Chapter 7

7 Financing Green Growth in Africa

7.1 Financial Requirements for Green Growth and the Cost of Inaction

How much does it cost to transition to green economies? This often becomes the central question in discussions about green growth. The reverse side of the question is: what will it cost the global economy if it continues with business as usual (BAU)? In other words, what are the costs of *growing first and cleaning up later*? Estimates of answers to both questions remain inconclusive in the literature. In terms of the former, the annual financing needed for transitioning to a green economy is estimated at the global level to be between US$ 1.05 trillion and US$ 2.59 trillion (UNEP, 2011a). In light of this substantial scale, there is often the implicit perception that transitioning to green growth might pose a constraint on development and poverty reduction, especially in developing countries. But the balance of empirical evidence suggests that the cost of inaction is ultimately higher than the cost of the green transition, at least in the medium to long term.

Climate change is one example within the broader scope of green growth which illustrates that the cost of inaction may ultimately be larger than the cost of action. The Stern Review estimated the annual cost associated with reducing emissions to stabilize greenhouse gas concentrations in the atmosphere at a level that would limit global warming at close to 2^0C (and hence avoid the most adverse consequences of climate change) to be around 1 percent of global GDP per annum (Stern, 2007). By contrast, BAU and the associated impacts from unabated climate change, such as declining agricultural production, heat waves, droughts, floods and other extremes, are estimated to result in costs of 5-20 percent of global GDP per year. Depending on the social discount rate, this estimate suggests that the cost of inaction could be higher than the cost of action by a factor of between 5 and 20[30].

7.2 Leveraging Financial Options for Green Growth

Recent studies suggest that green growth is necessary, efficient and affordable (e.g. World Bank, 2012a). After several years of global commitment to the principles of sustainable development, inclusive green growth now provides a practical model to reconcile the rapid economic growth required to address the needs of the increasing populations of the continent (including poverty reduction, employment creation, etc.), and halt further depletion of its natural capital assets. Through green technologies and innovations, training and skills enhancement, the bio-capacity of the natural assets (i.e. their productivity potential) and human wellbeing can actually be enhanced concurrently.

Green growth is a response to the contentious policy of *grow first and clean up later* (Beckerman, 1992; Dasgupta et al., 2002). That approach fails to address the fundamental concern that the current model of economic growth itself is at the root of both environmental harm and income inequality (Hueting, 1991). Again, evidence from global assessments shows that the global economy has outstripped its safe operating capacity in many biophysical sectors (MEA, 2005; Rockstroem et al., 2009; UNEP 2011a, 2011b), stressing the urgent need to act now before irreversible levels of harm are done to natural and social assets upon which human civilization depends. For example, under an average economic growth scenario and assuming no

30 Calculation based on Stern (2007).

efficiency gains, global demand to withdraw water would outstrip currently accessible water supplies by 40 percent by 2030. These stresses can be anticipated even if moderate progress is made in the transition to green growth. As the Report shows, a cost of 1 percent of GDP is projected if global warming is limited to 2 ^{0}C or less, but the timing and choice of mitigation actions will determine whether limiting warming to this level indeed remains a possibility (Rogelj et al., 2013). The same applies to other ecosystem services (MEA, 2005).

There are multiple pathways to green growth depending on stages of development, growth objectives, and other social and environmental circumstances of regions and/or countries. The pathways chosen by countries will define the scale and options for green growth financing. Lower income countries tend to have much smaller ecological footprints than middle and high income countries (WWF and AfDB 2012). On one hand, this means that less developed countries may be able to leapfrog to a green economy because they have lower sunk costs in the fossil fuel based economy than the industrialized countries. On the other hand, the resource and energy intensities of the least developed countries (LDCs) are also known to be much higher than those of industrialized economies (UNEP 2011b; IEA 2012).

For African countries, there are several strategies to finance green growth by focusing on (i) optimizing resource efficiency and productivity gains by greening value chains; (ii) reducing the fiscal cost of subsidies through realignment; (iii) leveraging global financing options for green growth; (iv) building targeted public-private partnerships; and (v) harnessing other fiscal and environmental policy tools.

7.2.1 Optimizing Resource Efficiency and Productivity Gains by Greening Value Chains

Considering the huge inefficiencies in the existing development infrastructure in less developed countries, it is clear that there are many financing options that can improve resource efficiency and productivity. For example, global investments of around US$ 90 billion in promoting energy efficiency in developing countries could provide US$ 600 billion in net savings (McKinsey and Company, 2010). Similarly, globally over US$ 18 billion worth of water a year is considered as non-revenue water (NRW) – as a result of leakage, private water sources, illegal connections and dysfunctional meters per year worldwide. In dysfunctional domestic water supply systems, NRW can range from 15 percent to more than 70 percent. This is hugely significant in a context where water demand outstrips current forms of supply, and where global government expenditure for upstream water supply at the global scale could increase from the current US$ 40 billion to US$ 45 billion per annum to around US$ 200 billion per annum by 2030, excluding distribution costs.

7.2.2 Reducing the Fiscal Cost of Subsidies through Realignment

Redirecting revenues from fuel subsidies is another financing option which could be explored by African countries. In 2010-11, over half of all African countries had some subsidy in place for fuel products, and these subsidies consumed, on average, 1.4 percent of GDP in public resources. Of the 25 countries with fuel subsidies, the fiscal cost of subsidies in six countries – primarily oil exporters – was at or above 2 percent of GDP in 2011. The fiscal cost for oil exporters was almost two-and-a-half times the levels observed for oil importers (World Bank, 2012b). The realignment of such subsidies would thus free substantial government money that could be used for green growth financing (see Chapters 5 and 8 for a further discussion on fuel subsidies).

7.2.3 Leveraging Global Financing Options

The financial resources for green growth will encompass many global financing options: Foreign Direct Investments (FDI), remittances, Official Development Assistance (ODA), and complementary finance for climate change adaptation and mitigation, biodiversity conservation, and other issues of environmental sustainability. Available finance through all these mechanisms has increased during the past decade, and will continue to increase in the near future.

FDI constitutes about 39 percent of the average annual external financial flows to Africa, with the majority concentrated in African countries with extractive industries.

In 2010, for example, extractive industries attracted 43 percent of FDI in Africa (AfDB et al., 2012). African countries should include green growth principles in their policies for FDI and extractive resources development. The factors promoting strong flows of FDI are very much consistent with green growth principles. These include clear industry and sector opportunities, appropriate structural and market-based signals, conducive macroeconomic policies, and a reliable regulatory environment.

Remittances, in addition to traditional forms of finance, can support inclusive green growth. Remittances represent 25 percent of the average annual external financial flows to Africa (AfDB et al., 2012). There is a strong indication that remittances may rise to a level comparable to ODA and FDI in the future. Because of their significant role in consumption and poverty reduction (Ratha and Maimbo, 2005), the potential should be explored for leveraging remittances for green and inclusive enterprise development.

ODA will continue to be a critical source of external financial flows, particularly for non-resource rich and low income countries in Africa. It represents 34 percent of the average annual financial flows from external sources to Africa. In particular, green ODA has increased over time (OECD, 2013).

There will also be the need for African countries to diversify the sources of ODA. Some emerging countries such as China, Saudi Arabia, Brazil and India are becoming key donors and development partners. African countries can take advantage of green growth strategies to diversify financing sources by attracting development cooperation flows from these emerging donors. African countries can also integrate aid effectiveness principles, such as those enshrined in the Paris Declaration of 2005[31] and the 2008 Accra Agenda for Action, with green growth principles of resource efficiency and inclusive growth to help develop and finance sound national green growth strategies (OECD, 2008).

31 Principles in the Paris Declaration include country ownership; alignment; harmonization; managing for development results; and mutual accountability.

7.2.4 Building Targeted Public-Private Partnerships

The engagement of the private sector will be essential in transitioning to green growth. With FDI increasingly exceeding ODA on the African continent, governments will need to provide the right enabling and regulatory environment for the private sector to invest in green projects in priority sectors, depending on comparative and competitive advantages of countries (for more on the enabling environment, see Chapter 8). Private sector resources include the assets or capital of financial institutions and market capitalization of both listed and unlisted companies. Taxes, incentives, and regulatory policies can be designed to attract investment into green technology and infrastructure, for example. In addition to strengthening the overall investment climate, targeted Public Private Sector Partnerships (PPPs) can help reduce risks that might discourage the engagement of the private sector in going green, thereby opening up new investment opportunities.

7.2.5 Harnessing Other Fiscal and Environmental Policy Tools

Most African countries have considerable domestic financial resources that could be mobilized through fiscal and financial policy to finance development while promoting the transition to green growth. This includes both public revenues and private sector resources.

Fiscal resources include taxes, fees and royalties. In 2010, domestic tax revenues in African countries amounted to US$ 416.3 billion, more than double the amount of the total external flow to the continent (AfDB et al., 2012). The challenge for African countries is to integrate green growth into fiscal policy measures.

Other environmental policy tools include green procurement, green bonds, micro-credit, weather index insurance, valuation/payments for ecosystem services, etc., in order to help promote resource efficiency and sustainable livelihoods. As discussed in Chapter 8, strengthening the enabling environment for green growth also requires improving the capacities of countries to monitor their natural asset base and assess the cost of environmental degradation and pollution; this allows countries to make informed decisions about environmental regulations and taxation. The early involvement of the Ministries of Finance and Planning is key in order to ensure that green growth concerns are integrated into national budgeting processes and that adequate resources are mobilized.

7.3 The Way Forward

Green growth offers huge potential opportunities for self-financing through efficiency and productivity gains by greening value chains in African economies. However, financing the initial stages of the transitioning process to green growth will require ambitious policies, market incentive structures and regulatory frameworks to realize opportunities. Specific tools considered in this chapter include realigning subsidies in the brown economy; using fiscal policy measures and market-based instruments to generate a double dividend of addressing the environmental impact of growth and generating financial resources to finance green growth; and leveraging traditional financing mechanisms (including ODA and FDI) and emerging global funds for climate change, biodiversity and environmental sustainability.

Achieving this at the country level will require substantial local skills, capacity to design and implement appropriate policies. The available evidence on global financing mechanisms such as the CDM so far suggests exclusion of less developed countries, especially sub-Saharan African countries, due to high transaction costs, inappropriate public policies, and, perhaps most importantly, lack of local capacity to package bankable projects (Urama et al., 2012; Byrne et al., 2012). Generally, while the academic literature is massive and growing (often nuanced by regional perspectives, with a sharp division between the green technology producers in the global north and the consumers in the global south), the balance of empirical evidence suggests that these traditional market-based approaches are unlikely to deliver substantive transitions to greener economies in less developed countries, without ambitious environmental policies and their effective implementation.

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Creating an Enabling Environment for Green Growth

8

Chapter

8 Creating an Enabling Environment for Green Growth

8.1 Introduction

Green growth requires making investment decisions with a long time horizon, with attention to market failures, and with appropriate incentives for private actors. The following sections discuss the enabling environment necessary for promoting green growth. The chapter focuses on government policies that encourage green economic activities and public and private green investment, as well as strengthening institutional and human resource capacities in Africa. It draws on the discussions of optimizing natural resources, technology transfer, fossil fuel subsidies, agricultural adaptation and low-carbon growth presented in the previous chapters.

8.2 Sustaining or Improving Africa's Growth by Creating an Enabling Environment

As this Report has argued, green management practises not only lead to environmental benefits, but also contribute to economic development. This will be achieved if an environment is created that incentivizes private actors to engage in green economic activities. Hallegatte et al. (2011) developed a framework that identifies connections between green policies and growth. Figure 8.1 shows three positive effects that appropriate green policies could have on output.

» The first, and most fundamental, is that, by increasing environmental capital from current suboptimal levels (e.g. through investments in land management, forestry planting, reduced fishing efforts, improved institutions, etc.), it is possible to reach further out on the production frontier. Furthermore, environmental investments have been shown to have positive impacts on other productive capital such as labor, through improved health, and physical capital, through reduced deterioration (e.g. corrosion, siltation, damages to infrastructure, etc.).

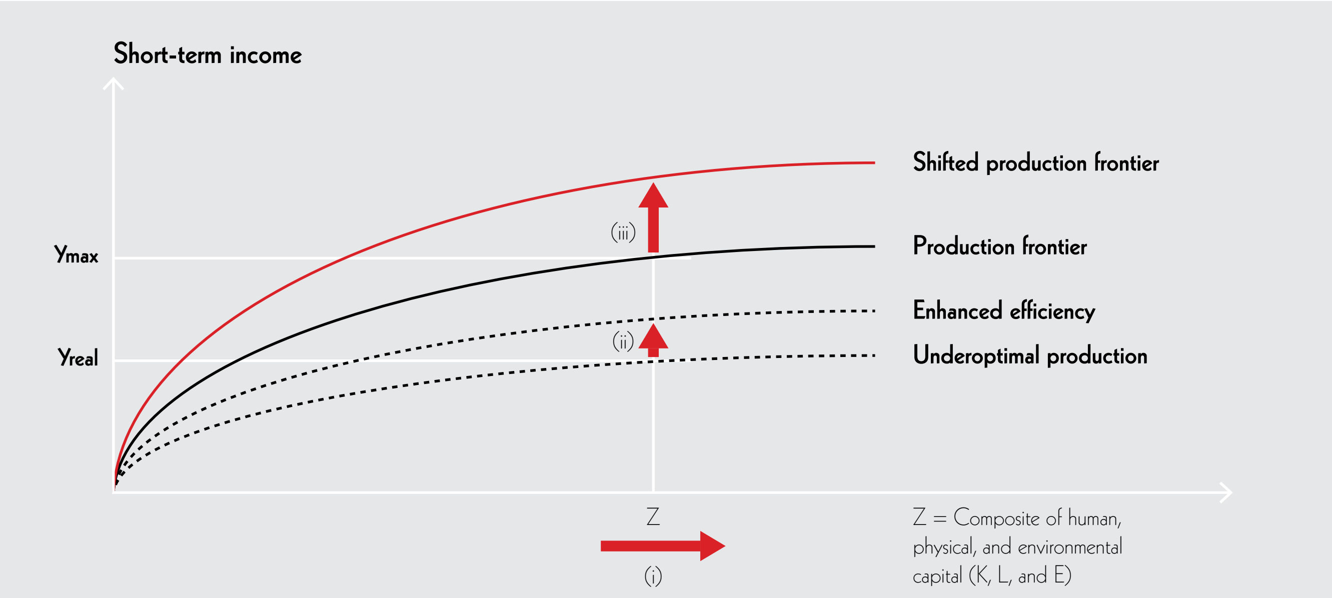
» The second effect is enhancing efficiency by correcting market and policy failures that have negative environmental implications. Thus, negative externalities from production can be addressed with a corrective/Pigouvian tax (Pigou, 1920). Unfortunately, these insights have not yet been implemented on a large scale in African policymaking and fiscal reforms. The green growth agenda is an excellent platform to identify and address such inefficiencies.

» The third shift relates to the dynamic effect that green policies might have on growth through accelerated innovation and knowledge spillovers. The Porter Hypothesis suggests that stricter regulation may lead to more innovation. Ambec et al. (2011) review 20 years of experience with this hypothesis and conclude that the empirical evidence supports it.

Thus, the enabling environment that facilitates green growth should focus on the following policy issues:

» *Subsidy Reforms.* Subsidies that encourage green economic activities are important investments in environmental capital and hence should be promoted. In contrast, subsidies that are environmentally harmful aggravate market failures and should be withdrawn (i.e., i). This was discussed in detail in relation to fossil fuel subsidies in Chapter 5.

Figure 8.1: The Effects of Green Policies on Output



Source: Hallegatte et al. (2011).
Note: The arrow (i) represents the increase in production factors; (ii) represents enhanced efficiency; and (iii) represents the shift in the production frontier.

- *Environmental Fiscal Reform.* Activities that generate negative environmental impacts should be addressed on the basis of the Polluter Pays Principle. Because such activities denote market failures, a correction by an environmental fiscal reform can increase economic efficiency (i.e., ii). This was discussed in Chapter 7.

- *Promoting technology transfer and diffusion.* The transfer and diffusion of new technology can lead to a shift in the production frontier (i.e., iii). The factors supporting successful green technology transfer are discussed fully in Chapter 6.

The ability to effectively implement such measures depends on a number of critical factors. These include the strength of institutional and human resource capacities; the extent to which public investments in green growth can be scaled up; and the successful promotion of regional integration and cooperation. These factors are discussed in the following section.

8.3 Government Policies To Drive Green Economic Activities

As noted earlier, government interventions are justified if market failures exist. Environmental goods and services generally have public goods characteristic. Because environmental goods are not marketed goods, production that uses environmental goods as inputs may generate externalities or spillovers, as when a lumber harvester degrades a forest ecosystem. The same is true for consumption of environmental goods, such as a villager's collection of wood for fuel. These typify market failures, as they result in suboptimal investments in natural capital. Conversely, private actions such as investment in green technology can have positive spillovers. Policy actions are therefore necessary to offer incentives to ensure the implementation of sustainable management practices or the diffusion of green technologies (Gebremedhin, 2011).

8.3.1 Subsidy Reform

A number of critical government policies are necessary to pave the way for green growth in Africa. One such reform is withdrawal of distortionary price and input subsidies. By lowering the marginal cost of production and/or increasing the marginal benefit from the sale of output, subsidies result in over-capitalization or over-investment in the extraction of natural capital such as agricultural soil, underground water, and capture fish stocks. In addition, subsidies sometimes benefit large-scale users of resources, who can afford subsidized inputs, but not the very poor, who are usually the intended beneficiaries of such schemes (see the discussion on fossil fuel subsidies in Chapter 5). Furthermore, the involvement of parastatals in the delivery of subsidized inputs can breed corruption and thereby crowd out and impede private sector investment. In most cases in Africa, subsidies are for political expediencies but not for economic reasons (Chinsinga, 2012). The following section discusses desirable subsidy reforms.

8.3.1.1 Smart Farm Subsidy in Africa

As discussed in Chapter 4, soil fertility in Africa has declined, leading to stagnant agricultural production and increased rural poverty in several African countries. This is partly driven by low fertilizer application. Average fertilizer application in Africa is less than 10 kg per hectare, constituting only 7 percent of the application in Latin America and South Asia. At the 2006 Africa Fertilizer Summit, it was declared that fertilizer was necessary for the African Green Revolution, and that the AU member states should set out to increase fertilizer intensity to an average of 50kg/ha by 2015 (Yawson et al., 2010). Moreover, as indicated in Chapter 4, it has been found that combining organic and inorganic fertilizers improves fertilizer use efficiency and soil moisture conservation. This has led many to advocate for smart fertilizer subsidies for the following reasons.

Firstly, fertilizer subsidy lowers the perceived risks of fertilizer application. The key barriers to greater fertilizer use are inadequate financial resources and/or imperfect knowledge about the potential benefits from using fertilizer, both of which lead to an aversion to using a new input. Box 8.1 traces the history of fertilizer subsidy in Malawi and its recent positive impact on yield.

Secondly, farm input subsidies, including subsidies for fertilizer, could be viewed as a potential social protection policy. These policies, which are common elsewhere in the world, include public works programs, welfare grants, food aid, and cash transfers to the very poor and vulnerable. Africa has a disproportionately large number of subsistence farmers, hence farm subsidies can be a form of social support program that redistributes funds within the economies. Proponents of farm subsidies are of the view that one cannot rely on a pure efficiency calculus as the basis for arguing against such subsidies. Nevertheless, like all other social programs, farm subsidies may have major problems of design and cost-effectiveness which should be carefully considered.

Thirdly, governments should subsidize a farm input, e.g., fertilizer, if it generates net positive externalities. A concern often put forward by opponents of fertilizer subsidy in particular is that it could generate negative externalities such as runoffs that could lead to eutrophication of shallow lakes and alter the biodiversity of fragile ecosystems. A counter-argument is that fertilizer subsidies in Africa could generate positive externalities by increasing plant growth and decreasing soil erosion. If such positive externalities or spillovers outweigh the negative ones, the quantity of fertilizer farmers apply currently may be lower than what society desires. In that case, government intervention through subsidies may be justified. All else equal, the net effect of the positive and negative externalities, which could vary from one geographical region to the other, may determine whether or not the subsidy is appropriate.

In addition to fertilizer subsidies, other input can include provision of small seed packages, small farm implements such as foot-driven irrigation pumps, improved breeding stock, and veterinary services for rural communities. Subsidies can also be directed to promoting green technologies for organic farming and educating farmers on best practices. Thus, farm subsidies should be directed to replenishment of soil fertility, target the very poor, and last for a short time and then be phased out in order to avoid chronic reliance on them. Overall, such subsidies can help stabilize output prices and increase agricultural production.

Box 8.1: Effective Farm Subsidies

The Government of Malawi financed a universal fertilizer subsidy program and provided cheap credit to smallholders from the mid-1970s to the early 1990s. However, with the widespread perception that the withdrawal of fertilizer support was the leading cause of a decline in maize production, which led to a food-cum-political crisis, the government started providing small "starter packs" to all households (in 1998-99 and 1999-2000) and then to smaller numbers of targeted households (from 2000-02 to 2004-05). Continuing severe food security issues led to significant political momentum for larger subsidies and the government decided to implement a large-scale input subsidy program – the Farm Input Subsidy Program (FISP) – across the country in 2005-06. The program has been acclaimed for its success to date in raising maize yields and enhancing food security. Maize production almost tripled in the first two years since the inception of FISP. Maize yield increased from an average of 1.06 ton/ha in 2000-05 to 2.27 ton/ha in 2009-10. A number of other African countries, such as Ghana, Kenya, Nigeria, Tanzania, and Zambia, have also implemented fertilizer subsidies.

Source: Gurara and Salami (2012)

8.3.1.2 Capture Fisheries and Effective Subsidy

Chapter 4 discussed some of the challenges Africa's fisheries face. Capture fish stocks at four FAO-designated marine fishing areas around Africa are either fully or nearly overexploited (NEPAD, 2011). As a result, less value is being generated from the fisheries. Currently, the continent is losing annual resource rents of US$ 2.63 billion from capture fisheries (Sumaila, et al., 2012). Subsidies that encourage fishers to intensify fishing effort are an important factor contributing to this phenomenon. These subsidies include direct assistance to fishers, loan support programs, tax preferences and insurance support, capital and infrastructure programs, and marketing and price support programs (WWF, 2001).

Subsidies in Africa that help fishers increase their fishing capacity should be eliminated. These subsidies include special fuel subsidies (also called "pre-mix" in some countries) and subsidies to foreign fleets fishing within the exclusive economic zones of coastal countries. The former tend to promote more fuel-intensive or capital-intensive fleets, contributing to overfishing. The latter exacerbates the challenges that many African countries face whereby, due to a lack of technology to undertake effective surveillance offshore, foreign fleets overexploit stocks within the exclusive economic zones of Africa coastal countries, with little benefit trickling down to the coastal communities. Africa should push for the ratification of the recent draft proposal of the Chair of the WTO to place a broad ban on dangerous forms of fishery subsidies and to subject the remaining subsidies to strict "sustainability criteria".

Decommissioning fishing boats by buying them back is an alternative program to reduce fishing capacity among small-scale fisheries. A number of fisheries economists are skeptical about the effectiveness of buy-back programs in industrialized countries, because decommissioned vessels find their way to other fisheries. Also, fishing units could act strategically in anticipation of a buy-back by accumulating more vessels than they would otherwise hold (Holland et al. 1999; Clark et al. 2006). Fortunately, small-scale fisheries are relatively immobile and are closely tied to coastal communities, making it possible to monitor such a process.

Well-targeted subsidies are required to reduce overcapacity and ensure sustainable management practices in fisheries management. These include subsidies for fisheries management, research, and conservation programs. Also, pressure on capture fisheries could be reduced if subsidies are provided for training programs in related activities such as aquaculture.

8.3.1.3 Fuel Subsidy in Africa

As discussed earlier in this Report, fuel subsidies are a politically charged issue. More than 50 percent of African governments subsidize fuel at an average cost of 1.4 percent of GDP, with oil exporting countries providing the largest subsidies. Because fuel is an input in a number of production processes, higher fuel prices can have pass-through effects to several other economic activities. It is difficult to make a case for withdrawing subsidies without linking the discussion to economic growth and distributional concerns, including potential relative benefits to the poor.

In Africa, subsidies on gasoline for transportation generally benefit the rich. In a recent study on the distributional impacts of fuel subsidies, it was found that the rich spend a larger proportion of their income on gasoline than do the poor in the five African countries (Ethiopia, Ghana, South Africa, Tanzania, and Kenya) included in the study (Sterner, 2012). This suggests that reforms may be required, but within specific country contexts. If necessary, such reforms should include appropriate social safety net programs to protect the very poor and most vulnerable. A delicate balance should always be sought between meeting the immediate needs of the most vulnerable and achieving long-term economic efficiency.

8.3.1.4 Payment for Ecosystem Services (PES)

Payments in exchange for ecosystem services can enable income diversification and environmental protection. Chapter 4 discussed their crucial role for sustainable forest management. Generally, PES schemes cover green activities such as biodiversity conservation, carbon sequestration and water resource management. These payments can enable the rural population to diversify their income earning streams and improve their livelihoods. As Africa does not have the financial resources to provide these payments, international initiatives such as appropriately designed REDD+ policies and measures could deliver global benefits, while providing the necessary resources that also deliver local development and environmental benefits.

A prominent example of a PES scheme is the REDD+ mechanism, as already described in detail in Chapter 4, offers countries the opportunity to capture the value of their forest ecosystem services. The opportunities that the REDD+ mechanism offers developing countries transcend financial transfers; there are important co-benefits. First, REDD+ offers opportunities to enhance biodiversity conservation. Biological resources, both plant and animal species, are natural assets for most countries. For example, wildlife resources are important for tourism in East Africa, which is a huge economic activity with potential for large revenues and employment opportunities in many countries. Continuous depletion of biodiversity thus has significant implications for national economies and local livelihoods. Any mechanism that supports the conservation of such biological resources would ideally be seen as a window of opportunity for national development.

Second, as a performance-based mechanism for avoiding deforestation in developing countries, REDD+ entrenches forest governance in its strategy and operations. The importance of new and innovative governance arrangements for forests is critical in delivering the benefits of forests to the societies that depend on this natural resource. Despite being in its early stage, REDD+ is already bringing different actors and stakeholders together in designing an effective and efficient strategy to achieve emission reductions and other benefits of poverty alleviation, biodiversity conservation and economic development.

Third, beyond climate mitigation, REDD+ also recognizes the importance of social safeguards, which many commentators have argued is an integral factor in determining whether REDD+ succeeds. The advantage is that climate change adaptation in the forest sector, which tends to revolve around these safeguards, can capture the attention of beneficiary communities (Somorin et al., 2012). This will expand the benefits of REDD+ to support improved economic and social resilience of the local communities that actually make land use decisions in favor of REDD+.

Fourth, forests in many developing countries have been lost due to a number of economic, social and political factors. These factors might include weak governance systems, a lack of defined property rights, and low enforcement of forest laws and legislation, amongst others. As some countries are beginning to develop national REDD+ strategies, they are increasingly becoming interested in addressing a number of these issues prior to REDD+ implementation. The fact that this is happening is already an achievement and a change from business as usual in some countries. In other countries, REDD+ introduces a framework for coordinating existing laws and initiatives, such as forest certification schemes, community forestry, and conservation programs, to deliver the desired outcomes of economic and social development at the local and national levels.

8.3.2 Environmental Fiscal Reform

The preceding sub-section discussed subsidy reforms, which include removing environmentally harmful subsidies and introducing "smart" subsidies that encourage the adoption of sustainable management practices. Equally important are public policies designed to address negative externalities from production or consumption. These can be integrated with an environmental fiscal reform to increase efficiency. This sub-section discusses fuel and carbon taxation.

Activities with negative environmental implications can be addressed on the basis of the Polluter Pays Principle. In most cases, this means those who benefit directly from using the environment, e.g., generate pollution, pay for such resources. This ensures that they take account of this use when making decisions. Additionally, fuel and carbon taxes can lead to positive distributional impacts. In the case of fuel taxation, a recent in-depth analysis from 25 countries shows that such taxes are typically progressive, particularly in poor African countries (Sterner, 2012).

Environmental tax reform can increase African countries' revenues. Chapter 7 argued that environmental tax reform could be a feasible instrument to increase the amount of green growth financing. The revenues obtained from environmental taxes can be used for priority areas with positive economic impacts, such as public investment in green economic activities. Following this approach, African countries such as Algeria and Mauritius have taxed fossil fuels to fund renewable energy (World Future Council et al., 2012). Other priority areas may include education, basic infrastructure investments, public services and targeted social protection.

As discussed above, the taxation of negative externalities has a positive impact on overall economic performance by enhancing efficiency and innovation. However, a tax can impose a short-term cost burden on businesses, leading to negative output effects. This is likely to explain why African governments are hesitant about their introduction. Exceptions, however, do exist. Rwanda, for example, taxes gas and oil, making the prices of diesel and petrol about 60 percent and 232 percent, respectively, higher

than the averages within the east African region (King, 2011). South Africa, as a middle-income country, has also recently announced the introduction of a carbon tax in 2015 (All Africa, 2013). In the context of its National Climate Change Response White Paper, South Africa has outlined the key considerations for the introduction of a carbon tax (see Box 8.2 below). This could serve as a blueprint for other African countries.

8.3.3 Promoting Technology Transfer and Diffusion

Over the past decade, public policy theorists have asserted that developing countries should implement green technologies from the start to avoid getting trapped in high-carbon pathways – in other words, should "leapfrog" over dirty technologies to low-carbon technologies. Such technologies are essential to enable trade with developed countries, where trade regulations relating to environmental performance are becoming increasingly stringent. Africa can promote green technology transfer and diffusion by tailoring national policies accordingly.

The best way to catalyze green TT across Africa is to focus on building innovation capacities and innovation systems. As Chapter 6 discussed, green TT may only be realized if indigenous innovation capabilities to adapt, develop, deploy and operate low-carbon technologies are created and tailored to the specific needs of each country. This can be done through Climate Innovation Centers (CICs) created to coordinate activities around climate technology innovation and transfer, including essential capacity building activities. As argued in Chapter 6, the hardware financing approach to green TT has failed to achieve the scale or pace required to deliver significant economic and human development benefits to developing countries.

Governments can signal investment security by announcing long-term targets for green technologies. This can attact potential donors because these targets indicate a country's strategic plans and how particular projects and programs may fit within them. As of 2011, 16 African countries used this approach by announcing a long-term renewable energy target (UNEP, 2012). For example, Morocco aims at an ambitious target of 42 percent of power supply coming from renewable energy by 2020. Other targets could focus on the uptake of energy efficient technologies.

TT for green technologies can benefit from national policies that provide incentives for their import. These could include reductions in import duties for green technologies or exemptions from certain taxes. In Rwanda, for example,

Box 8.2: Key Considerations for the Introduction of a Carbon Tax in South Africa

- The tax rate should, over time, be equivalent to the marginal external damage costs of GHGs to provide appropriate incentives. However, in the absence of an international climate change agreement and therefore a global emissions pricing system, a partial, rather than full, internalization of the externality will be considered as an interim measure.
- Technical and administrative feasibility consideration will be given to whether the tax applies to carbon emissions or a proxy for such emissions (e.g. fuel inputs or outputs). Should a proxy tax base be used, the levy of the tax according to the carbon content of fossil fuels will be considered.
- Distributional implications measures will be taken, either in tax design or through complementary expenditure programmes, to offset the burden the tax will place on poor households.
- Competitiveness – to address potential negative impacts on industry competitiveness, the carbon tax will be introduced at initial low rates with a commitment to a phased increase over a specific period.
- A phased implementation of the tax towards comprehensive coverage of all economic sectors is believed to be desirable and will be considered.
- Revenue recycling to minimise the costs of the tax will be considered. While the full earmarking of revenues is not regarded as being in line with sound fiscal policy principles, some form of onbudget funding for specific environmental programmes will be considered.
- Relief measures, if any, will be considered but these will be regarded as being minimal and temporary.

Source: Government of the Republic of South Africa (2011) green technologies such as energy saving lamps, solar and water heaters, wind energy systems, and LPG equipment are exempted from Value Added Tax and import duty, in order to encourage the conservation of energy and promote the use of clean technology (King, 2011). In addition, the introduction of minimum efficiency standards and energy efficiency labeling of energy consuming goods such as refrigerators, air conditioners, washing machines and so on, and the expansion of such standards and labels to thermal energy appliances, including gas room heaters and gas cooking stoves, are other ways to improve market access for green technologies (Parthan et al., 2010). Because such standards can lead to higher upfront costs for the purchase of those goods, a thorough appraisal is necessary before they are introduced.

National policy incentives can lower the cost barriers to green technology transfer and diffusion. Options include long-term, low-interest loans or loan guarantees for enterprises, in particular small and medium enterprises, that develop green technology based businesses (Parthan et al., 2010). Another option includes tax preferences for companies that engage in projects that promote clean technology. In this context, Rwanda offers tax incentives to companies in order to make the promotion of clean technology more attractive (King, 2011). If cost barriers are successfully lowered, green technologies and green technology based businesses can become increasingly competitive.

Large-scale diffusion of green technologies can benefit from public investment. It is important that African countries ensure that the use of technology becomes widespread and supports national growth and environmental sustainability concerns. Public investment is critical in bridging the gap between public demonstration of new technologies and mature deployment. Feed-in tariffs are a prominent example of such subsidies. These tariffs are a policy mechanism that offers compensation to renewable energy producers, based on the difference between the cost of electricity generation of each technology and the market price of electricity generation that, in the case of RETs, is usually lower. In Kenya, for example, feed-in tariffs led to the high level of uptake of solar PV. As of 2011, 7 African countries used feed-in tariff policies (UNEP, 2012).

8.4 Enabling Conditions for Green Growth

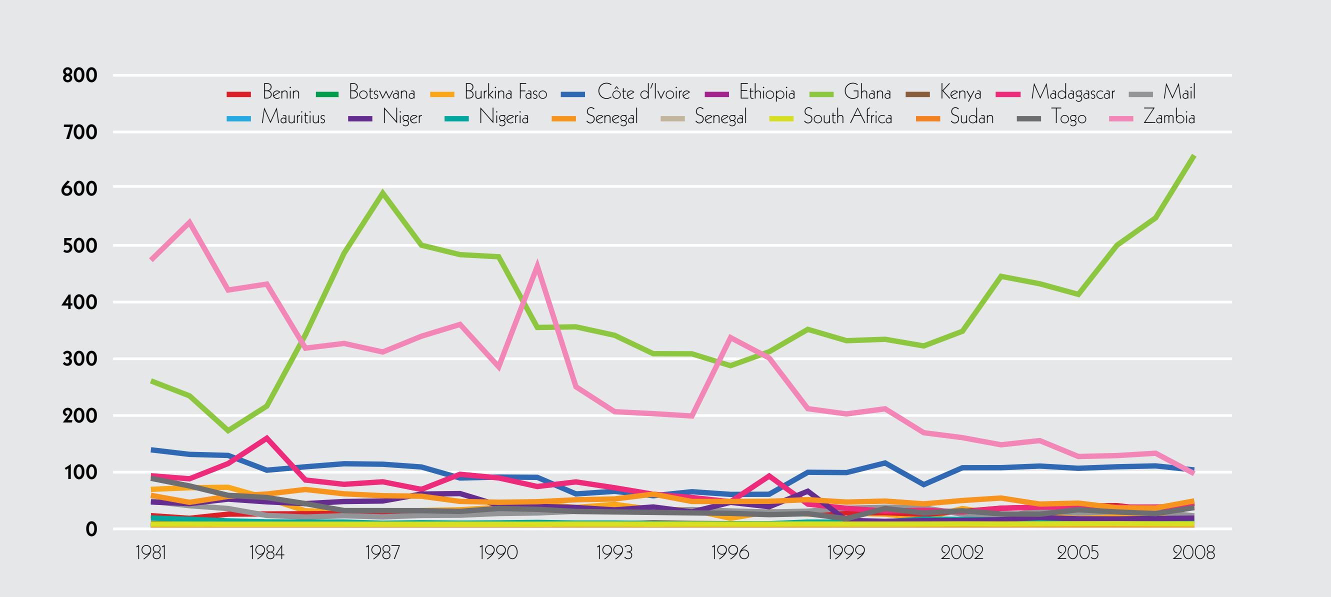
8.4.1 Strengthening Institutional and Human Resource Capacities for Green Growth

For Africa to realize its full potential under green growth, it is important for the continent to strengthen transparency and good governance, invest in high quality education of youth, and invest in institution building (Bloom et al., 2007). Capacity building in Africa has not developed as a well-defined area of development practice. This is in spite of the fact that the return to public sector and human resource capacity is potentially high (IEG, 2005).

Relative to advanced regions, African countries are less democratic and have more corrupt formal institutions. Studies have found that countries that have more advanced institutional capabilities and have acquired legal, economic and political capacities tend to be more developed economically, politically and socially (Kuncic, 2012). Weak institutions breed corruption and rent-seeking behavior, leading to mistrust in public policy, inefficiency, and suboptimal management of natural and reproducible capital, including public infrastructure. In this context, all resource-rich African countries are encouraged to sign on to organizations such as the Extractive Industries Transparency Initiative (EITI) that promote and support transparency, improved governance and increased scrutiny over government revenues.

Africa has increased its investment in human capital, including human capital in agriculture, but the distribution is uneven. During the period between 2001 and 2008, investments and human resource capacity building in public agricultural research and development (R&D) grew more than 20 percent on average in sub-Saharan Africa, with the region investing up to US$ 1.7 billion (in 2005 purchasing power parity dollars) and employing over 12,000 full-time equivalent (FTE) agricultural researchers in 2008 (Beintema and Rahija, 2011). Unfortunately, the growth in R&D is not evenly distributed across the countries on the continent. For example, a number of francophone countries in western Africa have experienced underinvestment at a dangerously low level, and are heavily dependent on

Figure 8.2: Evolution of Research and Development Spending per Unit of Labor in Agriculture in Africa, 1981 – 2008



Source: Agricultural Science and Technology Indicators (ASTI) data.

inadequate and often volatile external funding sources. Figure 8.2 shows that expenditure on research and development per unit of labor in agriculture has generally declined in several countries since the 1980s. Only Ghana and Ivory Coast, out of the eleven countries, have shown signs of recovery. A number of countries within the region have failed over the years to replace retiring senior scientists and to mentor junior researchers, thus creating a skills gap that has proven difficult to fill.

Africa's investment in capacity building must be based not just on knowledge accumulation but also on achieving different kinds of capacity needs under diverse conditions. The region has to articulate a framework for assessing capacity needs before designing and sequencing interventions. Regarding research and development in crop production, for example, the continent has a lot to learn from countries such as Brazil and India. A focus on local innovation and development of crops and techniques suited to local conditions, in partnership with farmers and the private sector, was fundamental to the transformation of the Brazilian agriculture sector, where every US$ 1 invested in publicly funded research into new rice, bean and soya varieties yielded US$ 16 of additional value from agricultural production (Pardey et al., 2004).

Collaboration between African universities and foreign institutions of higher learning can improve productivity. Universities have played critical roles in achieving successful agricultural transformations in countries such as India and Brazil (Blackie and Ward, 2005; Blackie, 2010). These countries have focused on building high-quality institutions that industrialize agricultural activities from production to consumption. In Africa, collaboration between Bunda University College of Agriculture, the Malawi Ministry of Agriculture, and Michigan State University resulted in tripling maize yield from applied nitrogen fertilizer and legume nitrogen fixation (Snapp et al., 2010).

Collaboration among African universities can also improve research capacity. The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) network is a strategy for creating centers of excellence through building "networks of specialization" in eastern and southern Africa. The leaders of the network are the universities that have the greatest expertise and most up to date facilities in a certain area of instruction or research (Blackie, 2010). Eastern and southern Africa already have considerable experience with the RUFORUM network.

Farmers should be actively involved in the process of implementing research findings in order to encourage them to embrace the results. By organizing farmers into research groups and having them work with scientists to access information, farmers' confidence is boosted, and they will be willing to spread lessons learnt to others. The farmers could be asked to volunteer pieces of land for experimentation with, say, improved seeds and livestock, fertilizers, tree nurseries, irrigation facilities, or soil and water conservation methods (Blackie and Ward, 2005). An example of such an initiative, which is already taking place on the continent, is the Millennium Villages Project (MVP) launched in 2006. This project focuses on participatory community decision-making and implementation to promote local ownership. It currently covers approximately 500,000 rural people in 80 villages across 14 sites in 10 African countries (Ethiopia, Ghana, Kenya, Malawi, Mali, Nigeria, Rwanda, Senegal, Tanzania, and Uganda). A review of MVP in four countries (Ethiopia, Ghana, Malawi, and Uganda) in 2008 found some remarkable achievements, including increased crop yield in the range of 85-350 percent and reductions in malaria incidence of over 50 percent (Buse et al., 2008).

In addition to a R&D capacity deficit in agriculture, Africa lacks the capacity to access climate funds. Relative to other continents, Africa has very low access to climate financing, in spite of the proliferation of climate finance instruments and the continent's huge potential to benefit from carbon projects. Factors contributing to this phenomenon include rigid international standards for funds eligibility, coupled with Africa's low institutional capacity to design and manage projects and to provide advisory services to potential donors and investors. Building capacity at national and regional levels in these areas will generate significant benefits. Local and regional centers may eventually evolve to provide carbon-trading services, advanced statistical and programming skills, and knowledge in geographical positioning systems and geographical information systems, all required to measure and monitor carbon storage and flows accurately and at low transaction costs (Rosegrant, 2007; Bryan et al., 2010).

8.4.2 Appropriate Land Reforms and Policies

In order for Africa to benefit from implementing the green growth agenda, land reforms are necessary. With the high fertility rate in Africa, the continent's population is expected to more than double between 2010 and 2050 (as discussed in Chapter 3). Coupled with the high proportion of the labor force in agriculture and sharply rising food prices over the past decade, land issues are of serious concern (Bremner, 2012). There is increasing evidence of fierce competition for land and very high pressures on tenure systems. In addition, due to increased demand by large multinational corporations for land for agrofuels and feed, the situation is expected to get worse. For example, in a number of countries in eastern and southern Africa, cultivated land per capita has halved over the last generation. The average cultivated area currently amounts to less than 0.3 hectares per capita (IFAD, 2008).

In many African countries, land tenure systems are highly complex, combining features of both colonial legacies and customary procedures (Mends and De Meijere, 2006). It is not uncommon to find patterns of land distribution riddled with overlapping and contradictory rules, laws, customs, traditions, perceptions and regulations that govern ownership rights. These in turn are made up of access rights (the right to be on the land); use rights (the right to use land for, say, growing crops, grazing animals or raising animals); management rights (the right to make decisions about how the land should be utilized and how its benefits are shared); and transfer rights (the right to sell, give, or rent out the land to others).

In addition to tenure insecurity, distributional equity can also affect agricultural growth. A study on land policies in 73 countries between 1960 and 2000 shows that countries with more equitable initial land distribution achieved growth rates two to three times higher than those with less equitable distribution (IFAD, 2008). Closely linked to this, it is well established that successful land reforms increase investment in land and contribute to rapid economic growth. As noted by Ostrom (2000), a farmer who owns his or her own land and other inputs is likely to see a direct relationship between investments he or she makes in the land and the level of benefits to be realized over the long term. Secure land rights may thus influence decisions on the nature of crops to be cultivated, as well as halt or reverse the depletion of soil capital, by, for instance, encouraging farmers to engage in innovative legume rotations, which fix nitrogen and increase long-term yields. In addition, tenure security could promote the adoption of new agricultural technologies for climate change mitigation and/or adaptation. Moreover, secure access to land would allow farmers to use land as collateral to obtain credit. With increased access to financial services, land productivity could be substantially enhanced, and farmers could transport their produce to local and distant markets for better prices.

8.4.3 Investment in Green Growth

Public and private investments in infrastructural development, efficient utilization of natural resources, and increased food security and livelihoods are necessary for the realization of green growth objectives in Africa. With limited public funds available for green growth projects, public investments should shift toward carefully targeted projects and programs. In an era when public budgets are dwindling, countries must ensure that public resources are targeted to programs that are likely to have the strongest possible impact in terms of stimulating economic growth and reducing negative environmental impacts. In addition, cooperation between governments and the private sector can be crucial in stimulating private investor interest, and African governments should look to provide policy frameworks that help leverage private financing (OECD, 2012).

This section presents a brief discussion on the need to scale up public investment in rural and urban infrastructural development and development of urban mass transport.

8.4.3.1 Rural and Urban Infrastructural Development

The current rate of urbanization in Africa calls for increased infrastructural development to meet the attendant social, economic, and environmental challenges. Essential issues relating to infrastructural development include the largely irreversible impact of current choices on future patterns of development, such as carbon, land use, and water intensity, and the environmental benefits of investing in physical infrastructure that facilitates growth and improves living conditions. For example, improving water and sanitation infrastructure will impact health and human capital, especially for the poor, and will minimize pollution of water bodies with human waste. Second, reliable networks of electricity will increase competiveness among firms and reduce pollution from fossil fuel usage, such as diesel generators. Better public transport brings large economic and health impacts through reduced congestion and air pollution (World Bank, 2012).

Africa must "build right" to avoid future regrets. A framework for green infrastructure has to be designed with strategies that minimize the potential for regrets and maximize short-term local benefits (World Bank, 2012). However, the huge infrastructure deficit in several countries on the continent presents an opportunity to carefully consider the tradeoffs between "building right" (which relates to economic plus environmental concerns) and "building more" (which relates to satisfying social needs). The tradeoff stems from the fact that it is generally more expensive to build infrastructure that is cleaner, more resilient, or both.

Africa's rural and urban infrastructure is improving but is worse than that of other regions. It is estimated that Africa is spending US$ 45 billion a year to address its infrastructure needs. While the supply of clean water and sanitation facilities in Africa relative to other developing regions is encouraging, the continent compares unfavorably in all other types of infrastructure. In fact, compared to low income regions elsewhere in the world, Africa is four times worse off in terms of paved road density, while the middle income countries in the continent are almost twice as badly off as their peers in other regions (Mafusire et al., 2010). The challenges with regard to transport infrastructure include the physical deficit, lack of linkages between roads and rail lines, and poor connectivity to ports (Mafusire et al., 2010). These all limit the size and scope of markets and therefore impede economic growth. It is estimated that the infrastructure deficit within the region costs the continent about 2 percent of GDP growth a year, while Africa was rated as the world's worst region in the Logistics Performance Index (LPI) in 2009.

Problems are most acute in rural areas (Banerjee et al., 2008). For example, only one-third of the rural population lives within two kilometers of an all-season road, compared with two-thirds of the population in other developing regions (Gwilliam et al., 2008). An obvious problem relating to bridging the gap between rural and urban infrastructure is the relatively sparse settlement in rural areas, making the per capita cost of providing infrastructure higher. For example, over 20 percent of the population in rural Africa lives in dispersed settlements with modal population densities of less than 15 people per square kilometer. It is estimated that the cost of providing a basic infrastructure package in these conditions is US$ 400 per capita, compared to US$ 200 per capita in densely populated cities (Foster et al., 2008).

For Africa to be competitive in the global market, it is particularly important to scale up investment in water infrastructure. Increased investment in water for agriculture will lead to intensification and diversification, and thereby increase farm productivity, earnings and employment. It can also reduce the rate of conversion of grasslands and forested area to farmland and thus preserve biodiversity. While the area under irrigation is about 30 percent of arable land in Asia, the corresponding rate for Africa is only 5 percent (Salami and Ajao, 2012). The rate for sub-Saharan Africa, for example, is as low as 3 percent. Several opportunities, such as water from mountain-related rivers and lakes that could be used for irrigation, have been underexplored. Further details on the potential benefits from greater irrigation in Africa and the options available to achieve this are discussed in detail in Chapter 4.

In sum, green growth pathways in Africa require making smart infrastructural investment decisions today. By capitalizing on the current infrastructure deficit and building right, African countries could mitigate the impact of extreme climate events in the future as well as improve current economic performance and lower the rate of poverty in both rural and urban areas.

8.4.3.2 Development of Mass Transportation in Urban Areas

In general, the transportation sector in Africa is inefficient, has poorly maintained infrastructure, and lacks a viable public transport system. In most countries on the continent, the transport industry is dominated by the informal sector, providing services that are unreliable, uncomfortable and unsafe. In a typical city, for example, public transportation is provided by a mix of privately owned minibuses, taxicabs and large buses. Sustainable transportation, which entails improving the current transport systems so that they are compatible with multiple environmental, social and economic concerns, is crucial for green growth on the continent (Sperling et al., 2012). For example, an effective and efficient mass transit system is likely to reduce urban pollution, exposure to disasters, and congestion costs within and across cities.

A considerable number of people converge upon urban areas each day all over the continent, resulting in an increasing number of privately owned vehicles. This places pressure on infrastructure and increases pollution. In addition to reducing commuting time and pressure on the roads, mass transit could be made greener and more sustainable by fueling it with cleaner fuel (e.g. bioethanol, biodiesel, and hydrogen). However, the development of sustainable public transport in Africa requires policy dialogue and capacity development at the planning and implementation levels.

8.4.4 Promoting Regional Integration and Cooperation

For Africa to experience sustained growth, it must put forward the right strategies for regional integration. These include developing strategies to foster regional and sub-regional cooperation in agricultural research and development, building strong infrastructure and support services such as information and communication, and establishing strong policies and institutional frameworks that could serve to promote trans-boundary investment in agribusiness enterprises and management of natural resources.

Sub-Saharan African investments in agricultural R&D are uneven within the continent, as noted earlier. Some countries have registered negative growth rates in this area, and average qualification levels have deteriorated. To overcome these challenges, regional centers of excellence are needed to provide further training and mentoring to junior researchers. The centers could also facilitate and strengthen the exchange of experiences and best practices.

Africa's rapid urbanization means there is growing demand for processed food and agricultural products. Yet agricultural input and product markets are incomplete and poorly integrated at national as well as at sub-regional and regional levels. There is a need for a comprehensive value chain approach to agricultural development, where the focus goes beyond the farm stage to embrace the agroindustry and agribusiness stages that connect farmers to wider regional markets. Taking actions to address the fragmentation and weak integration of the African agricultural market will increase overall demand for agricultural produce and inputs, which could further increase productivity and yield. The current situation discourages private sector investment, which is needed to allow the full realization of intra-regional production and trade potential on the basis of comparative advantage.

Furthermore, Africa is endowed with several natural resources that traverse national boundaries, necessitating regional collaboration to manage them sustainably. This includes capture fish stocks, oil deposits, forest stocks, and renewable energy, especially hydroelectricity. While fish and forest stocks are generally overexploited, other natural resources such as renewable energy are considered undercapitalized, inefficient, and uncompetitive. In relation to hydro-electricity, for example, extensive cross-border transmission projects have the potential of yielding benefits to partnering countries. It is also essential that the countries involved put in place international governance structures, including legal standards to harmonize resource extraction agreements with multinational corporations, as well as collectively enforce regulations, which would result in lower enforcement cost per unit to member countries. Regional economic communities such as SADC and ECOWAS could take the leading role in forging such collaborations.

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Chapter 9

Facilitating Green Growth in Africa: Reflection on Entry Points for Action and the Way Forward

9 Facilitating Green Growth in Africa: Reflection on Entry Points for Action and the Way Forward

9.1 Introduction

The preceding discussions have focused on describing Africa's economic progress and the remaining challenges to sustain this growth. The discussion has also outlined key development trends that need to be managed over the near to long-term to foster inclusion. As the Report highlights, there is both a global and a local rationale for transitioning towards green growth. At the global scale, evidence presented in this Report and elsewhere (e.g. MEA, 2005, IPCC, 2007, Rockstroem et al. 2012), underlines that the sum of human activities has led to degradation of ecosystems, undermining the earth's natural support systems upon which all people depend. While the African economies have only made a small or even negligible contribution to these global environmental changes, the continent is especially vulnerable to these changes, with climate change probably the most prominent example (see IPCC 2007). Furthermore, local environmental changes feed into global changes. For example, where land is being degraded and renewable resources are being depleted beyond their regenerative capacity, the impacts of climate change may be exacerbated. These impacts are already apparent and include reduced productivity of land and increased flood risk due, for instance, to forest degradation.

Africa has a tremendous opportunity to make significant development gains in the 21st century. But progress can only be made if the continent also simultaneously prepares for, and adapts to, the complex environmental and socioeconomic changes it is currently facing. Most African countries face major challenges over the next decades regarding the type of infrastructure that they build to address essential demands for energy and transport and to manage the increasing urbanization on the continent. In addition, there is growing internal and external demand for Africa's renewable and non-renewable resources. The continent is also faced with the task of building resilience to global environmental and socioeconomic changes. Taken together, these challenges represent the key focal areas for green growth (Sperling et al. 2012) as they require more integrated approaches for maximizing synergies between development objectives.

With this in mind, this final chapter reflects on existing building blocks for green growth and the strategic entry points for action. It explores the role the African Development Bank (AfDB) and other development organizations can play in facilitating the transition, and concludes with an outlook on the way forward.

9.2 Building Blocks for Green Growth

The good news is that many of the building blocks for green growth are already in place, as evident from earlier chapters. Green growth constitutes a reinforced emphasis on sustainable development, recognizing that in order to master the more complex challenges of this century, a more cross-sectoral approach to development coupled with better upstream planning and diagnostics is required. Consequently, green growth represents an umbrella under which a range of initiatives focused on managing natural resources, climate risks etc., are integrated within the broader development context. Thus, green growth strengthens the robustness and quality of the growth process by protecting the natural asset base upon which societies and economies depend and promoting the development of more efficient and sustainable economies. Green growth can and should build on existing institutional and policy structures. It can, for example, draw on national plans of action for adaptation, sustainable land management, integrated water resource management and other initiatives created to promote resource use efficiency.

However, green growth seeks to move away from isolated initiatives, towards empowering governments and stakeholders to make more informed decisions about development processes through better understanding of economic, social and environmental inter-linkages. The aim is to identify and implement solutions that deliver on development and growth targets, while maximizing natural resource use efficiency, minimizing waste and pollution, and strengthening resilience. If green growth strategies are well designed and implemented, this could lead to more sustainable and efficient African economies, making them more competitive and robust in the global marketplace.

There exists already a wealth of diagnostic tools, methodologies and financing instruments for identifying and implementing more sustainable development solutions. For instance, the AfDB, together with the Organization for Economic Cooperation and Development (OECD), the World Bank and the United Nations Environment Program (UNEP), has compiled an overview of tools and methodologies relevant to green growth (AfDB, et al. 2012). However, often these tools have not entered mainstream development projects. In order to promote green growth, the challenge lies in moving from piloting phases to general practice and systematic application of strategic and project based solutions that promote efficiency, sustainability and resilience.

At the strategic level, a more systematic application of Strategic Environmental Assessments (SEA), for example, can help in assessing the impact of development options on natural assets. Integrated planning tools (such as the Threshold 21 model used by UNEP) can further strengthen the evaluation of development pathways in terms of synergies and tradeoffs between economic, social and environmental objectives (UNEP 2011). Other tools also offer opportunities to identify likely cost effective entry points for specific thematic areas. For example, greenhouse gas marginal abatement cost curves help in the identification of the least cost mitigation options within or across development sectors and were an integral component of Ethiopia's green growth strategy (GoE, 2011).

In addition to guiding broader strategy development, there are a range of tools that can help identify opportunities for efficiency gains, sustainability and minimization of vulnerabilities. These tools can complement social and environmental safeguards by operating farther upstream and helping to optimize project design early on in the project cycle. In the natural resource management context, sustainable land management and integrated water resource management represent approaches that promote cross-disciplinary approaches, which seek to generate development objectives across multiple sectors and link broader policy level interventions with project specific measures.

Spatial planning tools in particular can help in mapping land use and establishing relationships between the environment and socioeconomic activities. Climate Risk Screening Tools, as developed by the AfDB and other organizations, can also help to identify climate-related vulnerabilities of projects and provide early guidance on possible risk-mitigating measures. As contributors to the G20 working group, the African Development Bank, together with the OECD, UN and the World Bank, have compiled a first toolkit outlining a set of policy options and measures that can guide the transition to green growth (see AfDB et al., 2012).

9.3 Entry Points for Action

There are several levers for promoting green growth and enabling the transition towards greener economies. The most systematic lever is the progressive mainstreaming of green growth into upstream development planning, which requires putting the right institutional enabling environment in place and providing the right incentives for scaling up private and public green investments.

Key entry points for mainstreaming green growth are the national development planning cycles such as Poverty Reduction Strategy Papers (PRSPs). Development objectives, such as increasing agricultural productivity and energy access, can usually be realized through these cycles. Emphasizing green growth means carrying out appropriate upstream diagnostics to determine which approach is most appropriate for a particular country from an economic, social and environmental perspective.

For example, a particular target aimed at improving energy security could be realized with different energy mixes: development of fossil fuel based solutions, scaling up renewable energy access, or a mix between renewable and non-renewable technologies. Improving efficiency can further help address energy security issues. In addition, vulnerabilities of technologies to climatic changes, implications of population growth and shifting demands and impacts of local environment and land use, with possible knock-on effects on other sectors, need to be considered in the planning stages of national development strategies. This does not mean that the greenest technology will be picked ultimately, but a stronger emphasis on upstream diagnostics helps focus the decision-making process on its implications across development sectors and on the country's long-term development trajectory.

Strengthened upstream and systematic planning also requires a broader integration of sectors, supported by the appropriate institutional enabling environment. According to the AfDB and OECD (2013), political commitment, long-term development visions and an emphasis on more integrated and programmatic development approaches can be effective in opening space for integrating green growth in the national development agenda.

Improved diagnostic, information and monitoring capabilities are important for adequately capturing a country's natural resource wealth, assessing risks to sustainability and monitoring progress. Only if development progress is defined and monitored along appropriate economic, social and environmental criteria will it be possible to assess the quality of growth in terms of sustainability.

Smaller levers for green growth are further downstream and focus on integrating principles of resource use efficiency, sustainability and resilience into the design of development programs and projects. However, while project-level investments are important, they are in themselves insufficient, if not more broadly supported by the right enabling environment that promotes a large-scale transition to more sustainable practices. It is about understanding development trajectories in their short, medium and long-term implications and how investment decisions relate to these implications.

In addition to improving planning processes at the country and project level, regional integration can further facilitate the advancement of green growth in specific areas. This applies in particular to energy solutions and the management of natural resources. For example, the large number of trans-boundary river systems will require enhanced regional collaboration to meet energy, agricultural and water security challenges.

9.4 Opportunities for Development Organizations: Early Lessons from the African Development Bank

It is clear that there is no silver bullet for overcoming complex environmental and socioeconomic problems. Green growth is driven by the recognition that economic growth objectives need to be linked to considerations of environmental sustainability, efficiency and resilience. Yet solutions need to be tailored to country-specific circumstances. While there may be efficiency gains and cost savings associated with green growth, there are also upfront investment costs, which will constrain the transition.

The AfDB, along with other multilateral and bilateral organizations, can facilitate the transition to green growth in Africa. This starts with building awareness, upstream knowledge sharing and technical support, and goes all the way to providing guidance and resources for programmatic and project specific interventions.

The Bank and other organizations can help African countries address the initial barriers towards green growth, in part through existing and innovative financing instruments. In this context, the Bank is managing or hosting a range of innovative financing instruments that may further help countries augment these internal financial options. For example, through the Climate Investment Funds (CIFs) and the Sustainable Energy Fund for Africa (SEFA), the Bank has several funding instruments that help mainstream climate mitigation and adaptation issues into development activities and promote scaling up of clean energy solutions at different levels.

As a CIF implementing agency, the Bank is currently supporting eight projects in five African countries and is expected to channel up to US$ 1 billion of investments to 17 African CIF partner countries over time (AfDB 2013). The Bank is also helping to channel resources from the Global Environmental Facility (GEF) to help address a range of environmental issues, aside from climate change, in Africa. The Africa Water Facility (AWF) is another example where the Bank is providing support for managing essential resources more sustainably.

Despite the need to tailor green growth policies and measures to country circumstances, decision makers and development practitioners can benefit from exchange of knowledge and experiences in assessing and prioritizing interventions and securing resources. As the continent's main multi-lateral development bank, the AfDB can act as a convener of stakeholders for exchange of knowledge and experiences, facilitating coordinated action.

Furthermore, the Bank has engaged with several interested countries in a dialogue on green growth. In Sierra Leone, it is providing technical support to the government in its effort to mainstream green growth perspectives into the country's PRSP, which represents the country's agenda for prosperity. The Bank has also initiated dialogue with the governments of Kenya and Mozambique, and is working with development partners, such as the UNEP and the World Wide Fund (WWF), in the development of strategic road maps that promote the transition towards greener economies. These countries represent examples of using alternative entry points to mainstream green growth into development planning.

Public-private sector partnerships and the use of the above-mentioned financing instruments can also help facilitate the engagement of the private sector in green growth. For example, a combination of CIF financing (US$ 25 million) and AfDB co-financing (US$ 120 million) for the Menangai Geothermal Development Project is seeking to pave the way for private sector engagement in developing this energy resource in Kenya by reducing exploration and drilling risks (AfDB, 2013). This is expected to improve energy access, prevent annual CO_2 emissions of about 2 million tons and use a renewable energy resource that is also resilient to climatic changes.

9.5 Outlook on Moving Ahead

The AfDB's 10 Year Strategy (2013-2022) is focused on strengthening the quality of growth in Africa by making inclusive growth and the transition to green growth central long-term development objectives. By establishing a cross-departmental green growth team, co-chaired by the Climate Change Coordination Committee and the Department for Energy, Environment and Climate Change, the Bank is working on framing green growth at the operational level, building internal awareness, and starting to pilot initiatives in selected countries. Other multi- and bilateral organizations are also moving forward from the conceptualization of green growth to concrete green economy initiatives. This presents the opportunity and challenge to build harmonized approaches on the continent, pooling knowledge, initiatives and resources.

The existing methodologies, tools and financing instruments can help promote the transition towards greener economies in Africa. This is a start. As an iterative process, green growth requires a strengthened emphasis on assessing development trajectories and evaluating investment choices in terms of their resource use efficiency, sustainability and resilience.

Thus, thinking about multi-purpose solutions that strive to provide benefits across sectors should dominate the debate for green growth. For example, increasing agricultural productivity needs to be reconciled with sustaining other ecosystem services. Dams can provide hydro-power, water for irrigation and help flood risks. Demographic changes, air pollution and congestion require mass transport solutions that are safe, environmentally friendly, equitable and democratic.

Green growth is about anticipating and adapting to these changing demands on Africa's economies, assessing the growth potential of economic sectors and also considering the impacts on environmental and social assets. Enabling green growth and promoting sustainable development pathways means that government institutions and development organizations need to provide incentives for strengthened cross-departmental coordination and collaboration.

Hence, in moving forward on green growth, what should African countries, development organizations and stakeholder groups think about and do more of?

► *Diagnostics in support of efficient and sustainable development trajectories*

In order to empower African economies to grow and become more competitive, efficient and sustainable, green growth policies and measures will be needed at the regional, national and project level. The AfDB and other development partners can assist in this transition by providing upstream diagnostic support to identify where efficiency gains can be realized and how natural and social capital can best be sustainably managed. This includes strengthening the emphasis on targeted analytical advisory and economic sector works (ESW), helping countries improve their knowledge base for investment planning prior to poverty reduction strategy development, and guiding the targeted support of AfDB through Country Strategy Papers (CSPs) in response to the PRSP. At the project level, a stronger focus on identifying standards for technologies and practices that reduce the environmental footprint of projects, minimize waste and pollution, and build resilience may further complement environmental and social safeguards by focusing on greening options early in project design.

► *Policies, incentives and enforcement capacities*

High-level buy-in is essential to systematically shift towards green growth. In order to be effective, this high level support must be supported by a long-term development vision of a country or region, shared by all stakeholders. There are important entry points for action with regard to strengthening institutional coordination mechanisms, capacities and governance structures.

Development organizations can help governments through budget support programs to create effective policy and governance frameworks for transitioning to green growth. This may include, for example, supporting countries in strengthening their institutional structures for managing their natural capital effectively and sustainably across sectors. The enabling environment set by governments, such as improvement of standards, strengthening of regulations and building incentive structures and enforcement mechanisms, will serve an important signaling function to economic actors and hence influence the transition to greener economies (see. e.g., UNEP, 2011). Strong emphasis on developing human capital, preparing livelihoods for managing the risks associated with climate change and other environmental challenges, and building the skills set for utilizing more efficient technologies and resource-efficient economies will have to be integral ingredients of comprehensive green growth policies and measures.

► *Expanding of financing options for green growth*

Among the first steps in financing green growth should be the focus on quick wins and no regret options that can be implemented quickly and directly contribute to strengthening a country's economic competitiveness by identifying efficiency gains and ensuring sustainability. An example is removing distortionary subsidies and providing the right incentive structures. Even though this Report cautions against removing fuel subsidies suddenly or without careful planning, it is advisable to promptly review subsidy policies. This may also mean providing technical assistance to Ministries of Finance and Planning in factoring green growth into budgeting processes.

Where upfront investment costs represent a bottleneck to the transfer of efficient technologies or other green strategies, the Bank and other institutions can help overcome these barriers by strengthening the capacity of countries to effectively access grant finance and other instruments, address climate change and sustainably manage natural resources in development programs and practices. Working with governments, the Bank can also assist in developing strategic approaches that integrate various financing instruments to comprehensively manage issues of environmental sustainability.

Public and private investments are necessary for realizing green growth objectives in Africa. With limited public funds available for green growth (see Chapter 7), public and private investments should shift toward carefully targeted projects and programs, accompanied by policy frameworks that help leverage private financing (OECD, 2012). Public incentives are needed to encourage private investment, as FDI is increasingly exceeding ODA in many African countries. Providing the right regulatory environment can remove market distortions that favor less environmentally sustainable activities and incentivize sectors that would otherwise fail to capture the value of green activities (Sperling et al., 2012).

► *Monitoring, tracking and willingness to adapt*

Sustainability concerns require moving beyond GDP as the sole measure of development success. While GDP will remain an important indicator for development, it does not adequately capture renewable and non-renewable resources, pollution, loss of ecosystem goods and services and environmental changes. Unless GDP is complemented by other indicators that examine the quality of growth, it will be difficult for decision makers to evaluate whether development choices will realize net economic gains; this requires thinking about whether each choice increases, maintains or depletes a country's natural and social assets. Hence, green growth requires indicators that provide insights about:

» the state of a country's natural assets;

» the resource use efficiency of an economy and its sectors; and

» the resilience of a country's livelihoods and sectors to environmental and socioeconomic shocks and hazards.

The joint work by the Global Green Growth Institute (GGGI), the World Bank, UNEP and OECD (GGGI et al., 2013) shows that green growth indicators need to demonstrate policy relevance, be based on sound science and measurable, and be easy enough to communicate, so they can be effectively applied by the target audience. The team proposed a set of indicators that could be used to measure the state of a country's natural assets. These include fisheries, forests (example indicators: area of forest and areas re-forested or afforested), water (e.g. availability of renewable resources) and biodiversity (species abundance).

Other types of indicators look at different aspects of resource use efficiency and productivity such as CO_2 emitted per unit of GDP, water productivity, and waste recycling. Still other indicators explore risks to human welfare and hence could help in gauging the vulnerability and resilience of societies. These include indicators of the population with access to safe drinking water and measures of the level of exposure to a variety of natural and man-made hazards.

There is an opportunity for development organizations to exchange data, test the application of various indicators, and share experiences, with the goal of providing a common platform for dialogue with developing countries. Which indicators will be best suited will ultimately depend on country circumstances.

In conclusion, development partners have the chance to facilitate the green growth transition through appropriate upstream dialogue, targeted technical assistance, facilitating access to financing and supporting effective implementation. The time for coordinated action is now, so that African countries can harness the fruits of economic growth for the benefit of current and future generations in a time of rapid regional and global change.

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Green growth in Africa encompasses the achievement of critical development objectives while seeking to maximize efficient use of natural resources, minimize waste and pollution, and enhance the resilience of livelihoods. Seeking such a delicate balance is crucial because, as the size of Africa's economy continues to grow, natural resource degradation and the global GHG problem may increase, eventually putting a brake on the region's progress. This could have serious implications for livelihoods.

Pursuing green growth pathways will entail African countries making "smart" investments now, focusing on activities necessary to sustain Africa´s progress. These include investing in sustainable infrastructure, energy and urban settlements; better management of natural resources including land, fish stocks, water, forests; building resilience to natural disasters and climate change; and enhancing food security.

The largest and most systematic lever for promoting green growth is the progressive mainstreaming of green growth into upstream development planning and ensuring that the right institutional environment is put in place. Smaller levers for green growth are further downstream, focusing on integrating principles of efficient use of resources, sustainability and resilience into the design of development programs.

The AfDB, together with other multi-lateral and bilateral organizations, can facilitate the transition to green growth in Africa by building awareness, knowledge sharing and upstream technical support, as well as providing guidance and resources for programmatic and project specific interventions. In addition to its operational experience, the Bank can help provide building blocks for promoting green growth and hence function as a partner to its member countries in the transition towards sustainable development.

AFRICAN DEVELOPMENT BANK GROUP

15, Avenue du Ghana, Angle des rues Pierre de Coubertin et Hedi Nouira, BP 323, 1002 Tunis Belvédère, TUNISIA
Tel (216) 7110-2876 **Fax** (216) 7183-5705
Email economic-research@afdb.org, afdb@afdb.org **Website** www.afdb.org

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