

Working Paper

Green Industrialisation and Entrepreneurship in Africa

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Executive Summary

Policymakers across Africa have widely embraced economic transformation as a key to help accelerate and sustain inclusive growth. Economic transformation refers to two linked development processes. One is structural change: the shift of workers and other resources from low-productivity sectors, such as subsistence agriculture, to high-productivity sectors, such as industry and modern services. The other is faster productivity growth within various sectors. Sustained robust economic growth is essential to achieve rapid job growth and poverty reduction in Africa.

African policymakers also increasingly stress the need and the growing opportunities for green growth – growth that protects Africa’s natural environment in ways that increase the welfare of present and future generations, and which creates new opportunities for economic transformation and development. Ensuring that the natural environment is able to continue to provide the services on which human welfare depends is essential to ensuring the sustainability of economic transformation and growth. Africa is experiencing the ill effects of environmental degradation on several fronts. But such outcomes are not inevitable. Economic transformation can and should deliver green growth.

Economic transformation and green growth both depend on doing new things or doing things differently: making risky investments in new, unfamiliar sectors or products or adopting new, unfamiliar methods, processes, technologies, or inputs. Therefore they depend crucially on the activity of entrepreneurs, who drive change through their innovation and risk-taking.

This paper discusses the opportunities – and challenges – for African policymakers and businesses on these three related issues: economic transformation, green growth, and entrepreneurship. Better policies and institutions, changing world markets and global technological progress have the potential to foster both economic transformation and green growth in Africa, or to better manage trade-offs between them, as well as to encourage more vigorous entrepreneurship, a key for economic transformation and green growth.



Photo credit: Solar Sister

About this working paper

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THE CHALLENGE OF ECONOMIC TRANSFORMATION

While there is widespread agreement on the need for economic transformation, Africa has so far experienced relatively little such change. In the typical historical path followed by today's developed countries, most output and employment are at first in agriculture, a low-productivity sector, whose share, however, ultimately falls to less than 5%. The share of manufacturing first rises and then, at an upper-middle-income level, starts to fall, while the share of services tends to rise throughout. The shift of jobs from low- to high-productivity sectors boosts the overall productivity of the economy and is accompanied by rising productivity within each sector.

In sub-Saharan Africa, around 60% of employment remains in agriculture. While there has been some growth-enhancing structural change in the 2000s, labour has tended to move from agriculture into relatively low-productivity urban informal services sectors rather than into high-productivity manufacturing or modern tradable services. Sub-Saharan Africa's share of employment in manufacturing is an extraordinarily low 5%, the lowest in the world. Per capita exports of manufactures from sub-Saharan Africa are only around 10% of the developing country average. In North African countries, output and employment shares are also high in agriculture and low in manufacturing, relative to per capita income.

There is, nevertheless, great potential for economic transformation across Africa. In sub-Saharan Africa, the large scope for growth through structural change is indicated by the vast percentage of the population still in agriculture who could be employed in other sectors with much higher productivity. Within-sector productivity in sub-Saharan and North Africa remains much lower than in developed countries or even other developing regions; these sectors can grow by absorbing ideas and technologies from abroad.

A stronger performance in manufacturing is central to Africa's prospects for economic transformation. There is abundant international evidence on the special role of manufacturing in generating rapid sustained growth due to features such as economies of scale, learning by doing, and the opportunity to absorb advanced knowledge through integration into global production networks. Manufacturing has historically generated rapid job growth for low and semi-skilled workers, including women and youth. This is particularly important in Africa, where over 450 million new workers are expected to enter the labour market by 2035.

Changing conditions in the world economy and African countries' distinctive characteristics mean that there is unlikely to be a single model for economic transformation on the continent. African countries will display significant differences as well as similarities to the historical path followed by today's developed countries. The rise of global production networks has created new opportunities to enter global trade, as have changes in information and communications technology and transport costs. Many services and agro-industrial products have become tradable and, sharing features with manufacturing, can be described as "industries without smokestacks". African countries can serve as global leaders in pioneering these new economic transformation models and pathways. A major expansion of infrastructure is urgently needed across much of the continent, creating opportunities for countries to "leapfrog" to clean, resource-efficient modern infrastructure models. African countries are well placed to help develop global production networks that serve growing world markets for green or sustainably produced commodities, and other goods and services, for example ecotourism.

Structural change in China and other East Asian countries is also creating favourable competitive conditions for African countries to achieve more success in export-led economic transformation. Real wage costs in China tripled between 2005 and 2016. There is some evidence that China is encouraging off-shoring of some low-end manufacturing to Africa. Other East Asian countries, such as Malaysia, Thailand, and Vietnam, are increasingly focused on medium- and high-tech exports, leaving space for Africa to enter into low-end manufacturing. An opposing factor is the increasing technology and skill intensity of global manufacturing, which may limit how extensively African countries can exploit these opportunities.

For African countries to make the most of global opportunities, they will need to create a policy environment that enables existing firms to increase their productivity and attracts new firms able to compete in regional and global markets. A key issue for policymakers is how to shape policies for economic transformation in ways that also improve environmental protection and foster green growth.

ECONOMIC TRANSFORMATION AND GREEN GROWTH

Economic transformation and growth can and should be green. It should ensure that natural assets – the soil and sub-soil assets, water resources, life forms of various kinds, and the atmosphere – continue to provide the services on which human well-being depends; and it should strengthen the resilience of the economy to environmental stresses, including climate change. Green growth, in turn, creates new opportunities for economic transformation and development. These features of green growth are essential to ensure that the path of development is sustainable in the long run.

Africa is experiencing the ill-effects of environmental deterioration on several fronts, including the impacts of climate variability and change. Rapid population growth and land use practices are contributing to deforestation and land degradation, damaging fragile ecosystems, and producing water scarcity. In cities, air pollution and ineffective waste management pose serious and growing problems.

But such outcomes are not inevitable. There are close links between economic transformation, the potential for green growth, and environmental outcomes. Economic transformation and growth tend to increase demands on natural capital, especially as countries move from low-income to upper-middle-income status. However, the extent and nature of this impact depend greatly on the specific structural transformation path a country takes, its population's income level and consumer preferences, technological progress and improvements in the efficiency of resource use, and, crucially, economic policies and institutions.

Both channels for economic transformation – structural change and within-sector productivity growth (or improvements in the efficiency of resource use) – have significant implications for environmental outcomes and green growth. Different patterns of structural change impose different demands on natural assets and the environment. Global technological progress improves resource use efficiency over time. Because their resource efficiency is typically well below global levels, African countries have the potential to “leapfrog” rapidly to the global standard. More efficient resource use is part of a more “circular economy”, which also emphasises recycling and reuse of waste materials. The report looks in particular at implications of a green economic transformation for energy use (a key driver for various kinds of pollution), water demand, and land use patterns.

Most African countries consume little energy compared with countries in other regions. Per capita energy use in low-income Mozambique, for example, is only 15% that of upper-middle-income Malaysia, or 9% that of high-income countries. African energy use is expected to increase substantially in coming decades if the continent is to be able to achieve sustained economic growth. Global evidence suggests that energy use rises most rapidly as countries transition from low-income to upper-middle-income levels (Figure ES1). The underlying drivers of this acceleration include structural change and the shift of activity from less energy-intensive subsistence agriculture to more energy-intensive industry and (to a lesser extent) services. Urbanisation also entails a more energy-intensive pattern of life than rural life. Rapid poverty reduction contributes to accelerating energy use as previously poor families gain access to electricity and purchase household appliances for the first time. A vast expansion in Africa's energy infrastructure will be needed to meet rising demand, especially in power generation.

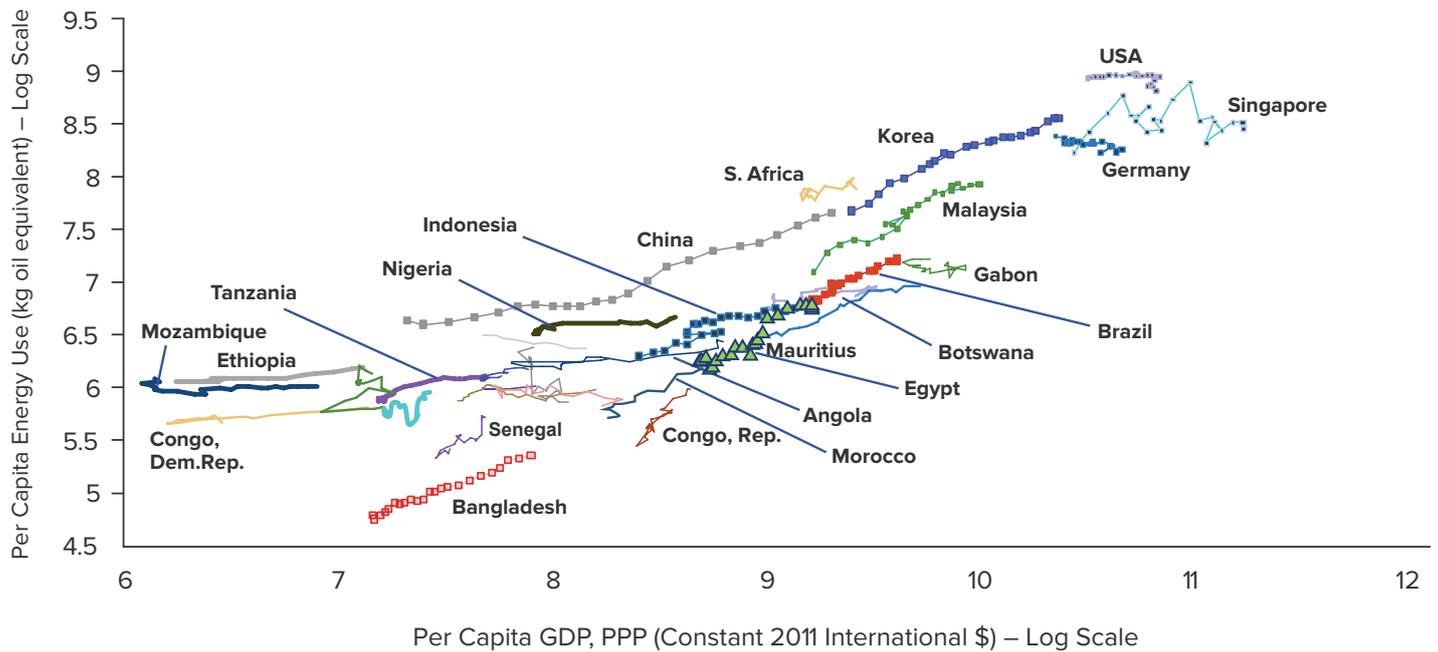
Structural change will also shift the type of energy consumed. Sub-Saharan Africa still depends heavily on traditional biomass, such as firewood and agricultural waste. Low-income countries like the Democratic Republic of the Congo and Ethiopia rely on traditional biomass for around 90% of their energy, compared with 10% globally. With economic transformation, countries shift from traditional biofuels to modern energy sources – traditionally these were fossil fuels, but there is a growing potential to leapfrog to low-carbon energy sources instead, such as solar, wind, hydro, geothermal, and nuclear. These are increasingly cost-competitive in a number of regions and, together with emerging storage solutions, can provide access for remote communities far from the grid. Furthermore, Africa is at the forefront of developing innovative pay-as-you-go financing schemes for solar power, to facilitate access to basic electricity for low-income households and small businesses.

The energy path that African countries take in the coming decades is not set in stone. Figure ES1 indicates that countries at the same per capita income often have very different energy use levels. One important factor will be the type of structural change going forward. A pattern of structural change dominated by heavy industry and manufacturing on the model of China and some other East Asian industrialising economies would tend, other things being equal, to be more energy and pollution intensive than structural change with a more balanced emphasis on high value added, internationally traded services and other sectors, in addition to more manufacturing. Mauritius, for example, consumes 70% less energy per unit of GDP today than Korea did in 1996, when it was at the same level of per capita income as Mauritius today. This difference is linked not only to global improvements in energy efficiency since 1996, but also to the greater importance of the service sector in Mauritius today than in Korea at that time.

The pattern of urbanisation will also matter: more compact, well-connected cities with good public transit systems will tend to be more energy efficient and competitive than sprawling, poorly planned cities that rely on private cars for transport. Global technological progress is yielding rapid cost reductions in energy efficiency and renewable energy technologies, but African countries' own policies also have a critical role to play in encouraging the uptake and widespread use of these technologies in their own economies.

Figure ES1

Per capita energy use and GDP in selected African and comparator countries, 1990–2012



Source: Data from World Bank (various years) World Development Indicators.

Africa’s water challenge is similar to its energy challenge in some respects. Over 300 million people in sub-Saharan Africa lack access to an improved water source, while some 700 million lack access to improved sanitary facilities. Per capita freshwater withdrawals are very low – only 128 cubic metres per year, less than 25% of the world average – but they are expected to increase substantially alongside economic transformation and rapid population growth in the region. Worldwide, households consume only around 10% of all water used, with the rest being an input to economic sectors such as agriculture, the power generation sector, and industry. A major increase in water infrastructure is needed to tap and effectively manage Africa’s limited internal renewable freshwater resources. Economic incentives must encourage more efficient water use.

An important challenge for African governments is to develop and implement policies that advance both economic transformation and green growth, as well as manage trade-offs when they arise. Governments must implement broad policies to strengthen “basics”, such as macroeconomic management, infrastructure, the private investment climate, and competition in domestic markets. These policies should set appropriate incentives for green growth, for example elimination of fossil fuel subsidies and other subsidies that encourage excessive environmental damage. In addition, governments need to design targeted policies to foster exports, agglomeration, and foreign direct investment in a way that furthers green growth.

ENTREPRENEURSHIP FOR ECONOMIC TRANSFORMATION AND GREEN GROWTH

Economic transformation and green growth depend on making risky investments in new industries, developing new products, or adopting new processes, business models, or ways of doing things. Entrepreneurs are the innovators who undertake these new activities and thus play a crucial role in making economic transformation and green growth a reality. Green entrepreneurs are those who implement innovations and develop new markets that make the economy more efficient in its use of the natural environment and more resilient to environmental impacts, such as climate change.

Large, fast-growing green markets are emerging worldwide. For example, renewable energy technologies saw a record global investment of US\$256 billion (excluding large hydro) in 2015, and energy efficiency-related investments reached an estimated US\$221 billion. Markets for water infrastructure, related to improved methods for water collection, storage, distribution, recovery, treatment and reuse, are growing, as are new ways to improve efficiency in water use. Similarly, urban waste

management markets are expanding rapidly in line with urbanisation and rising living standards, with an increasing focus on recycling and reuse of waste materials. Finally, there is an increasing market for climate-smart agriculture, which refers to production systems, technologies, institutions, and policies that simultaneously boost agricultural productivity, build resilience to climate change in agriculture, and reduce agricultural greenhouse gas emissions.

Green entrepreneurship and green markets are also emerging in Africa, but to accelerate and sustain the momentum African governments will need to develop supportive policies at two levels. First, governments must implement pricing policies and regulations that create appropriate market incentives for green processes and products, for example incentives for more efficient energy and water use. Without such incentives, private green demand will be less than socially desirable due to environmental market failures.

Second, governments need to strengthen firm capacity, performance, and entrepreneurship, taking into account the very different features of the various major types of firms that exist in a typical African economy. In most African economies, the industrial sector comprises three distinct types of firms: “Elephants”, a small number of large formal firms, which dominate their sectors; “Gazelles”, corresponding to about 10–15% of all micro, small, and medium enterprises (MSMEs), the ones with relatively high productivity and capacity to grow; and “Survival Entrepreneurs”, other MSMEs with very low productivity and growth capacity.

Getting the Elephants moving. Elephants have an important potential role in green entrepreneurship and industrialisation, given their relatively high technical capacity and large financial resources. Many of these firms operate in concentrated markets, which they dominate and in which they face little competitive pressure. Thus, they have little incentive to innovate or raise productivity. For example, in Tanzania, the top three or four firms control more than 50% of domestic production in most manufacturing sectors, and firms that face less competition are less active in introducing new products and processes. African governments should use regulatory reforms to promote competition and implement policies that encourage Elephants to upgrade their capabilities through more intensive interactions with advanced, typically foreign-owned firms. This can be done through policies to encourage foreign direct investment (FDI) and exports, and through more supply chain relationships with FDI-led value chains, which serve as valuable conduits for the sharing of technological knowledge and working practices. Special economic zone (SEZ) regulations need an open architecture to incentivise linkages between firms, in particular firms in the domestic economy.

Clean energy development is an important potential green market opportunity for Elephants. Africa needs a massive expansion in electricity generation, transmission and distribution over the next two or three decades, including renewables. These technologically sophisticated projects may be dominated by international suppliers using imported equipment, but they also create important domestic supply chain opportunities for African firms. Some of these opportunities are for the supply of basic construction materials like cement, but, with efforts to strengthen African firms’ capacity and skills, there are also opportunities to compete higher up the supply chain. South Africa is developing a domestic industry to supply manufactured components for wind and solar projects. Its Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) requires at least 45% of spending on clean power projects to be captured in the local economy. At present, most African economies lack the technical capacity to emulate South Africa’s ambitious approach. But, given the significant scale of the expected clean power sector investment in Africa, it seems a mistake for countries not to explore supply chain opportunities appropriate to their conditions. Green market opportunities are also emerging in energy efficiency, water, waste management, and climate-smart agriculture.

Finding the Gazelles. Gazelles are that minority of MSMEs with relatively high productivity, committed proprietors, and growing businesses. These are Africa’s future entrepreneurs. One challenge for governments seeking to support the Gazelles is actually identifying them. Most African programmes to support MSMEs are untargeted, providing credit and training programmes to Gazelles and non-Gazelles alike, but studies suggest this approach is ineffective. Rather, MSME support programmes need to be better targeted at Gazelles, including through better incentive design and more sophisticated use of administrative data from existing support programmes and surveys.

Growing green market opportunities for Gazelles include sales, installation, and servicing of smaller-scale clean energy technologies, such as household solar units and clean stoves, as well as in water supply, waste management and sanitation, especially in rural areas. Among numerous examples is Solar Sister, a Ugandan enterprise created in 2009 to give women economic opportunities in “last mile” distribution of clean energy products like household solar kits and clean stoves. The pilot has been replicated in Nigeria and Tanzania. Maji Safi is a start-up that helps increase access to safe drinking water in Kenya by installing groundwater wells with ceramic and slow sand filters. Safi Sana in Ghana builds public toilets in urban slums and collects waste to produce biogas and bio-fertiliser.

Reducing the pressure on Survival Entrepreneurs. Survival Entrepreneurs are the large numbers of people – often migrants from the countryside – who undertake a wide range of very low-productivity informal activities in the city merely to survive. Most would readily leave survival entrepreneurship for a wage or salaried job, were such jobs available. Given that these are occupations of last resort that most individuals are seeking to leave for better things, African governments should focus on broad policies to raise urban job growth and boost productivity and prospects in rural areas, so as to create better opportunities for survival entrepreneurs.

Even as the share of agriculture in employment and output shrinks in the long run, rising agricultural productivity and rural prosperity play an important role in economic transformation overall, including by stimulating the growth of the non-agricultural and urban sectors. In Africa, they can also make an important contribution to green growth. While agricultural productivity has picked up in the 2000s, its level remains extremely low and a large part of agricultural output growth still derives from increasing the area of land under cultivation. The latter was responsible for around 70% of deforestation in sub-Saharan Africa between 2000 and 2010. Agriculture, land use change, and deforestation are the biggest sources of greenhouse gas emissions in the region.

African countries should focus on improving agricultural productivity and adopting climate-smart agricultural approaches, both as a foundation for poverty reduction and wider structural change, and as a means of tempering agriculture's impact on the environment. Since the 1990s, farmers in the Maradi and Zinder regions of Niger have adopted "landscape approaches" involving the widespread interplanting of nitrogen-fixing trees on cropland, increasing tree and shrub cover by 10 to 20 times. This strategy has sharply boosted agricultural productivity and farmer income, restored large areas of severely degraded land, and increased biodiversity and soil fertility. These gains were mainly achieved by giving farmers more ownership rights over trees, which provided greater incentives for the adoption of the new methods.

POLICIES TO DEVELOP GREEN MARKETS, INDUSTRY, AND ENTREPRENEURSHIP

Developing green markets

In Africa, as elsewhere, the development of green markets will continue to benefit from global technological progress, which reduces the costs and increases the range of green processes and products. However, governments' environmental policies and incentives will be critical to offset the impact of market failures and existing policy distortions that hamper the emergence of green markets. Such policies include the following.

Strengthening market incentives to preserve natural capital across the whole economy. This includes the reform of fossil fuel subsidies and the creation of price incentives for more efficient water use. Fossil fuel subsidies in sub-Saharan Africa amount to around an estimated 5% of regional GDP. They encourage wasteful energy consumption, increase pollution, and divert public funding from more productive uses. While supporters of subsidies sometimes justify them as a way to help the poor, subsidies are often quite regressive and fail to efficiently provide social protection. Moreover, there are some useful lessons that can be drawn on from recent reform experiences in a number of countries. Pricing water resources through user tariffs and eliminating subsidies would also encourage more efficient water use, as well as spur investment in water infrastructure and supply, and would lead to quicker adoption of new water technologies in industry and agriculture. Well-designed tariff structures or direct assistance can ensure the effective protection of poor water consumers.

Expanding green infrastructure and increasing infrastructure efficiency. Most African countries need significant infrastructure investment in electricity generation, water, and waste management. Countries should take advantage of low-cost clean energy technologies to exploit their abundant clean energy resources. The international community has a strong incentive to invest in developing Africa's clean energy assets, since this will reduce greenhouse gas emissions associated with Africa's industrialisation, which will benefit not only Africa but the world as a whole, a global public good. This will often need to be accompanied by utility reform to raise currently low levels of efficiency in electricity generation and distribution and to attract new investment. More investment is needed in innovative water collection and storage capacity. Given that three-quarters of sub-Saharan Africa falls into 53 international river basin catchments, strong regional cooperation is a must.

Promoting agricultural modernisation and climate-smart agriculture. Implementation of the African Union's Comprehensive Africa Agriculture Development Programme (CAADP) should be accelerated to boost investment in rural public goods, strengthen institutional capacity, and improve the enabling environment for private investment in agriculture. Governments should expand flagship programmes so as to mainstream climate-smart agricultural approaches in national agricultural plans.

Adopting green urban policies. Urban growth in Africa has not, for the most part, been accompanied by economic transformation because of lack of adequate governance, planning, and critical public goods. Reforms should promote the development of compact, connected, and coordinated cities that encourage both transformation and green growth. African governments should formulate national urban development strategies, empower city governments and increase their fiscal capacity, and greatly expand urban infrastructure for public transit, water and sanitation, water management, and energy.

Greening industrial development

Structural transformation in Africa may follow a different path both from today's developed countries and East Asia's new industrialisers. Nevertheless, because "industries without smokestacks" share many characteristics with manufacturing, industrial policies similar to those that have succeeded in other places hold promise in Africa.

Mount an export push using a coordinated set of public investments, macroeconomic policies, and regulatory and institutional reforms to boost the share of industrial exports in GDP similar to export push strategies used in Asia since the 1970s. These policies must align with interventions noted above to improve efficiency of resource use and strengthen infrastructure. Governments can support green exports by helping to identify markets and supporting certification and standards.

Strengthen special economic zones (SEZs) to promote industrial agglomeration by concentrating investments in areas with reliable infrastructure, high-quality institutions, and social services. African SEZs have so far failed to attract foreign investment and need to be brought up to international standards. SEZs designed as green or eco-industrial parks can have significant environmental benefits by providing shared infrastructure, reducing transport and waste management costs, and facilitating recycling and waste recovery between firms. Ethiopia's Hawassa industrial park is the country's flagship eco-industrial park, powered mostly by hydro-electricity and using energy-saving innovations in factory lighting and shared infrastructure.

Attract foreign direct investment (FDI), a key source of knowledge and other capabilities for domestic firms. Most of Africa's FDI promotion agencies perform poorly. They lack sustained support from top government leaders, have insufficient coordination across government agencies, and are burdened by multiple objectives, diluting focus and capacity. Reform of FDI agencies is essential because foreign firms using green production methods or serving green markets are a potent source of green knowledge. Electrical power, renewable energy, and water infrastructure offer attractive opportunities, if backed by ambitious regulatory reforms. South Africa, Nigeria, Kenya, Uganda, and Ghana have unbundled power generation from transmission and distribution, opening the generation market to private power producers.

Policies for green entrepreneurship

Entrepreneurs – agents of change – are central to the success of green industrial development in Africa. Given broad economy-wide policies to create appropriate incentives for green markets, governments need to consider policies to help strengthen firms' capacity, performance, and entrepreneurship, taking into account the different characteristics of firm types – Elephants, Gazelles, and Survival Entrepreneurs.

African governments must prioritise policies to increase competition, so as to incentivise innovation and productivity growth at Elephant firms. Policies to strengthen MSMEs should target the Gazelles. Reducing the pressure for Survival Entrepreneurs will depend on broader policies to raise urban job growth and boost productivity and opportunities in agriculture and rural areas.

Overall, coherent action across government is needed in order to develop green markets and promote green industrial development and entrepreneurship. Strong links are needed between the finance, planning, and environment ministries, line ministries responsible for domestic industrial development, the SEZ development agency, and the FDI promotion agency. This level of coordination will require strong leadership by the head of state or government.

1. Introduction

This paper discusses the challenges facing Africa on three closely related issues: economic transformation, green growth, and fostering entrepreneurship.¹ African policymakers and pan-African institutions, such as the African Union, the African Development Bank, and the United Nations Economic Commission for Africa, have embraced industrialisation and economic transformation as keys to accelerate inclusive growth, which is a fundamental driver for poverty reduction and more rapid job growth, especially for youth. They also increasingly stress the need and the opportunities for economic transformation to deliver green growth – growth that protects Africa’s natural environment in ways that increase the welfare of present and future generations, as in the African Union’s *Agenda 2063: The Africa We Want* statement, and the *Greening Africa’s Industrialization* report from the United Nations Economic Commission for Africa (UNECA).²

Further, economic transformation and green growth both depend on doing new things, on making risky investments in new sectors, products, technologies, or business models. All this depends crucially on the activity of entrepreneurs, who drive change through their innovation and risk-taking.

This section introduces some key concepts and arguments developed in the rest of the paper to discuss the links between economic transformation, green growth, and the role of entrepreneurs as key agents of change.

Economic transformation boosts the productivity of the economy as a whole through two linked channels: by fostering opportunities for workers and entrepreneurs to shift from lower- to higher-productivity sectors – *structural change* – as well as through productivity growth *within* major sectors of the economy.³ While there is broad agreement on the need for economic transformation, many questions remain about the direction and pace of change and the policies needed.

Africa – both north and south of the Sahara – has experienced relatively little economic transformation relative to the historical pattern followed over the last 200 years by today’s developed countries.⁴ Around 60% of employment in sub-Saharan Africa is still in agriculture, a much larger share than in other regions, while the share of employment in manufacturing is only about 5%, the lowest in the world. In the middle-income countries of North Africa, the share of employment and output is high in agriculture and low in manufacturing relative to their levels of income.⁵

The potential for economic transformation in Africa is very large. First, there continue to be huge gaps in productivity across sectors.⁶ The fact that so many workers remain in low-productivity agriculture indicates considerable scope for growth through structural change. Second, productivity within sectors in both sub-Saharan and North Africa remains far lower than in advanced countries or most other developing regions, indicating potential for within-sector growth by absorbing more advanced ideas and technologies from abroad.

Africa’s weak performance in manufacturing is of concern, due to evidence that “what you make matters”, and that manufacturing has the ability to generate unusually rapid, sustained growth because of features such as large economies of scale, the potential for learning-by-doing, and the opportunity to integrate into global production networks, which facilitates technology transfer and absorption. Historically, manufacturing has also generated rapid growth in jobs for low-skilled and semi-skilled workers, youth, and women.⁷

Changing global conditions and the distinctive characteristics of African economies suggest there could be a range of possibilities for the future path of economic transformation in Africa. In most countries, it seems clear that manufacturing will need to become significantly more important if economic transformation is to yield sustained and rapid inclusive growth. Section 2 discusses how changing global conditions affect the prospects for African manufacturing and how domestic policies can help countries to achieve greater success in this sector. However, while most African countries will benefit from stronger manufacturing, they will also likely have distinctive features that differentiate them from the historical patterns in today’s developed countries, or in China and other recent East Asian industrialisers. Section 2 discusses some of the new opportunities that are emerging for African economies, such as the rise of “industries without smokestacks” – services and agro-industrial products that have become more tradable and share many features with manufacturing as a result of changes in information and communications technology and transport costs.

How these structural changes play out will have an important impact on the potential for green growth in Africa, as well as on the broader goals of social inclusion expressed in the international Sustainable Development Goals and the vision statements of Africa’s regional institutions, such as the African Union’s *Agenda 2063: The Africa We Want*.⁸

Economic transformation and environmental change are closely linked. Africa is already experiencing the ill effects of environmental degradation on many fronts, including the impacts of climate variability and change, rising urban air pollution, waste management problems in cities, deforestation, land degradation, damage to fragile ecosystems, and water scarcity. Economic transformation and growth should not endanger the natural environment in ways that reduce the welfare of future generations of Africans. That is, the kind of growth generated by economic transformation should be *green growth*.

Although there is no single or strict definition of green growth, the basic idea has been described as “fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies”.⁹

Several features of this approach are noteworthy. First, it emphasises the importance of natural assets for human welfare. Natural assets include: soil and sub-soil (including minerals, in which Africa is particularly abundant); water resources (the hydrosphere); life forms of various kinds (the biosphere); the atmosphere; and a vital extra-terrestrial resource – solar energy.

Second, these natural assets are valued because of the useful services they provide to humans, including flows of goods and services that are consumed or used as inputs in production. The natural environment also provides valuable services as a sink for various kinds of pollution and waste from human activity, such as greenhouse gas emissions. It is also a source of amenity values, such as natural beauty.

Third, the green growth approach stresses an ethical requirement to consider the welfare of future generations. It requires the current generation to preserve natural assets so that future generations can also draw from them the valuable services they provide.

One can also take into account the harmful impacts of a deteriorating natural environment on the economy, for example climate change. An expanded definition of green growth includes innovations and actions that strengthen the resilience and adaptive capacity of the economy.

In short, green growth is not primarily an idealistic call to look after the natural environment for its own sake. Rather, it is a call for careful, prudent management of valuable natural assets to ensure that the benefits of economic transformation and growth are spread equitably across many generations. This approach takes a realistic view of the potential trade-offs between current growth and the environment. It argues that such trade-offs can be softened with good policies, and that there are often significant win-win opportunities, as a result of market failures and policy distortions.¹⁰

Section 2 looks at the links between economic transformation and green growth, using energy and water use as examples. Economic transformation and growth tend to increase demands on natural capital, although the extent of this impact depends on the structure of the economy, income levels and consumer preferences, technological progress, and, crucially, economic and environmental policies.

Energy and water use in most sub-Saharan African countries are still very small compared with other regions. These demands are likely to rise substantially over coming decades as a result of the linked processes of structural change, rising incomes, poverty reduction, urbanisation, and demographics. Just how substantial the increase in demand will be, however, depends on how these processes play out, which will depend, in turn, on policies. Other things being equal, an African economic transformation heavily dominated by industry and manufacturing, similar to the path followed by China and some other East Asian economies, would be more energy and pollution intensive than a structural change with a more balanced emphasis on high value added, internationally traded services, and other sectors, in addition to more manufacturing.

Improvements in the efficiency with which natural resources are used in the economy are a powerful long-term force in favour of green growth. Efficiency in natural asset use improves over time as a result of global technological progress. Because poorer countries' efficiency levels are well below global levels, they have the potential to “leapfrog”, rapidly moving towards the global frontier. But resource use efficiency also depends heavily on policies. Consumption of natural assets is often inefficiently high due to policy distortions, such as fossil fuel subsidies, or to the lack of policies to offset market failures such as environmental externalities. Examples include excessive air pollution and greenhouse gas emissions, over-depletion of water resources, damaging forms of waste disposal, soil degradation, deforestation, and biodiversity loss.

Section 2 discusses the scope for African governments to implement policies that can help with both economic transformation and green growth.

Economic transformation and green growth depend crucially on doing new things: making risky investments in new, unfamiliar sectors or products or adopting new, unfamiliar methods, processes, technologies, or inputs. This focus on the new highlights the role of the entrepreneur as the key agent of change in economic transformation and green growth.

In Schumpeter's classic definition, "the entrepreneur is the innovator who implements change within markets through the carrying out of new combinations". These combinations can take several forms, such as the introduction of new goods or quality improvements, the introduction of a new method of production, the opening of a new market, the conquest of a new source of supply of new materials or parts, or the new organisation of an industry.¹¹

We can define *green entrepreneurship* as efforts by entrepreneurs to develop and exploit markets for new processes, technologies, and products that make the economy more efficient in its use of the natural environment. Green markets can be for new intermediate processes or inputs in production, or for new consumer goods and services. Take energy efficiency. Here there are new markets to supply businesses with processes, technologies, services, or intermediate inputs that increase the energy efficiency of their production process. There are also new markets for energy-efficient consumer goods and services, such as more energy-efficient lighting and other household appliances, better household insulation, and so on. We can also expand the definition of green entrepreneurship to include the adoption of technologies and products that help households and businesses better adapt to environmental change, in particular climate change.

Section 3 provides a brief overview of the emergence of green markets worldwide, including markets for renewable energy technologies, energy efficiency, water infrastructure and technologies, urban waste management, and climate-smart agriculture. The discussion notes the important dependence of green markets on the existence of appropriate policy frameworks and incentives.

Section 3 links the potential for African entrepreneurship – and green entrepreneurship in particular – to a characteristic three-part typology of firms in most African countries: "Elephants", "Gazelles" and "Survival Entrepreneurs". The discussion reviews the capacity for entrepreneurial activity of these various types of firms, including conditions affecting women entrepreneurs.

While the focus of the discussion is on firms and entrepreneurship in urban industrial and services sectors, there is nothing in the definition of entrepreneurship that precludes its application to agriculture. African farmers who introduce risky new crops, seed types, and tillage or irrigation methods are entrepreneurs in the sense used here. Section 3 discusses the importance of the agricultural sector for economic transformation and green growth, including the introduction of climate-smart agricultural production methods and policies.

Because of low technical capacity, the entrepreneurs who introduce green processes and products in African economies may initially be importers and distributors working with foreign suppliers. With growing domestic capacity and skills, African entrepreneurs also have opportunities to enter domestic green markets and to indigenise aspects of green processes, services, and inputs – as some are already doing for climate-smart agricultural equipment, or in the delivery and installation of rooftop or off-grid solar energy systems, for example. Section 3 discusses the policies needed to spur entrepreneurship and highlights some recent experiences with green entrepreneurship in African countries.

Section 4 summarises the key policies needed to accelerate economic transformation, support green industrial growth, and foster greener African entrepreneurship.

2. Structural transformation, industrialisation, and prospects for green growth

This section discusses the relationship between industrialisation, structural transformation, and the prospects for green growth in Africa.

Section 2.1 reviews Africa's current pattern of structural transformation, the role of industry, and the extent to which Africa falls short of other developing economies in industrial development. Section 2.2 looks at some aspects of the relationship between structural transformation and the environment, focusing on energy and water use. Section 2.3 considers the importance of industrial development for sustaining growth and creating jobs, identifying changes in trade and technology that may create a window of opportunity for more rapid industrialisation. It suggests how African countries can seize the day by learning to compete in global industry. Section 2.4 offers some ideas on greening Africa's industrial development. It presents two lines of argument. The first is that, because of differences in resource endowments and changing global opportunities, Africa's industrialisation path may look different from the East Asian mass-manufacturing model, implying a different set of environmental outcomes. The second is that opportunities exist to make industrial development strategies more responsive to environmental concerns.

2.1 STRUCTURAL TRANSFORMATION AND INDUSTRY

One of the enduring stylised facts of economic development is that *structural change* – the movement of labour from low-productivity sectors into higher-productivity employment – is a key driver of growth, especially in lower-income countries. Despite two decades of annual per capita economic growth of 2–3%, Africa has experienced relatively little structural change. Indeed, in sub-Saharan Africa the share of workers employed in high-productivity sectors actually declined between 1990 and 1999, although productivity increased within sectors.¹² Structural change in the 1990s was “growth reducing”.

After 2000, labour began to move out of agriculture into more productive employment, but 8 out of 10 workers in sub-Saharan Africa who left agriculture ended up employed in services, mainly in trade, restaurants, and personal services.¹³ Workers thus moved from very low-productivity employment to slightly higher-productivity jobs. Output per worker in services in Africa is only about two times higher than output per worker in agriculture, compared with much higher differentials in other sectors.

Similarly, although some structural change has been under way in North Africa for at least four decades, it has not been sufficient to sustain rapid economic growth and employment creation. In Egypt and Tunisia, the services sector has absorbed much of the increase in the labour force since around 2000. In both countries, a large proportion of service sector jobs are informal and characterised by low productivity and low wages.¹⁴ Only Tunisia has exhibited sustained “growth-enhancing” structural change.

Industry has been a key driver of structural transformation in other regions; it has played only a minor role in Africa, both north and south of the Sahara. In sub-Saharan Africa, the share of manufacturing in GDP is about what it was in the 1970s. It is less than half of the average for all developing countries and, in contrast with developing countries as a whole, declining. Per capita exports of manufactured goods from sub-Saharan Africa are only about 10% of the developing country average, and the share of manufactured exports in total exports is strikingly low.¹⁵ These measures have changed little since the 1990s. Even the region's recent growth success stories – Ethiopia, Ghana, Kenya, Tanzania, and Uganda – have shares of manufacturing in GDP that are well below the historical trends for their level of per capita income.¹⁶

North of the Sahara, Tunisia has had the greatest success with industrialisation. Its level of manufactured exports per capita compares favourably with East Asia. In contrast, Egypt and Morocco lag behind international competitors. In Egypt, manufactured exports were less than US\$100 per capita in 2010. In Morocco, per capita exports are only about 60% of the average for all developing countries. Egypt, Morocco, and Tunisia mainly export very simple manufactured products. The share of medium- and high-technology exports in total manufactured exports – an important indicator of learning by exporting – is very low in comparison with other developing regions (20% of the developing country average for Egypt, 41% for Tunisia, and 48% for Morocco).¹⁷

Virtually every sub-Saharan African country has published a national vision calling for achieving middle-income status within the next 10–15 years. Comparing the region's low- and lower-middle-income countries' economic structures with that of a benchmark lower-middle-income country suggests the extent of structural change that may be needed during the transition.¹⁸

The World Bank classifies a country as lower-middle-income if its per capita gross national income (GNI) is \$1,045–4,125 in 2012 purchasing power parity (PPP) international dollars.¹⁹ The lower bound of this range would seem to be a reasonable target for Africa’s low- and lower-middle-income countries.

We constructed a lower-middle-income benchmark economy by identifying a group of middle-income countries that crossed the \$1,045 threshold (in 2012 PPP international dollars).²⁰ It includes South Korea and Malaysia (both 1968), the Philippines (1976), Thailand (1987), China (2000), Indonesia (2004), and India (2007). The economic structure of the benchmark is the average of the shares of value added and employment in four sectors – agriculture, manufacturing, other industry, and services – for these seven countries in the relevant year.

North Africa consists of lower-middle-income countries that are striving to achieve upper-middle-income status. There are also a handful of middle-income countries in sub-Saharan Africa, including Mauritius and South Africa, arguably sub-Saharan Africa’s two most successful industrialisers. For that reason, we constructed a second benchmark for countries outside Africa that have made the transition to upper-middle-income status. The World Bank’s upper-middle-income threshold is per capita GNI of \$4,125 (in 2012 PPP international dollars). The following upper-middle-income benchmark countries passed this threshold: Malaysia (1992), Chile (1995), Turkey (2004), Brazil (2005), China, and Thailand (both 2010).

The differences between low- and lower-middle-income African economies and the benchmarks are substantial (Table 1). The largest difference is in the role of manufacturing: the share of manufacturing in value added and employment in the sample of African countries (mainly those south of the Sahara) is about half the benchmark values. More than 60% of the labour force in the African countries is still engaged in agriculture, compared with 45% for the benchmark.

Table 1
Economic structure of Africa and benchmark countries, 2010

Sector	Low- and lower-middle-income		Upper-middle-income	
	Benchmark countries ^a	African countries ^b	Benchmark countries ^c	African countries ^d
Percentage of value added				
Agriculture	21.7	27.8	8.7	9.6
Manufacturing	21.9	11.1	28.1	16.4
Other industry	12.2	11.8	13.9	13.8
Services	44.2	49.3	49.3	60.2
Percentage of labour force				
Agriculture	45.2	63.1	18.2	22.6
Manufacturing	11.6	6.6	22.2	15.2
Other industry	6.6	5.1	14.9	10.8
Services	36.6	25.2	44.7	51.5

Notes:

- a. China, India, Indonesia, Malaysia, the Philippines, South Korea, and Thailand.
- b. Ethiopia, Ghana, Kenya, Madagascar, Malawi, Mozambique, Senegal, and Tanzania.
- c. Brazil, Chile, China, Malaysia, Thailand, and Turkey.
- d. Egypt, Mauritius, Morocco, South Africa, and Tunisia.

Source: McMillan and Rodrik (2011) database; World Bank (various years) World Development Indicators database; de Vries, Timmer, and de Vries (2013) database; African Development Bank country data. Author calculations.

Africa's middle-income countries differ from the upper-middle-income benchmarks. The largest difference is in the role of manufacturing. The average African middle-income country trails the benchmark by about 12 percentage points for GDP and 7 percentage points for total employment. At the individual country level (not shown in the table), Mauritius and South Africa fall short of the upper-middle-income benchmark in terms of the share of manufacturing value added and labour force in GDP. Egypt, Morocco, and Tunisia also face a “manufacturing deficit”.

2.2 STRUCTURAL TRANSFORMATION AND THE ENVIRONMENT

A more rapid pace of economic transformation will affect many aspects of Africa's natural environment. The extent and character of these impacts will depend on factors such as the direction of structural change, income levels, consumer preferences, the level and pace of technological progress and innovation, and, crucially, policies and institutions. This section discusses the potential for greener growth in Africa in two important fields: energy use and water.

Structural transformation and Africa's energy transition

The greenness of Africa's future growth will depend to a significant extent on how growth affects the continent's energy use and how energy use patterns in turn affect pollution, including greenhouse gas emissions. A number of factors help explain both the broad common patterns in energy use and the wide variations across countries. One of the most important is structural change.²¹ We focus first on how energy use and energy intensity change as per capita incomes rise. We then look at the link between incomes and changes in the mix of fuels used to supply energy.

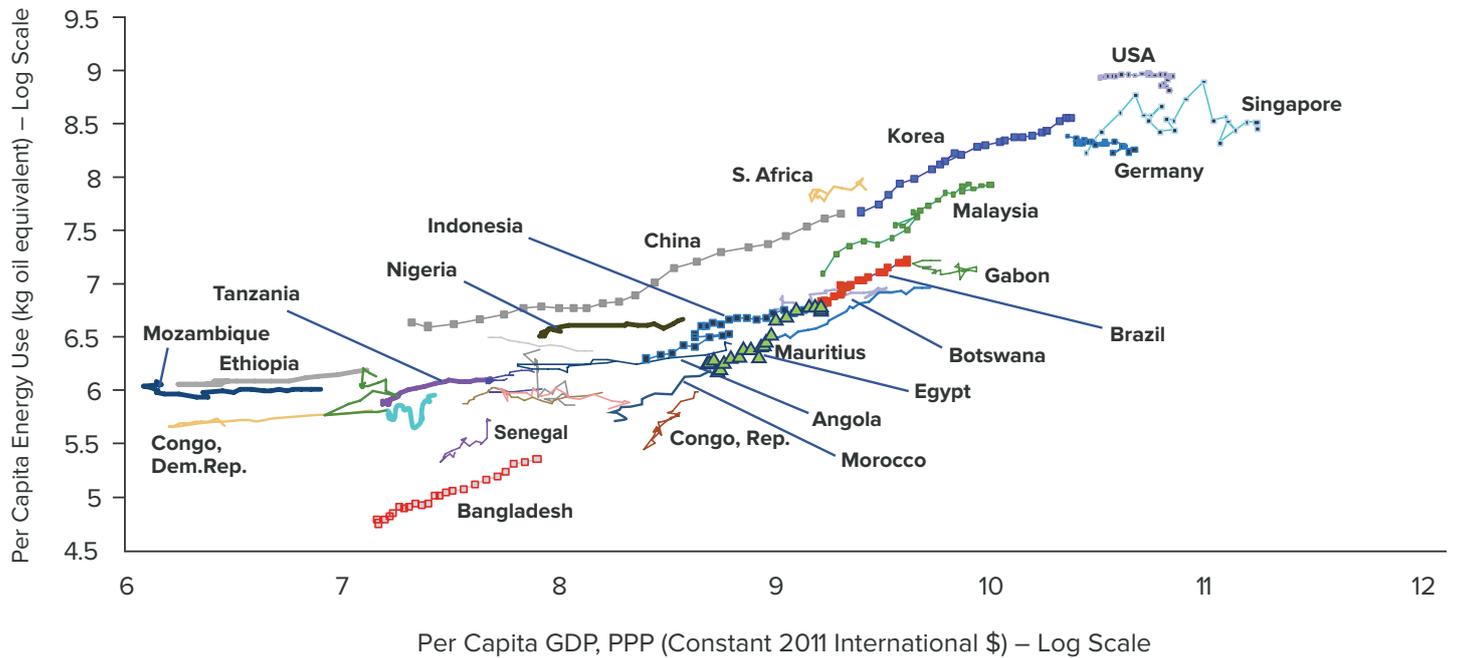
Historically, countries have experienced a roughly similar pattern of structural change and energy use, albeit with wide variations in the pace and emphasis of the transition – a so-called “energy ladder” or pattern in the relationship between per capita income on the one hand and per capita energy use and energy intensity on the other.²²

Per capita energy use is low in low-income countries, where most of the population works in subsistence agriculture and lives in rural areas (Figure 1). The bulk of energy use is residential use, supplied almost entirely from firewood, agricultural waste, and other forms of traditional biofuel.

Although per capita energy use in low-income countries is low, energy intensity (the amount of energy consumed per unit of real GDP) tends to be higher than in middle- and high-income countries (Figure 2). The reason is that per capita GDP in these countries tends to be even lower relative to the rest of the world than their per capita energy use levels. Just as these countries have low labour productivity, they also have low energy productivity – a low capacity to convert energy into output.

Figure 1

Per capita energy use and GDP in selected African and comparator countries, 1990–2012



Source: Data from World Bank (various years) World Development Indicators.

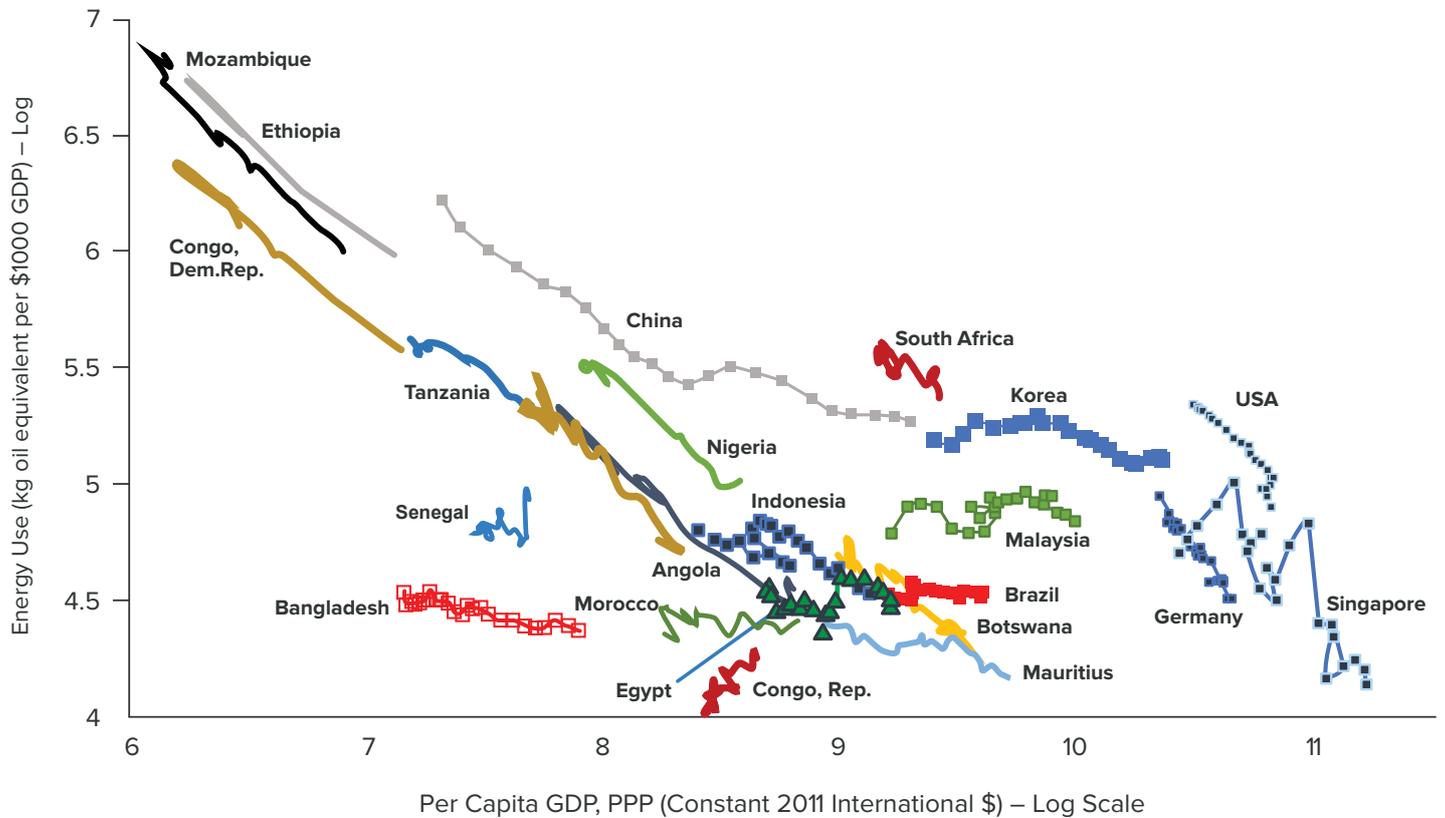
The pace at which energy use responds to changes in income – the *income elasticity of energy use* – varies with the level of development.²³ It tends to be low (less than 1) in low-income countries, so that per capita energy use tends to rise relatively slowly with income. Energy intensity tends to fall rapidly with increases in income in these economies, as shown in Figure 2.

As countries move into and through the middle-income level, the income elasticity of demand for energy rises, approaching or exceeding 1. The level of per capita energy use rises, and it does so more quickly in response to rising incomes. The energy intensity of GDP falls more slowly or even rises. This phase of development is associated with the largest increases in energy use. Finally, at high-income levels the income elasticity of energy use falls towards zero. Per capita energy use in countries like Germany, Singapore, and the United States is flat relative to income, and energy intensity falls at a rapid rate.

Energy use varies widely across countries at the same per capita income level. For example, when Mauritius attained per capita GDP of around \$8,500 (in 2011 PPP international dollars) in 1993, its per capita energy use was only two-fifths that of China when it reached the same income level in 2009. Thus, while energy use generally rises with income, at least until countries reach a high-income level, within that broad pattern there are also significant differences in the “greenness” of their development paths.

Figure 2

Per capita energy intensity and GDP in selected African and comparator countries, 1990–2012



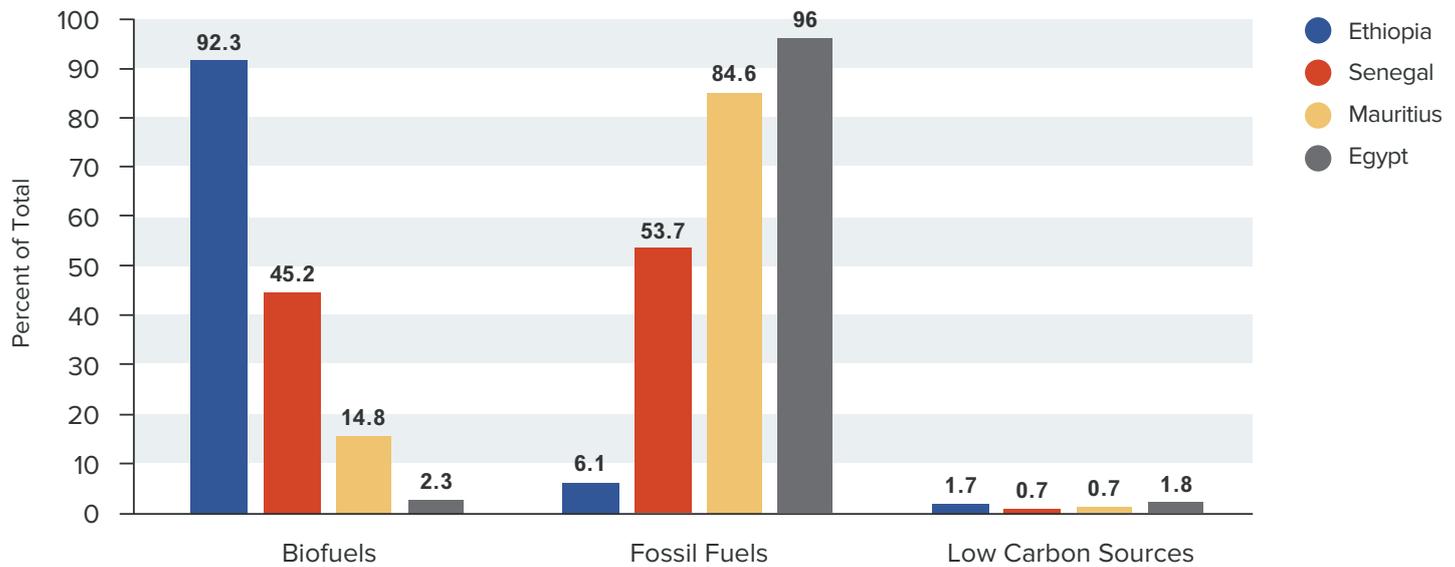
Source: Data from World Bank (various years) World Development Indicators.

A second major pattern of structural change in energy use occurs in the mix of fuels used. Because different fuels emit different levels of pollution, the mix has significant environmental implications. Among fossil fuels, for example, coal emits the most carbon dioxide (CO₂) per unit of energy, followed by oil and then natural gas. Low-income countries typically have a heavy reliance on traditional biomass for energy (firewood, agricultural wastes, etc.), but this falls sharply as per capita incomes rise, offset by a rise in modern energy sources, such as fossil fuels, which provide much greater energy density, constancy of flow, flexibility, transportability, and ease of control.²⁴

Figure 3 illustrates this for four African countries at various stages of development: Ethiopia (a low-income country), Senegal and Egypt (lower-middle-income countries), and Mauritius (an upper-middle-income country). Over 90% of Ethiopia’s primary energy supply was still from traditional biofuels in 2014, related mainly to use as fuel for residential use by rural households. In upper-middle-income Mauritius, on the other hand, biofuel use had fallen to 15% of the country’s total, with 85% coming from fossil fuels. Interestingly, Egypt, a lower-middle-income country, has an even higher reliance on fossil fuels.

Figure 3

Sources of primary energy supply in four African countries, 2014



Source: IEA (2016b) *World Energy Balances*.

A large share of the energy consumed in sub-Saharan Africa comes from burning wood, agricultural waste, and other traditional biomass in rural areas (as well as charcoal in urban areas). In low-income African countries, such as the Democratic Republic of the Congo and Ethiopia, the share of traditional biomass in total primary energy supply exceeds 90%; in lower-middle-income countries, such as Cameroon, Congo, Côte d'Ivoire, and Kenya, it is 60–75%. For comparison, biomass provides 14% of primary energy consumption across all non-OECD (Organisation for Economic Co-operation and Development) countries and 10% worldwide.²⁵

The predominance of biomass in sub-Saharan Africa's energy sources is an important factor in explaining the region's very low CO₂ emissions from energy use – a mere 2.1% of global emissions in 2014.²⁶ Burning biomass releases only the CO₂ accumulated by plants during their life cycle. Protocols and guidelines by the Intergovernmental Panel on Climate Change and other standard-setting bodies therefore treat biomass use for energy as neutral with respect to CO₂ emissions to the extent that it does not exceed the rate at which forests can regrow.

In the past, the shift to modern energy has meant a rapidly rising reliance on electricity and fossil fuels, resulting in higher CO₂ and other harmful emissions. Both the OECD countries and developing countries as a group derive around 80% of their primary energy from fossil fuels, compared with a median 28% in sub-Saharan Africa.²⁷ However, as Figure 3 indicates, the fossil fuel share is also rising in Africa, as countries move from low- to lower-middle- to upper-middle-income status.

The historical shift to fossil fuels has been far from uniform. Emissions of carbon and other types of pollution per unit of energy vary widely across countries at similar levels of per capita income because of differences in their fuel mix. Carbon intensities per unit of energy consumed are high in China and India, for example, because of the exceptionally high proportion of coal in those countries' energy mixes. To the extent that the transition to modern energy can be supplied through modern low-carbon options – hydropower, geothermal, nuclear, solar, wind – the rise in CO₂ intensity can be moderated. Brazil, an upper-middle-income country, has a lower CO₂-intensity of energy than other countries at its level of development because of plentiful hydropower. Appropriate investments in alternative energy sources, including Africa's abundant solar and hydro endowments, can reduce the carbon intensity of its structural transformation.

Structural transformation and water use in Africa

Water is fundamental for all types of life – human, animal, plant – as well as a key input for the economy. One of the critical economic-environmental questions facing African countries in coming decades will be how to meet rapidly increasing demand for water from the continent’s relatively limited naturally renewable freshwater resources.

In 2015, worldwide, an estimated 663 million people still lacked access to an improved water source. Some 324 million were in sub-Saharan Africa, almost a third of the region’s population. Globally, at least 1.8 billion people – and possibly many more – lacked reliable access to safe drinking water. Some 2.4 billion people lacked access to improved sanitation facilities, 703 million in sub-Saharan Africa, approximately 70% of the region’s population.²⁸

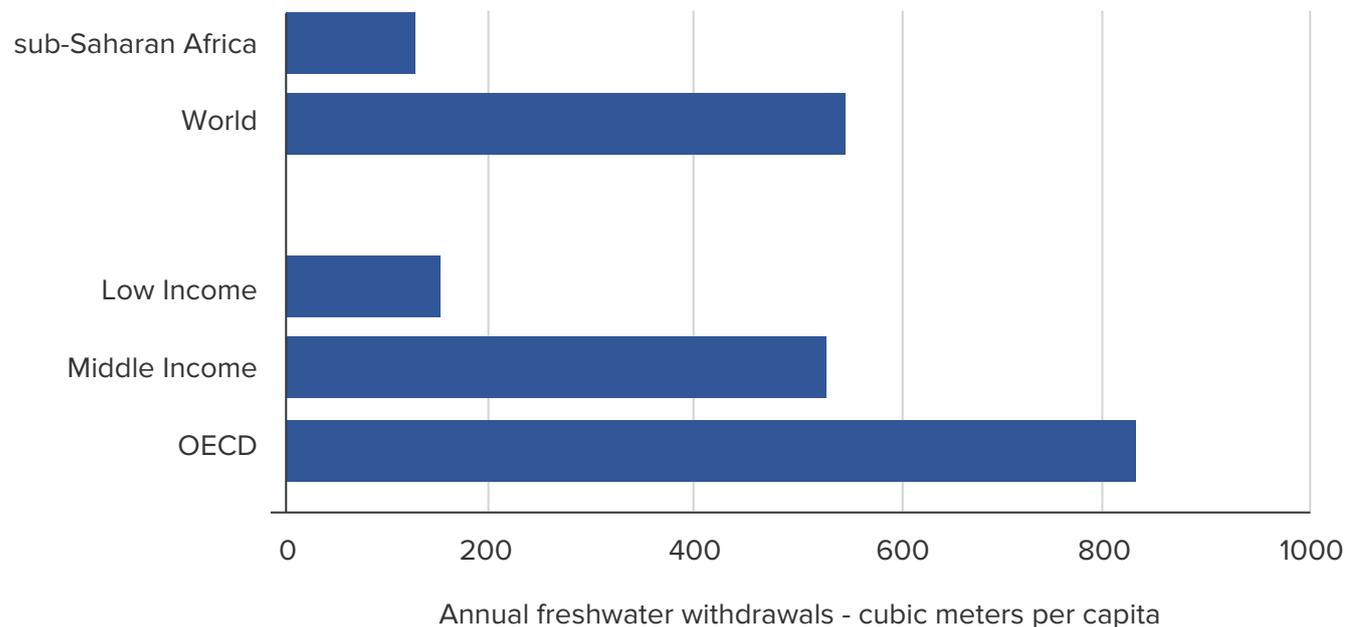
Inadequate provision of water and sanitation services is a significant source of illness and premature death. Diarrheal diseases, for example, are estimated to have caused 1.5 million premature deaths worldwide in 2012, 842,000 of which were attributed to unsafe water supply, sanitation, and hygiene. Almost half of the deaths attributed to lack of adequate facilities were in sub-Saharan Africa.²⁹

Household use of water for drinking, sanitation, and hygiene accounts for only around 10% of global water use. Agriculture is the largest economic user, accounting for 70% of global water use. This proportion increases to around 90% in low-income countries, where agriculture is the largest economic sector. Water use in the energy sector accounts for another 15% of global water use. The largest use is in power generation, in particular for cooling thermal power plants, both fossil fuel and nuclear. Seepage and evaporation from hydro reservoirs is also a major source of water use. Water use by other renewable power sources varies considerably, depending on the technology. Water use by non-thermal renewable sources such as wind and solar photovoltaic is negligible. Geothermal and concentrating solar power (CSP) can, however, have significantly higher water requirements, depending on the type of technology used. Other industrial sectors, finally, account for the remaining 5% of global water use.³⁰

Global water demand is expected to increase substantially in the period to 2050. The *OECD Environmental Outlook to 2050* forecasts global water demand to rise by 55% between 2000 and 2050, or about 1% a year. All of this growth is expected to occur in developing countries, with especially strong increases in water demand from manufacturing, power generation, and household use. Continued population growth in developing countries, rising per capita incomes and structural transformation towards fast-growing, water-intensive sectors such as power generation are among the factors underlying projected water demand growth. The OECD is concerned that, without major policy changes and improvements in water management institutions and techniques, rising water demand will create increasing competition for and uncertainty about water access. Some 3.9 billion people, or 40% of the world population in 2050, could be living under conditions of severe water stress by 2050.³¹

Africa is expected to be among the developing regions that will experience a major increase in water demand over the coming decades. In the absence of significant improvements in water management and efficiency, it could experience increases in already high levels of water stress, posing a significant constraint on future growth. Sub-Saharan Africa’s annual freshwater withdrawals per capita are extremely low (just 128 cubic metres per capita in 2014).³² These levels are expected to rise dramatically as income rises. Indeed, the sharpest increase in per capita water use – a more than tripling – occurs as countries move from low-income to middle-income levels (Figure 4). There is a further increase as countries move from middle-income to high-income levels. Once countries reach high-income levels, growth in water demand slows considerably.

Figure 4

Annual per capita withdrawals of fresh water, by region and income level, 2014

Source: Data from World Bank (various years) World Development Indicators.

This broad global pattern suggests that water demand in sub-Saharan Africa will rise rapidly if the region achieves middle-income levels. Demand in water-intensive sectors, such as thermal power generation and manufacturing, will rise rapidly with structural transformation. Household demand will also rise rapidly, as standards of sanitation and hygiene improve.

The region's rapid population growth will also increase demand for water. Sub-Saharan Africa's population is expected to rise from just under 1 billion in 2015 to 2.1 billion in 2050 and 3.9 billion in 2100 (under the United Nations' medium-variant scenario). Its share of the world population would rise from 13% in 2015 to 35% in 2100. Although the share of food in family budgets will decline with rising per capita incomes, total demand for food and other agricultural products will continue to rise because of rapid population growth, boosting water demand.

Africa's rising water demand must be set against its freshwater resources, which are renewed through the natural water cycle of evaporation, precipitation, and runoff. The continent's renewable internal freshwater resources in 2014 are estimated at 3,931 billion cubic metres, about 9% of the world total, compared with its 23% share of the world's land area, making it the second-driest continent (after Australia).

The region's freshwater resources are unequally distributed. Central and West Africa command 51% and 23%, respectively, of the continent's freshwater resources; much less is available in the northern, Sahelian, eastern, and southern parts of the region. In per capita terms, annual renewable internal freshwater resources range from a mere 20 cubic metres in Egypt to 97,175 cubic metres in Gabon.³³

There are several approaches to estimating water scarcity or stress, each providing insights into Africa's water supply. One approach focuses on physical water availability, by establishing benchmarks for internal renewable freshwater resources per capita. A country is considered to be suffering from *water stress* when its annual per capita renewable internal freshwater resources fall below 1,700 cubic metres. Annual per capita freshwater resource availability of less than 1,000 cubic metres is defined as *chronic water scarcity*, while *absolute water scarcity* is defined as less than 500 cubic metres per capita per year. Some 841 million people in Africa, or 77% of the continent's population, live in countries that are water stressed or water scarce.³⁴

A broader approach argues that water scarcity depends not only on physical limits to water availability, but also on economic and institutional factors that prevent efficient use of the water (e.g., lack of water infrastructure or management capacity). This form of economic or institutional water scarcity also appears to be widespread in Africa. Over 700 million people, or two-thirds of Africa's population, live in countries where annual freshwater withdrawals are less than 10% of the available renewable freshwater resources. An extreme example is Gabon, where annual per capita water withdrawals are only 82 cubic metres, a mere 0.08% of internal renewable freshwater resources of 97,175 cubic metres. For many African countries, a key challenge in meeting rapidly rising demand for water will be to strengthen water infrastructure and put in place policies and institutions to better manage available water.³⁵

Climate change will add to the challenges that African countries face in meeting rising water demand. In its Fifth Assessment Report, the Intergovernmental Panel on Climate Change argues that climate change over the course of the 21st century will cause significant changes in the spatial and temporal patterns of precipitation and water availability and a deterioration in water quality, resulting in an increase in the fraction of the world population that experiences water scarcity and major river floods. While there is much uncertainty as to the geography of these changes, there is robust evidence and a high level of agreement that climate change will cause a significant reduction in renewable surface water and groundwater resources in most dry tropical regions and likely increase the frequency of drought in these areas. The regions identified as vulnerable to increasing water stress include sub-Saharan Africa and North Africa, as well as China and parts of South America and Australia. Growing water stress will have especially severe impacts on agriculture, the largest source of employment in sub-Saharan Africa. It will constrain or complicate growth in other water-intensive sectors, such as thermal power generation and hydro-power.³⁶ Climate change adds to the urgency to adopt sound policies for management of water supply and demand.

2.3 THE CHALLENGE OF INDUSTRIALISATION

Industry remains central to Africa's future prospects because it has a special role to play in sustaining growth and creating jobs. The region's growth turnaround from the late 1990s was largely due to improvements in basic economic policies, rising commodity prices, and significant natural resource discoveries.³⁷ It was accompanied by relatively little structural change and even less industrial development. Sustaining growth into the future will require new activities that offer the possibility of rapid productivity growth and employ large numbers of moderately skilled workers. Manufacturing is one such sector.

Since 1960, output per worker in manufacturing in developing countries has tended to converge towards advanced economy levels, regardless of country-specific or regional factors. This "unconditional convergence" is not characteristic of agriculture or services.³⁸ Unconditional convergence in manufacturing opens up two channels for economy-wide growth. The first is productivity change in the manufacturing sector itself. Its contribution to overall productivity change depends on the size of the manufacturing sector, the rate of convergence, and the economy's distance from best practice. The second is structural change into manufacturing. Because the manufacturing sector has the potential to converge unconditionally to high levels of productivity, a shift in employment out of agriculture into manufacturing – the pattern of structural change seen in East Asia – can be strongly growth enhancing.³⁹ In both cases, economy-wide growth depends on the size of the modern manufacturing sector and its rate of growth; in short, on the pace of industrialisation.

More than 450 million new workers will enter Africa's labour market by 2035. Twenty years of economic growth have not resulted in robust growth in jobs offering higher wages and better working conditions.⁴⁰ In fact, there is no statistical relationship in sub-Saharan Africa between economy-wide growth and the rate of growth of formal employment.⁴¹ In North Africa, slow economic growth, low employment elasticities of growth, and rapidly growing cohorts of young people have produced the worst problem of youth unemployment in the world, with an average unemployment rate among people aged 15–24 of about 30%, more than twice the world average of 14%.⁴²

Africa's structural pattern of growth during the last two decades is at least partly responsible for the lack of job growth. The sources of growth in the region's most rapidly growing economies have not been employment intensive. Lack of employment-intensive growth, together with the absence of progress in transforming traditional agriculture, are largely at the root of sub-Saharan Africa's slow pace of poverty reduction. Indeed, the data, while partial, suggest that during the past 20 years there has been a shift in the composition of employment in North Africa towards lower-productivity jobs.⁴³

The employment prospects of women in North Africa are among the worst in the world. Only 2 out of every 10 working-age women have jobs; among working-age men, 7 out of 10 are employed. Low labour force participation among women explains some of the difference, but many women who want jobs are unable to find them. Women also face much longer waiting periods for employment than men do.⁴⁴

Global evidence and evidence from Africa suggest that a more dynamic pace of economic transformation would generate large dividends in terms of youth and female employment and empowerment. Manufacturing growth has long been associated with increases in female labour force participation. Employment in industry adds to household incomes and may also increase women's independence, particularly when complemented by social policies to boost investment in education and health and promote gender equity. Bangladesh provides an important example of the positive impact of export-led manufacturing on women's empowerment.⁴⁵

Manufacturing improves the welfare of women workers in other ways as well. Evidence from South Asia suggests that by increasing the returns to education and raising the opportunity cost of marriage, access to factory jobs increases the chances that girls stay in school and postpone marriage.⁴⁶

A similar transformation in the working lives of women has taken place in Lesotho. From the early 1980s to 2010, Lesotho's manufacturing sector expanded from about 6% to 18% of GDP, driven mainly by strong growth of apparel exports. These exports created a large number of new jobs for relatively unskilled women, more than 60% of whom come from rural areas. Women working in apparel factories have access to innovative workplace health programmes that provide free HIV care and treatment – a critical benefit in a country where as many as 40% of workers are HIV positive.⁴⁷

A window of opportunity?

The global economy has experienced major changes over the last quarter of a century. Growth of manufactured exports greatly exceeded growth of manufacturing output, and developing countries captured an increasing share of the world market in both simple and complex manufactures. As manufacturing production has shifted to developing countries, Asia has become the world's factory.

The emergence of East Asia has shown that it is possible for new entrants to succeed in global markets. Its success also shows what is needed. East Asia broke into global manufacturing on a massive scale only around 1980, when the gap in per capita incomes and wages between China and the OECD economies had become large enough to offset the productivity advantage of the OECD's incumbent industrial producers. Today, new entrants in global markets must compete with incumbent producers that enjoy both low wages (at least relative to the high-income countries) and high productivity.

Given its late start, can Africa reasonably aspire to break into the global market for industrial goods? While the challenges are formidable, we believe Africa may be able to begin to compete with Asia in some products and markets, for four main reasons:

1. *Costs in China are rising.* China is growing so rapidly that it is encountering rising costs in manufacturing production. Real wage growth in China has accelerated significantly since 2005. Average real hourly manufacturing wages in China tripled between 2005 and 2016, to US\$3.60. They now substantially exceed hourly wages in Brazil and Mexico and are closing in on wages in European countries like Greece and Portugal.⁴⁸ Stiffer enforcement of labour and environmental regulations, gradual expansion of safety net provisions, and the prospect of further increases in the value of the renminbi are likely to erode the low-wage advantage further.⁴⁹ Geography will play a role as well. China has only a limited number of coastal cities. As they expand, they are likely to encounter diseconomies of congestion. Chinese manufacturers may shift production into the interior, but doing so will increase coordination and transport costs.
2. *Domestic demand in Asia is growing.* Since the global financial crisis of 2008, Asia's established industrial economies have introduced domestic policies intended to reduce their dependence on exports. In China, targeted stimulus measures, including higher infrastructure investment, have helped to strengthen domestic demand. In the region more broadly, domestic demand has benefited from strong credit growth.⁵⁰ Continued growth of domestic demand is likely to cause some reorientation of manufacturing activity towards the local market, creating space for potential competitors in third-country markets.

3. *Some Asian industrialisers are moving up the technological ladder.* A number of successful Asian industrialisers, including China, Malaysia, and Thailand, are making efforts to move up the ladder in terms of the sophistication and technological complexity of their manufacturing.⁵¹ The share of medium- and high-technology exports in total exports exceeds 70% in Malaysia and Thailand. Between 2000 and 2010, this share rose from 45% to 59% in China and from about 25% to nearly 34% in Vietnam.⁵² The change partly reflects a market response to rising real wages in these countries. It also reflects the desire to replicate the successful experiences of Japan, Korea, Singapore, and Taiwan in upgrading industry to sustain growth. As countries move up technologically, less sophisticated competitors should be able to enter new sectors and product groups.
4. *Chinese policy may help African manufacturing.* There is some evidence that economic policymakers in China have made a decision to “offshore” a portion of low-end manufacturing to Africa. By the end of 2009, China’s outward foreign direct investment (FDI) in Africa had reached US\$9.33 billion. A large share (22%) – second only to mining – went to manufacturing.⁵³ Between 2009 and 2012, China invested an estimated US\$1.33 billion in Africa. China currently offers tariff-free entry to more than 400 products from Africa’s low-income countries. It is also backing the construction of six overseas special economic zones (SEZs) in Africa.⁵⁴

Changes in technology also offer Africa an opportunity that was not available to earlier generations of newly industrialising countries. When the economic statistics used today were first drawn up in the 1950s, there was little confusion over what industry meant. At the broadest level, it encompassed mining, manufacturing, utilities, and construction. Of these, manufacturing – “smokestack industry” – was the subject of central interest.

However, changes in transport costs and information and communications technology have shifted the boundaries of industry. Many services and agro-industrial products have become tradable and have many features in common with manufacturing.⁵⁵ Like manufacturing, they benefit from technological change and productivity growth. Some exhibit tendencies for scale and agglomeration economies.⁵⁶ These are “industries without smokestacks”, and they are an increasingly important part of global industry. For that reason, it is essential to take a broad view of what constitutes industry today. It is manufacturing and those tradable services and agro-industrial value chains that share the same firm-level characteristics.

The good news is that Africa has many location-specific sources of comparative advantage in industries without smokestacks: major languages, a southern hemisphere climate, and exotic wildlife, among them. South of the Sahara, Ethiopia, Ghana, Kenya, and Senegal have emerged as major players in the global market for cut flowers and horticultural products. Ghana, Kenya, and Rwanda are emerging as remote services suppliers. For the economies of North Africa, proximity to the European market, climate, and fertile agricultural areas provide a basis for developing new agro-industrial value chains. Language and proximity may encourage the development of remote services, and the tourism assets of the region are well known, if not well developed.

Set against these opportunities, changes in manufacturing technology and changes in the global market for manufactured goods may pose challenges to the export-led, mass manufacturing model used with great success in Asia over the past 50 years. Rodrik (2015) argues that late developers have begun to deindustrialise at lower and lower levels of income, and that industrialisation in low-income countries is running out of steam considerably earlier than was traditionally the case.⁵⁷

The first wave of industrialisers, such as Britain and Germany, employed more than 30% of the labour force in manufacturing before they began to deindustrialise. The most successful Asian exporters, such as Korea, peaked well below 30%. Countries such as India, along with many Latin American countries, are deindustrialising from peaks in manufacturing employment that do not exceed the mid-teens. Even Vietnam, one of the most successful recent industrialisers, shows signs of having peaked, at 14% of employment. Vietnam is still a poor country and in an earlier period would have had many more years of industrialisation.

For Africa to capture a larger share of global industry, it must succeed in two areas. First, most firms must become more productive. Second, governments must create the conditions to attract new firms able to compete in regional and global markets. Because the structural characteristics of sub-Saharan and North African economies are broadly similar, allowing for their different levels of per capita income, the broad outlines of a new industrialisation strategy aimed at these two objectives apply to both.

Making firms more productive

Productivity differences across enterprises in narrowly defined industries in Africa are very large. One study finds that the ratio of labour productivity between a textiles and garments plant in the 90th percentile of productivity and one in the 10th percentile ranged from 10 to 1 in Senegal to 79 to 1 in Ethiopia to an astonishing 698 to 1 in Mozambique.⁵⁸ These differences reflect variation in products produced and capital intensity, but they also point to very substantial differences in production efficiency across firms. Reducing these differences and raising the average are keys to promoting manufacturing.

Firm-level productivity increases in two ways. The first is through changes that increase the level of productivity within the firm. Such changes can come from firm-specific initiatives (e.g., a change in management) or changes in the environment in which firms operate. The *bathtub effect* refers to mechanisms that increase the potential productivity of all firms.

Not all firms will seize on productivity-changing opportunities when they are available. Less efficient firms will exit and more efficient firms will enter or expand. This second, between-firm, effect is often referred to as *churning*.⁵⁹ In every economy, within-firm and between-firm changes constantly take place. When they work in tandem, they can provide a powerful engine of productivity growth.

Public policy has a role to play in both filling the bathtub and churning the waters. Investments in infrastructure and education, for example, help to raise the potential productivity of a broad array of firms in an economy, particularly if such investments are distributed equitably across social groups, including women and ethnic minorities. Econometric studies highlight the productivity penalty African enterprises pay as a result of poor infrastructure and skills.⁶⁰ Efforts to improve the business environment can have a similar effect. Policy reforms to remove barriers to competition help to promote churning.⁶¹ In Tanzania, for example, firms facing less competition are less active in introducing new technologies, products, and processes.⁶² Regulatory reforms can promote competition and innovation, a topic to which we return in the next section.

Attracting new investment

The literature on industrialisation in developing countries suggests that three factors have largely shaped the global distribution of industry.⁶³ The first is the presence or absence of some “basics”, including sound macroeconomic management, infrastructure, human capital, and institutions. Cross-country evidence shows that a variety of country-specific factors, including basic infrastructure and human capital, financial depth, and barriers to entry, are correlated with industrial development and diversification in low-income countries.⁶⁴ More reliable electrical power, lower costs of transport, and workers better able to perform their jobs make countries more attractive to both domestic and foreign investors.

The second factor is exports. All manufacturing success stories of the past 50 years are stories of export success. Exports permit firms to realise economies of scale. In low-income countries, the act of exporting raises firm productivity through learning.⁶⁵

The third factor is industrial agglomeration. Manufacturing and service industries tend to concentrate in clusters and cities because they enjoy significant productivity gains from a number of sources, including thick labour markets, information and knowledge spillovers, the ability to share overhead expenses and services, and the opportunity to observe customers and competitors closely.⁶⁶

These three drivers of industrial location are interdependent and mutually reinforcing. In Vietnam, for example, the mass movement of a large number of East Asian-owned exporting firms into the economy within a relatively short period let foreign and domestic firms benefit from agglomeration economies. Public policy played an important role in making things happen. The Vietnamese government adopted a coordinated set of policies aimed at promoting the growth of manufactured exports. It actively courted foreign investors and developed SEZs.

2.4 OPPORTUNITIES FOR GREENER INDUSTRIAL GROWTH

Making firms more productive and attracting more investment will not be easy, as the history of African countries' efforts to industrialise attests. These objectives do, however, provide a basis for thinking about the region's prospects for green industrialisation.

Given the magnitude of the challenge, it is tempting to focus first on getting industrial development moving, deferring consideration of the environmental costs to a later time. Doing so would be an error. The industrialisation path taken, the choice

of policies, and the capacity to absorb new energy-efficient and clean energy technologies will all significantly determine how large the increase in energy use, and its impact on the environment, will be.⁶⁷ It makes sense for policymakers to think systematically about the environmental consequences of their industrial policy choices from the outset, both to identify potential win-win opportunities and to understand fully the trade-offs.

Increasing the prospects for greener industrial development in Africa will depend on two factors. The first is the extent to which the environmental impact of structural change may differ from the patterns associated with industrialisation in East Asia, driven in part by factors such as the region's resource endowments, the availability of new technologies, and the changing nature of global industry. The second is the extent to which the policy interventions designed to support the drivers of firm-level productivity outlined above – the basics, exports, and agglomerations – can be adapted to support greener industrial development.

Prospects for greener structural transformation: The case of energy

How are the emerging or potential patterns of structural change in Africa likely to affect the environment? To what extent will structural change occur in a greener form? This section builds on the discussion in Section 2.2, focusing primarily on energy use.

More rapid economic growth and poverty reduction in sub-Saharan Africa will substantially increase demand for energy services. Energy consumption in sub-Saharan Africa is very low by global standards. Per capita primary energy consumption was just 694 kilograms of oil equivalent in 2012, 15% of the OECD level; in low-income countries in Africa, consumption was just 9% of the OECD level.⁶⁸

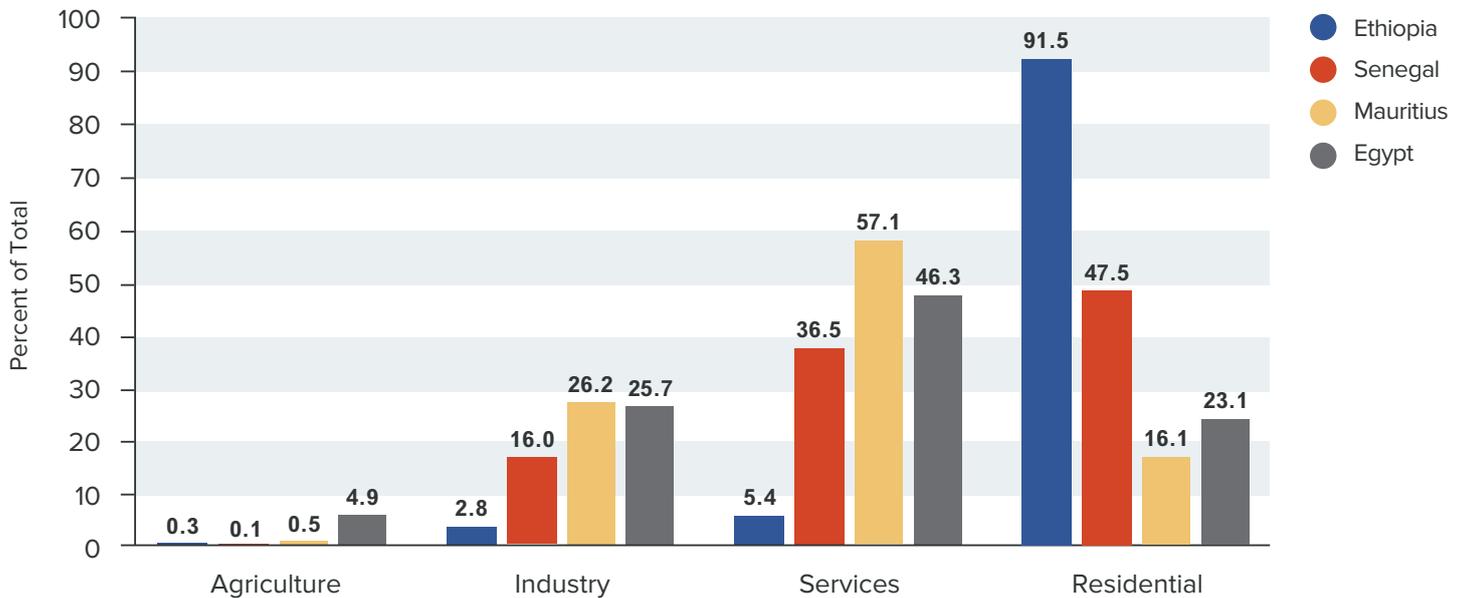
Electricity consumption is even more limited, at 512 kilowatt hours per capita in 2012, only 6% of OECD levels – less than is needed to power a 50-watt light bulb continuously for a year. More than 620 million people in sub-Saharan Africa have no access to electricity. The electrification rate in the region was only 32% in 2012 (just 16% in rural areas). Investment in the power sector has stagnated, and generating capacity across the continent is a mere 80 gigawatts (GW), no more than in South Korea. Leaving out South Africa, capacity is a mere 34GW, and as much as a quarter of that is non-operational due to age and lack of maintenance.⁶⁹

Firm-level studies highlight the productivity penalty African firms pay as a result of poor infrastructure. Electrical power is Africa's greatest single infrastructure constraint. More than half of the firms in more than half of the African countries in the World Bank's Investment Climate Assessments cite the quality of electricity service as a major problem.⁷⁰ Average power costs are twice what they are in other developing countries.⁷¹ The region is in the midst of a power crisis. The International Energy Agency (IEA) concludes that "the current state of the energy system represents a major threat to the realisation of the region's economic hopes."⁷² Power interruptions and shortages are a significant problem in many countries. By some estimates, these disruptions cost 1–4% of GDP per year.

Energy use in the region grew by 3.2% a year between 2000 and 2012 (albeit from a low level), enough to double energy use in a little over 20 years. This pace is about the same as other developing countries excluding China. Annual growth can be broken down into the sum of growth in real GDP, which rose 5.7% a year over this period, and the change in the energy intensity of GDP (the amount of energy consumed per dollar of real GDP), which fell 2.5% a year on average. African countries would like to grow even faster, at 7% or more, to achieve rapid improvements in living standards and poverty reduction. Future increases in the region's energy demand will then depend crucially on how quickly energy intensity can decline to offset more rapid GDP growth.

One of the key drivers of energy intensity is the pace and direction of structural change, given that different sectors are more or less intense users of energy. Historically, the shift of employment and activity out of less energy-intensive agriculture into more energy-intensive industry has had a significant impact on the economy's overall energy use. The growth of "industries without smokestacks" and the possibility of "premature deindustrialisation" may also have important implications for how green Africa's industrialisation process turns out to be. Figure 5 illustrates the rising share of industry and services in final energy demand by comparing low-income Ethiopia with lower-middle-income Senegal and Egypt and upper-middle-income Mauritius.

Figure 5
Final energy use in four African countries, by sector, 2014



Source: IEA (2016b) *World Energy Balances*.

Africa faces a changing trade and technological environment that may open up new options for structural transformation at a lower cost to the environment. It is likely that the share of tradable services and mineral extractive activities will be higher in Africa than in today's developed countries at an equivalent stage of development. Africa's abundant tourism assets are still under-utilised, for example, and show great potential for growth, particularly in the area of sustainable tourism, including ecotourism.

Table 2 compares differences in energy use and economic structure in some economies at the same level of per capita income.

Table 2
Income, energy consumption, and economic structure of selected middle-income countries

Country	Years	Per capita GDP (PPP constant 2011 international \$)	Per capita energy consumption (kg of oil equivalent)	Energy intensity (energy use per US\$1,000 GDP)	Manufacturing (% of GDP)	Per capita electricity consumption (kwh)
Lower-middle-income countries						
China	2005	5,675	1,362	240	32.3	1,784
Congo, Rep. of	2012	5,698	400	70	3.8	182
Indonesia	1999	5,610	688	123	26.0	357
Upper-middle-income countries						
Korea	1996	17,835	3,455	194	24.5	4,282
Malaysia	2005	17,962	2,549	144	27.5	2,862
Mauritius	2012	17,737	1,068	64	16.7	2,075

Source: World Bank (various years) World Development Indicators.

The Republic of Congo is representative of the many natural resource-rich economies in Africa. GDP, exports, and government revenues are heavily dependent on highly productive oil and other mineral sectors in these countries. These activities are located in enclaves and create little employment. They co-exist with little structural change and high poverty in the rest of the economy. The Republic of Congo’s valuable oil production pushes it into the lower-middle-income category, with a 2012 per capita GDP of around \$5,700 (in constant 2011 PPP international dollars). Congo’s per capita energy use is only around 400 kilograms of oil equivalent per head, 42% less than Indonesia when it reached the same level of per capita GDP (in 1999) and 70% less than China when it reached that per capita GDP level in 2005.

Congo’s low energy use is linked to lack of development outside the natural resource sector, however. The manufacturing share in value added was less than 4%, compared with 26% in Indonesia and 32% in China at the equivalent per capita income. Poverty also remains high. Some 37% of the population lived in extreme poverty in 2011, at less than \$1.90 per day in constant 2011 PPP international dollars (\$690 per year), and 60% lived on less than \$3.10 per day (\$1,130 per year). Living standards for most people are thus much lower than suggested by per capita GDP, which also helps to explain the country’s low energy consumption. The apparent “greenness” of natural resource-rich African economies is therefore misleading. To the extent that the future development path for such countries entails greater structural transformation and growth in manufacturing, as well as greater inclusiveness and more rapid poverty reduction, these countries’ energy use is likely to rise more rapidly than in the past.

Table 2 also looks at Mauritius, another African economy with low energy use. Per capita energy consumption in Mauritius was 1,068 kilograms of oil equivalent, almost 60% less than Malaysia when it reached the same level of per capita GDP (in 2005) and 70% less than Korea when it did (in 1996). The share of manufacturing in Mauritius is also much lower, however, at around 17% of GDP (compared with around 27% in Malaysia and around 24% in Korea the year they had the same per capita income). Mauritius’ success in building a more services-led, relatively green economy may provide an example for other African economies, although there will be significant challenges for countries to establish the preconditions for success in high-productivity services, such as high levels of education and skills and high-quality infrastructure.

The inclusiveness of development is another important driver of energy use patterns. Growth that is more inclusive and successful in reducing poverty also tends to be more energy intensive. Residential demand for energy grows especially rapidly when people who were poor gain access to electricity and purchase appliances such as electric lighting, refrigerators, stoves, fans, air conditioners, and TVs for the first time.⁷³ Women in traditional gender roles especially benefit from access to these devices and the electrical power on which they run, because it reduces the time spent on domestic work, leaving them with more time for productive investment in education and employment. The shift from traditional biomass to modern energy sources also helps to reduce indoor air pollution and improve health.⁷⁴

Sub-Saharan Africa is home to the largest number of people living in absolute poverty and without access to modern energy.⁷⁵ If, as seems desirable, African countries succeed in promoting more inclusive growth, the energy intensity of these economies is likely to increase.

Cutting in the opposite direction are ongoing improvements in the technical efficiency of energy use for production processes and consumer goods, as a part of global technological progress. These improvements create the potential for developing countries to “leapfrog” to much more energy-efficient processes and products than were available to today’s developed countries when they were at comparable income levels.⁷⁶ Yet energy efficiency in many sectors is well below economic levels because of policy distortions, such as wasteful energy subsidies, inefficient urban forms, and market failures.

Towards greener industrial policy: Beginning with the basics

Can Africa develop an industrialisation strategy that is green and can protect the natural capital upon which the welfare of future generations depends? We begin with some basics. Existing firms face an uphill battle to become more productive, and new investors will continue to bypass the continent without good macroeconomic management, policies that encourage efficient resource use, a competitive exchange rate, and reform of regulatory burdens and poorly functioning institutions that inhibit competition, increase the cost of doing business, and reduce competitiveness. Stronger infrastructure, in particular power and transport infrastructure, is critical. Infrastructure directly affecting the competitiveness of exports has been particularly neglected, for example roads, ports, and railways.

There are significant opportunities to close Africa’s infrastructure gap in an environmentally sound way. Well-designed fiscal policies and regulations are key to promoting efficient resource use. Reform of energy subsidies and more effective use of energy taxes should be top priorities, as we discuss in Section 4. Such policies encourage energy efficiency, boost revenue for high-return development programmes such as infrastructure, increase energy security, and help curb local air pollution and greenhouse gases.

Electrical utilities throughout the region suffer from poor management, lack of technical and institutional capacity, lack of competition, weak regulation, high costs, heavy transmission and distribution losses, and poor financial results. Reform of electrical utilities is critical to both expanding electricity supply and improving energy efficiency. Better urban planning and more compact and better-connected cities boost energy efficiency while improving economic productivity and quality of life.

Africa is particularly well placed to exploit low-carbon fuels. Because it is undertaking its economic transformation at a time of rapid technological advances and rapidly falling costs in renewable energy technologies, Africa has options that were not available even a few decades ago. Sub-Saharan Africa has an enormously rich portfolio of clean energy assets, including about 1,100GW of solar capacity, 350GW of hydro, and 109GW of wind, plus large natural gas reserves to fuel another 40GW of power.⁷⁷ Off-grid and mini-grid electricity distribution options provide a way to harness clean energy sources to help expand electricity access for the poor, particularly where consumers are widely dispersed.⁷⁸ Growing exploitation of the continent’s abundant clean energy will reduce the greenhouse gas emissions associated with Africa’s industrialisation, which will benefit not only Africa but the world as a whole, a global public good. The international community therefore has a strong incentive to invest in developing Africa’s clean energy assets.

Greener opportunities also exist for addressing the region’s transport and logistics constraints. A strong emphasis on investment in mass public transit systems in urban areas would contribute to the development of more compact, well-connected, and coordinated city forms that improve economic productivity, increase energy efficiency, and curb pollution.

But focusing on the basics alone does not address other key drivers of firm location. For that reason, we suggest three policy instruments aimed at making Africa more attractive to global manufacturing: mounting an export push, strengthening SEZs and industrial parks and making them greener, and attracting more (and greener) FDI.

Mounting an export push

For the vast majority of countries in Africa, the regional and global export market represents the best option for rapid growth of manufacturing, agro-industry, and tradable services. Because individual firms face high fixed costs of entering export markets, there is a risk that countries will export too little unless public policies are put in place to offset the costs to first movers.

To deal with these externalities, African governments need to adopt “export push” strategies similar to those Asian countries have used since the 1970s. Asian governments adopted a set of macroeconomic and exchange rate policies, public investments, regulatory reforms, and institutional changes to increase the share of industrial exports in GDP.

Many of the public actions needed for an export push involve the basics but with the twist that priority should be given to reducing constraints on exports. Institutional and regulatory reforms should aim to reduce the transaction costs that exporters face. Duty drawback, tariff exemption, and value added tax (VAT) reimbursement schemes are often complex and poorly administered. Port clearance times are long, and customs delays on both imported inputs and exports are significantly longer than in Asia. Trade-related infrastructure is particularly weak; poorly functioning institutions and logistics markets increase trade costs.⁷⁹

Governments can support green exports by developing initiatives to identify green markets and support certification and standards. Africa’s regional economic communities can play a role in certification. Development partners can also give consideration to supporting green exports through trade preferences, although care must be taken in the design of such schemes, to ensure that they do not in practice serve as a form of protection against developing country exports.

Strengthening special economic zones and industrial parks – making them greener

Industrial agglomeration poses a collective action problem: if a new industrial location can attract a critical mass of firms, each firm will realise productivity gains from clustering. Until such a critical mass is reached, however, there is no incentive for a firm to move.

Governments can foster industrial agglomerations by concentrating investments in high-quality institutions, social services, and infrastructure in a limited area, such as an SEZ or industrial park.⁸⁰ Appropriate public policies to attract a critical mass of investors into such areas are a prerequisite to breaking into global markets.

Most African SEZs have failed to reach the levels of physical, institutional, and human capital needed to attract global investors. A World Bank survey finds that non-African SEZs had an average monthly downtime from electricity outages of 4 hours; the average downtime in sub-Saharan African SEZs was 44 hours.⁸¹ A similar pattern is observed in the institutions supporting SEZs. Clearing customs takes about twice as long in African zones as it does in non-African competitors.

Experience with spatial industrial policies in North Africa has been mixed. Tunisia’s manufacturing success is based largely on its export processing zones (EPZs), which have been criticised for their limited links to the domestic economy. Egypt’s EPZs have generally been regarded as failures, especially in the public sector.⁸²

Thus, a first order of business is to raise the performance of Africa’s SEZs to international standards. The benefits of doing so include not only more rapid export growth and economic transformation but also social gains, such as greater female employment in industry.⁸³ Ethiopia has demonstrated that it is possible to pursue green growth and spatial economic policies at the same time (Box 1).

Box 1**Ethiopia's experience with special economic zones**

In 2015, the government launched its second Growth and Transformation Plan (GTP II), which set out a range of development priorities to achieve its overarching objective of reaching middle-income status by 2025. Building on commitments made in 2011, GTP II also highlighted the need to reach middle-income status with no net increase in greenhouse gas emissions and with increased resilience to climate change.

A key instrument of GTP II is a revitalised SEZ programme. The Ethiopian Industrial Parks Development Corporation (IPDC) was established in 2014 to build and maintain federal industrial parks. The IPDC is operating or planning 16 publicly owned industrial parks. The most recently opened public sector industrial park, Hawassa, was designed and constructed by the China Communications Construction Company in less than a year. It houses textile and garment firms from China, India, Sri Lanka, and the United States, as well as Ethiopian companies. The zone has 35 factory sheds and 19 buildings. It is Ethiopia's flagship eco-industrial park, powered largely by hydro-electricity and featuring a number of energy-saving innovations in factory lighting and shared infrastructure.

Ethiopia also provides a cautionary tale on the importance of complementarity between spatial industrial and urban development policies. Road networks and public transportation in Addis Ababa are already stretched. It has been challenging to get workers to the site of the Bole Lemi Phase I SEZ, on the outskirts of Addis Ababa. The site is not served by public transportation; some tenants provide shuttle buses. Upon completion of Phase 2, the SEZ's two sites are expected to create up to 75,000 jobs (in two shifts), significantly exacerbating transportation bottlenecks and their environmental impact.

Attracting more – and greener – foreign direct investment

Policies and institutions for attracting FDI are key to any industrialisation strategy. As in the case of SEZs, efforts to attract FDI must derive from the national economic transformation strategy. The types of investment that governments try to attract and the targets they set should not be developed independently of public actions to improve the basics, promote exports, and strengthen SEZs.

Many African countries – including Egypt, Ethiopia, Ghana, Tanzania, and Uganda – have created or reformed institutions intended to attract FDI. Implementation and results have been disappointing.

Four institutional features of FDI promotion agencies play a crucial role in their success: active support of the head of government, operational independence to fulfil its coordinating role, high-quality personnel, and focus.⁸⁴ Most African FDI agencies have not received the sustained support of the president or prime minister. Without such support, they lack the ability to coordinate across government. Personnel practices and compensation policies have not been sufficient to attract the high-calibre staff needed. The agencies are also frequently burdened with multiple objectives, blurring their focus. These institutional problems must be solved to attract foreign investors outside the natural resources sector.

As African governments seek to revitalise their investment promotion agencies, they should be able to pursue a number of green objectives. For example, opening generation markets to private independent power producers (IPPs) can increase energy efficiency. Ghana, Kenya, Nigeria, South Africa, and Uganda have taken steps to unbundle generation from transmission and distribution in recent years, opening the door for IPPs.

3. Agents of change: firms, entrepreneurs, and greener industry

Entrepreneurs at all levels will be central to the success of green industrial development in Africa. Economic transformation and green growth depend crucially on doing new things: making risky investments in new, unfamiliar sectors, industries, or products, or adopting new, unfamiliar methods, processes, technologies, or inputs in the production of goods already being produced. This focus on the new highlights the role of the entrepreneur as the key agent of change in economic transformation and green growth.

This section addresses two major themes: where Africa's change-makers may come from and how to get them moving towards greener products and processes. Section 3.1 provides a snapshot of firms in a typical African economy. Section 3.2 describes the roles that competition, green markets and improved programmes for micro-, small-, and medium-size enterprises (MSMEs) need to play in creating a business environment that promotes innovation and is responsive to the new opportunities created by changes in green technology.

3.1 FIRMS AND ENTREPRENEURS IN THE INDUSTRIALISATION PROCESS

The industrial sector in the average African economy consists of three types of firms: a small number of relatively large formal firms ("Elephants"); a larger number (about 10–15%) of MSMEs with relatively high productivity and the capacity to grow ("Gazelles"); and a much larger number of tiny firms with low productivity and little capacity to grow ("Survival Entrepreneurs").

The predominantly agricultural structure of African economies, lack of diversification, and low productivity and technical capacity in most sectors constrain the types of green markets available to African entrepreneurs, at least initially. Nevertheless, there are opportunities to strengthen incentives, institutions, and firm capabilities in ways that support greater attention to the environment. Each group of entrepreneurs represents a separate challenge:

- *Getting the Elephants moving.* Elephants are large by African standards, but the majority of these firms are family owned and managed. These enterprises have the potential to play an important role in greener industrialisation, provided that they face incentives that encourage movement towards new, more environmentally friendly innovations or products. The challenge is to design a set of policies that increases competitive pressure to get the Elephants moving and to develop regulatory and incentive policies that move them towards greener outcomes.
- *Finding the Gazelles.* Firms in the informal sector are widely viewed as unproductive employers of last resort.⁸⁵ For that reason, interventions to support MSMEs have tended to focus on raising the incomes of their owners to reduce poverty, rather than on their possible role in a growth strategy. Tanzania's first nationally representative survey of MSMEs provides a new and more nuanced perspective on the potential of smaller firms.⁸⁶ It finds that about 15% of MSMEs have labour productivity that is higher than the average in manufacturing. The owners of these businesses report that they would not leave their jobs for full-time salaried positions and that their businesses are growing. The Gazelles are Africa's future entrepreneurs, but little is known about them. Policymakers need to identify these firms and then design policies to support them.
- *Reducing the pressure for Survival Entrepreneurship.* Not every owner of an MSME is an entrepreneur capable of contributing to growth. More than half of Tanzania's MSMEs, for example, have extremely low productivity. These businesses help families survive and are therefore important, but, unlike Gazelles, these business owners would prefer to have wage-paying jobs. They are "Survival Entrepreneurs", people who engage in entrepreneurship not out of choice or a sense of enterprise, but because they were unable to find a wage-paying job. Survival Entrepreneurs lack the organisational capital to grow their firms and are the least likely to innovate. Governments and donors need to focus on addressing the causes of Survival Entrepreneurship: lagging agricultural productivity and slow urban employment growth.

Cutting across the three firm types is the need to take account of the special problems facing female entrepreneurs. Economic actors often have different responses to risk, for example. Women in agriculture can be more risk averse in adopting new crops, inputs, or technologies than men, as was the case with the take-up of micro-irrigation pumps in Kenya and Tanzania. Sociocultural norms and a lack of access to information, skills, finance, and other assets can limit the potential role of women as entrepreneurs. Policies need to be sensitive to these social conditions in order to encourage broad-based entrepreneurship.⁸⁷

3.2 TOWARDS GREENER FIRMS AND ENTREPRENEURS

This section examines how Africa can move in the direction of greener entrepreneurship. It begins by discussing a supporting condition for green entrepreneurship: the emergence of green markets. It then considers a number of opportunities for Africa's Elephants. Whether these activities are taken up will depend largely on whether the competitive environment encourages innovation and on the incentives for green investments.

The case of the Gazelles is more complex. Greening these firms will depend on two complementary sets of public actions: developing effective programmes of MSME support that identify firms with the potential to grow and innovate and providing these firms with the incentives and information needed for green innovations.

The last sub-section examines the role agriculture has to play in reducing the incentives for survival entrepreneurship.

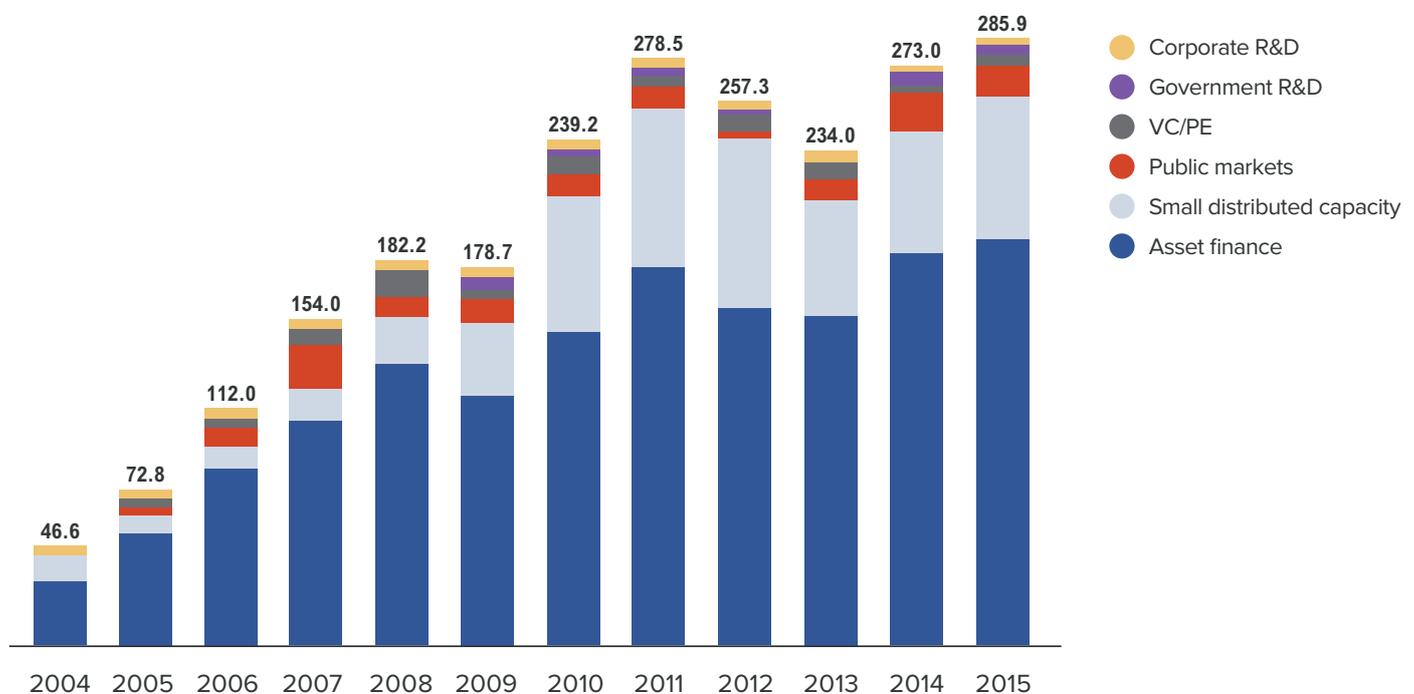
Green markets

In the absence of appropriate policies, private demand for green goods and services will be lower than socially optimal because of market failures. Firms will choose relatively dirty production methods and sources of energy when they do not take into account the pollution damage their choices impose on others. There is thus a major role for public policies that create the right incentives for firms and consumers, inducing them to take into account the environmental costs of their actions through, for example, elimination of fossil fuel subsidies, taxes on pollution, and appropriate environmental regulations. Such policies play a key role in shaping robust green markets.

Important green markets that are emerging in many countries include the following:

- Renewable energy.** Renewable energy includes solar, wind, and other clean energy projects on a large enough scale to supply power to national utility companies (“utility scale”), as well as smaller-scale installations for distributed generation markets, including standalone micro-grids and residential rooftop units. The manufacture of parts and components and the provision of design, installation, and operations and maintenance services are an important part of this green market. A 2016 study estimates that global investment in renewables (excluding large hydro projects) climbed to a record US\$285.9 billion in 2015, a 5% increase over 2014 and more than a sixfold increase since 2004 (Figure 6).⁸⁸ For the first time, renewables (excluding large hydro) represented over half of the new electricity generation capacity installed worldwide. Investment in renewables in developing countries pulled ahead of developed countries in 2015, also for the first time. Investment in the Middle East and Africa reached a record US\$12.5 billion. South Africa emerged as an important renewable investor, with spending of US\$4.5 billion. Other sub-Saharan African countries with renewable investment of US\$100 million or more in 2015 included Ethiopia, Kenya, and Uganda.⁸⁹

Figure 6
Global new investment in renewable energy by asset class, 2004–15, \$bn

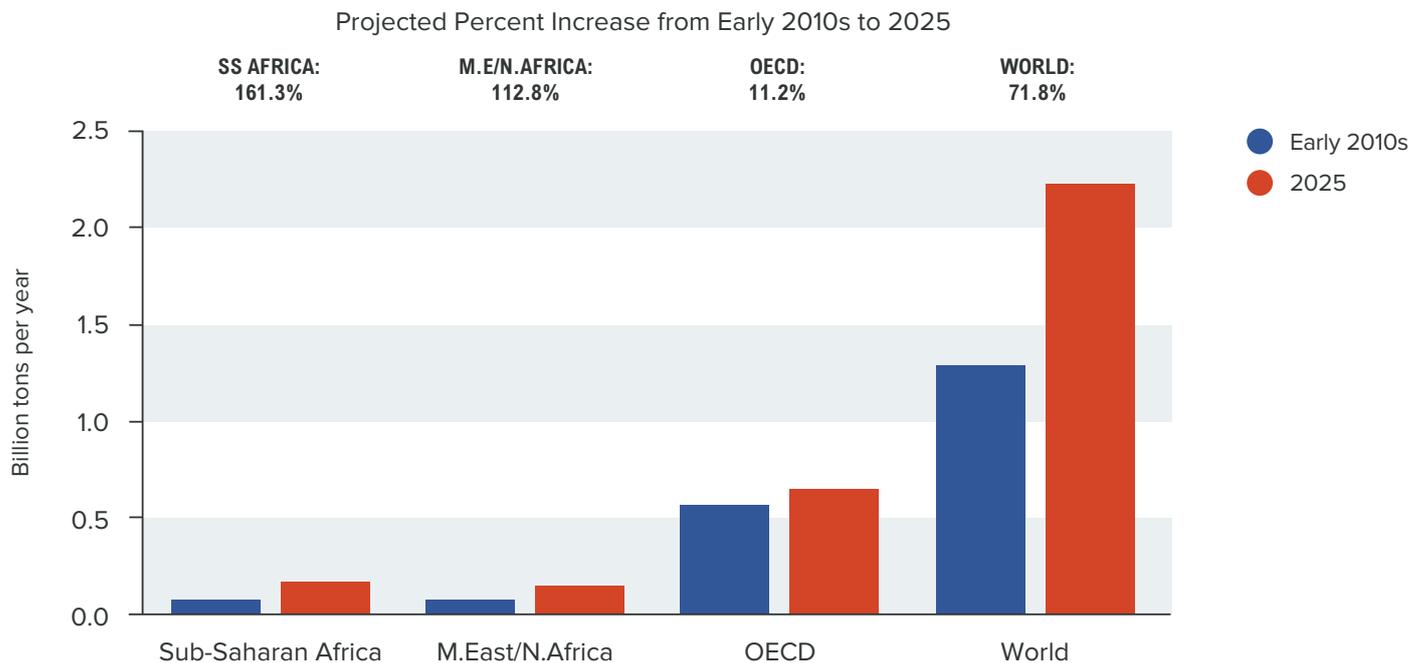


Notes: Asset finance volume adjusts for re-invested equity. Total values include estimates for undisclosed deals. “VC/PE” refers to “Venture Capital/Private Equity”.

Source: Frankfurt School-UNEP Centre/BNEF (2016).

- *Energy efficiency.* Diverse processes and products improve energy efficiency in industry, services, agriculture, government, passenger and freight transport, and residential uses. The IEA estimates that global investment in energy efficiency (i.e., the additional investment required for efficient products) was US\$221 billion in 2015, up 6% over 2014. Of the total, US\$118 billion was in buildings (including appliances and lighting), US\$64 billion in transport, and US\$39 billion in industry. Total investment in energy efficiency in 2015 was two-thirds greater than investment in conventional power generation. The fast-growing market for energy efficiency services provided by dedicated energy service companies (ESCOs) reached US\$24 billion in 2015. Such companies provide comprehensive service packages to increase energy efficiency for their customers. ESCO activity is especially significant in the United States and China.⁹⁰
- *Water.* Rapidly rising demand for water is bringing water scarcity to the forefront, both globally and in Africa, creating broad new markets and entrepreneurial opportunities for the private sector, civil society, and municipal actors. There is an urgent need for increased investment in water infrastructure in Africa, including in water collection and storage; water supply; distribution and sanitation infrastructure; water treatment; and wastewater recovery, treatment, and reuse. The creation of economic incentives for efficient water use will not only render water infrastructure more financially viable, it will also accelerate the development of markets for water-efficient products and processes, an area of rapid innovation globally, encouraging more rapid technology transfer and adoption in major water-using sectors, such as agriculture, power generation, industry, and households.
- *Waste management.* Waste management is a major and fast-growing green market worldwide. Urban solid waste generation rose by 90% in the first decade of the century, reaching 1.29 billion tonnes per year in the early 2010s. It is projected to rise by 72% to 2.2 billion by 2025 (Figure 7). In recent years, global markets for recycled secondary materials have emerged, creating new opportunities for waste management businesses. Africa still generates relatively little waste, but the volume is rising at more than twice the world rate. Urban waste generation in sub-Saharan Africa is projected to rise 161% between the early 2000s and 2025. The institutional capacity to take up these opportunities is still limited. Waste collection rates in sub-Saharan Africa are less than 50%, the lowest among all regions; the bulk of waste ends up in open landfills, polluting nearby aquifers, bodies of water, and settlements. Some 65–80% of urban solid waste is organic material. Although there is growing awareness of the potential to convert it to compost, energy, and other valuable products, progress has been very limited. Strengthening the fiscal and technical capacities of city governments in Africa would allow them to provide more resources for waste management and coordinate their efforts with those of the private sector, non-governmental organisations, community-based organisations, and the informal sector.⁹¹

Figure 7

Actual (early 2010s) and projected (2025) urban waste generation, by region

Note: Figures over bars indicate projected percentage increase between the two periods.

Source: Data from World Bank (2012).

- *Climate-smart agriculture.* Climate-smart agriculture refers to a framework to (a) sustainably increase agricultural productivity and incomes; (b) adapt and build resilience to climate change; and (c) reduce greenhouse gas emissions, drawing on a wide array of production systems, institutions, and policies that should aim to suit the diverse climatic, social, cultural and other conditions of specific locations.⁹² We discuss these emerging markets in more detail below.

Opportunities for the Elephants

Pressure from potential or existing competitors can get firms moving in an industry. This usually happens when more efficient (lower-cost and generally lower-price) producers enter a sector or expand. Relatively high-cost firms or plants see their market shares erode and are sometimes forced to exit. This kind of churning takes place in Africa, but there is some evidence that large, formal manufacturing firms face too little competition.

The formal manufacturing sectors in nearly all sub-Saharan countries operate in highly concentrated product markets. In many industries, the top three or four firms account for more than half of domestic production. World Bank Enterprise Survey data for the formal sector in Kenya show that the five largest firms account for 58% of total value added. In Tanzania, the top three or four firms account for more than 50% of domestic production in most manufacturing subsectors.⁹³ Concentration is particularly high in capital-intensive, higher-technology sectors, such as machinery and equipment, motor vehicles, and electrical machinery and apparatuses, but even sectors such as leather and leather products, apparel, textiles, and wood products show high levels of concentration relative to global norms.

High concentration need not imply limited competition. In small, open economies, imports ought to provide contestability in domestic markets, even markets dominated by a small number of large domestic firms. Although Africa's economies have become much more open to imports over the past 20 years, World Bank Enterprise Surveys indicate that, imports notwithstanding, many firms do not feel pressed by competition. In the 2006 Enterprise Survey, for example, about 24% of large firms in Tanzania stated that there were no new competitors in the markets in which they operated.⁹⁴ The private sector faces far less competition in North

Africa than in Asia, Latin America, or Eastern Europe. Protection in output markets and barriers to entry are substantial. Entry of new firms and exit of inefficient businesses is weaker, and firms are on average older than in other regions.

Not surprisingly, lack of competition reduces the incentives for firms to innovate or become more productive. The relationship between competition and firm-level performance in Africa has not been extensively studied, but a few studies suggest that there is a positive link between the two. One analysis of firms in Ghana, Kenya, and Tanzania finds that higher initial profits reduced subsequent productivity growth.⁹⁵ A study in South Africa finds a negative relationship between lagged price-cost margins and productivity growth among firms, suggesting that competition has a positive effect on productivity.⁹⁶ The Tanzanian data from 2006 show that firms that faced less competition were less active in introducing new products and new processes in their industrial activities.⁹⁷ Thus, a necessary precondition for green entrepreneurship among the Elephants is regulatory and institutional reform to promote competition.

Box 2 provides ideas about how to get the Elephants moving in a greener direction once they begin to move. Over the coming decades, development of clean energy could provide a major opportunity for entrepreneurship, particularly for larger, more sophisticated domestic firms. Opportunities are also emerging in energy efficiency, water and waste management, and climate-smart agriculture.

Whether Africa's Elephants can seize these opportunities will depend on their capabilities – the knowledge and working practices possessed by the people who make up a firm. Building firm capabilities is a complex process, driven mainly through firm-to-firm interactions. Capability transfer consists of both “hardware” (technological knowledge and engineering practice) and “software” (the working practices that are crucial to master the technology and achieve higher quality) transfer. FDI and learning by exporting are two ways in which higher capabilities are acquired. Management information and training may be another.

Transmission of knowledge from higher-capability (often foreign-owned) firms to other firms in the economy usually takes place through supply-chain relationships. Few supply-chain linkages exist between firms in most African countries.⁹⁸ One area for action is therefore to remove the obstacles that current policies – mainly in SEZs – place in the way of linkages between firms. An open architecture that encourages maximum contact between firms in the zone and the rest of the domestic economy – the opposite of the regime found, for example, in Tunisia's off-shore economy – has been shown to promote transfer of capabilities.⁹⁹ Beyond removing obstacles, governments can pursue more active policies to help local firms connect to FDI-led value chains.

Box 2

Can local firms help to develop clean power in Africa?

One of the key developments in Africa over the next two to three decades will be the major expansion of electricity generation, transmission, and distribution capacity. A 2012 McKinsey report estimates that sub-Saharan Africa will demand about 1,600 terawatt-hours of power by 2040 – four times the current level of consumption. Bridging this gap will require around US\$835 billion of new investment, including US\$490 billion for new generating capacity and US\$345 billion for transmission and distribution. Sub-Saharan Africa's abundant natural gas, hydro, solar, and wind resources are expected to play a major part in the expansion of capacity. The share of capacity generation from natural gas is projected to rise from 6% in 2010 to 44% in 2040. This change is significant because natural gas is the cleanest fossil fuel, emitting only 50–55% as much CO₂ per unit of energy as coal. Renewables (including hydro) are projected to represent 26% of generation by 2040.¹⁰⁰ Power generation scenarios by the International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA) also look to a major role for renewables and natural gas.¹⁰¹

The primary benefit of future expansion in African power generation capacity will be to support growth in the rest of the economy. In addition, construction of new power plants and transmission and distribution facilities could generate 1.9 million jobs, which, while temporary, would help to build labour force skills. The new facilities would also create 300,000–450,000 permanent jobs in operation and maintenance and an unspecified number of jobs in industries supplying the power sector.

To what extent will African firms be able to participate in building and supplying the input needs of the expanding power sector, particularly the clean power sector? Local firms should be able to supply basic construction materials like cement, but they are likely to face significant challenges in competing at higher levels of the supply chain. Most projects will be utility-scale, technically sophisticated investments in hydropower, solar, wind, and geothermal power that are undertaken primarily by international suppliers using imported equipment.

South Africa is taking a well-planned approach to both clean energy development and the expansion of the role of local firms in that development. Its Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) has incentivised a significant expansion in renewable power production through power purchase agreements with private renewable power producers.¹⁰² The Jasper Solar Energy Project, a photovoltaic power station completed in October 2014, produces 180,000 megawatt-hours of energy annually, powering up to 80,000 homes. It is one of the largest solar farms in the region. The project was developed by a consortium consisting of SolarReserve, a US company; the Kensani Group and Intikon Energy, two South African firms; and substantial investment from Google.¹⁰³

REIPPPP also seeks to boost the role of local firms in the supply chain of clean power development through local content policies, which seek to ensure that the local economy captures at least 45% of spending on clean power projects. An estimated ZAR22 billion (approximately US\$1.8 billion) has been spent on local content in the first three rounds of the REIPPPP. For the wind industry, a study by the Department of Trade and Industry concluded that there was potential to establish up to five wind tower manufacturing facilities (two of which have already been built), as well as blade manufacturing and nacelle assembly facilities. It also assessed the potential for five solar photovoltaic component manufacturing plants.

Grant, loan, and technical assistance from various levels of government and national development banks, as well as tax incentives, back the push to expand local content in clean energy in South Africa. The country's SEZ programme is also being designed to support expansion. Projects include the Upington Solar Corridor in the Northern Cape and the Atlantis Greentech SEZ in the Western Cape. Wind tower manufacture and some other green technology manufacturing have already started in the Atlantis area.¹⁰⁴

How relevant is South Africa's experience for the rest of sub-Saharan Africa? Almost no other African country has South Africa's technological capacity, skill base, infrastructure, or business environment. And developing countries' experience with local content regulations is mixed at best. Economies with low capacity can hardly be expected to quickly expand local content in line with ambitious regulations. Moreover, unrealistic regulations may scare off foreign investors and suppliers, especially in technologically sophisticated industries, where foreign suppliers rely on intricate and highly cost-competitive global supplier chains. The forced participation of inefficient local suppliers could reduce the efficiency and competitiveness of the clean power sector, limiting or eliminating the desired benefits of more abundant and cheap power for the economy as a whole.

To have a chance of success, local content policies need to be closely coordinated with many other aspects of a country's development strategy, such as improvements in education and skills training, infrastructure, labour market mobility, the business environment, and financial sector development. It is also important to foster competition among local firms, in order to prevent high-cost but politically well-connected firms from capturing local content opportunities. For the same reason, government agencies that design and implement local content policies need to establish high levels of transparency and public accountability, including by establishing clear market-based performance criteria.¹⁰⁵

Meeting these criteria may seem like a tall order for the low- and lower-middle-income economies of sub-Saharan Africa. Local content policies are controversial even in South Africa, and their ultimate success remains to be seen.¹⁰⁶

That said, so large is the expected level of investment in the power sector over the coming decades that it seems a mistake for African countries not to make any effort to promote domestic green entrepreneurship and green industrialisation. These efforts should be suited to the development level of the country and implemented in close coordination with overall development strategies. Regional cooperation may help less advanced countries learn from the experience of more advanced countries. The Southern Africa Development Community (SADC) could provide a forum for its 15 members through its two regional energy platforms, the Southern African Power Pool and the Southern African Sustainable Energy Network. Information sharing, joint ventures, and partnerships through these forums may provide a way forward.

Moreover, not all aspects of clean energy development are as sophisticated as utility-scale renewable energy projects. One of the most dynamic sectors in African clean energy is the mini-grid and rooftop solar kit sector. These small-scale projects may provide manufacturing opportunities for countries with less capacity. In Kenya, for example, a local company, Chloride Exide, is the largest player in the sale and distribution of smaller-scale photovoltaic solar power, which it promotes as a strategy to foster the market for its main product, batteries. Ubbink, a Dutch subsidiary of the German group Centrotec, has set up a solar module manufacturing company in Naivasha, Kenya, the first in East Africa. Solar modules in the 4–80W range are manufactured based on reworked broken high-quality solar cells. Learning by seeing the experience of this foreign firm could encourage local Kenyan firms to enter this type of manufacturing.¹⁰⁷

Greening the Gazelles

The first challenge in greening the Gazelles is finding them. A wide range of MSME programmes are in place, executed by a wide range of government institutions, donors, and NGOs. Most of these programmes seek to contribute to job creation and growth, but assistance to the MSME sector by governments, donors, and non-governmental organisations has been ad hoc and has not targeted firms with growth potential.

Much of the assistance has been in the form of credit programmes. The evolving literature on microfinance suggests, however, that the assumption that relaxing financing constraints will boost business start-ups or allow owners of MSMEs to scale up their operations and grow into larger firms is only true when business owners have the skills and resources to profit from the investment.¹⁰⁸ Many programmes focus on MSME training. Research suggests that microenterprise training initiatives have largely been ineffective.¹⁰⁹

In order to improve the efficiency of MSME support programmes, they should be designed to be attractive to Gazelle firms but not to unproductive firms whose owners are not capable of growing their businesses. One approach to identify high-potential firms may be to use administrative data from existing programmes to identify firms that have grown. Another might be to survey management practices. McKenzie and Woodruff (2016) examine the relationship between management practices – marketing, record keeping, financial planning, and stock control – and firm outcomes in MSMEs.¹¹⁰ They find that improvement in business practices is associated with significant increases in productivity, higher rates of enterprise survival, and higher rates of sales growth.

There appear to be many opportunities for Gazelles in sales, installation, and servicing of smaller-scale clean energy technologies, such as household solar units and clean stoves, waste management, and water and sanitation (Box 3). It remains to be seen whether such small beginnings will provide a launch pad for Gazelles to enter clean energy-related manufacturing in competition with Elephants and foreign suppliers.

Box 3

Can local firms help to develop clean power in Africa?

Many smaller-scale African firms and entrepreneurs are pursuing a broad array of green business opportunities.

Clean energy

- **Green Bio Energy (GBE)** was created as a social enterprise in Uganda, initially to produce and sell eco-friendly charcoal briquettes. It has since begun producing and selling its own brand of energy-efficient stoves, Briketi Eco Stoves. It also sells small quantities of solar lamps and water filters.¹¹¹
- **L's Solutions**, in Tanzania, promotes and sells solar-powered lamps, chargers, and stoves at village trade fairs and installs larger-scale devices, such as solar water pumps and solar photovoltaic panels.¹¹²
- **Micro Power Economy for Rural Electrification**, in Senegal, installs standalone off-grid power systems, using renewable energy sources, such as hybrid wind-solar-diesel power systems. It also helps arrange for microfinance and business training for rural customers.¹¹³
- **RK Renew Energy PLC** is a women-led enterprise in Ethiopia that has obtained financing from investors to produce and distribute fuel-efficient stoves to refugee camps.¹¹⁴
- **Solar Sister** was created in Uganda in 2009 to give women economic opportunities from “last mile” distribution of clean energy products, such as household solar kits and clean stoves. The experiment has since been replicated in Nigeria and Tanzania.¹¹⁵

Waste management

- **City Waste Recycling** is a Ghanaian company that processes and recycles a wide variety of waste types, from electronic waste (e-waste) and batteries to sawdust and plastics, which it collects from local industries and waste collectors. The company reprocesses waste materials into plastic pellets, printed circuit boards, and biogas (compost) and exports recycled e-waste products.¹¹⁶

- **The Recycling and Economic Development Initiative of South Africa (REDISA)** is a public initiative that works with South African tyre manufacturers, importers, dealers, transport companies, and recyclers to recycle the country's scrap tyres. The initiative aims to gather scrap tyres on a sufficient scale to make viable, advanced, high-value material recovery processes.¹¹⁷
- **Recycling for Environmental Recovery** is a Moroccan firm that seeks to recycle plastic waste into a range of secondary raw materials for the plastics industry for domestic use and export.¹¹⁸

Water and sanitation

- **Maji Safi** is a start-up that is helping increase access to safe drinking water in Kenya by installing groundwater wells equipped with ceramic and slow sand water filters, using new water filtration technologies. The company's filters are providing clean drinking water at 10 rural schools in Western Kenya.¹¹⁹
- **Safi Sana** is a Ghanaian company that builds public toilets in urban slums and collects wastes to produce biogas and bio-fertiliser. The company's new factory in the Ashaiman slum east of Accra will provide toilet services for 125,000 slum dwellers, deliver green power for 7,500 people, and produce 2,500 kilograms of organic fertiliser daily.¹²⁰

Agriculture and Survival Entrepreneurs

Survival Entrepreneurs reflect the region's increasing urbanisation and lack of job growth. The solution to reducing the pressure for survival entrepreneurship rests more with agricultural than industrial policy. Historical experience around the world shows that faster productivity growth in agriculture and rising rural prosperity play important roles in stimulating the growth of industry and other non-agricultural sectors, as well as the urban economy. Rising rural prosperity provides growing markets for industry and services, including consumer products and farm inputs of various kinds. At the same time, rising agricultural productivity provides food, agricultural raw materials, labour, and savings as inputs for non-agricultural sectors. The role of agricultural reforms and surging agricultural productivity in kick-starting China's rapid growth after 1979 is well documented.¹²¹

African agriculture can also play a large role in economic transformation and green growth. There are already some positive trends in this direction. Agriculture remains a vitally important economic sector in sub-Saharan Africa, accounting for some 60% of employment, mostly of smallholders operating farms of less than 5 hectares. Over 60% of Africa's population – more than 600 million people – live in rural areas, and their numbers are still growing at almost 2% a year. Poverty is disproportionately concentrated in rural areas, and there is much evidence that faster agricultural growth has an especially strong impact in reducing poverty.¹²²

Agriculture is also the sector most affected by climate change. Soil degradation and deforestation are serious problems. Agriculture, land use change, and deforestation are the largest source of greenhouse gas emissions in the region.

Agriculture played an important role in the African growth recovery of the 2000s. Agricultural productivity growth picked up significantly during the 2000s. Growth in cereal yields accelerated from a mere 0.3% a year in 1980–2000 to 1.8% a year in 2000–13, with especially strong performances in the Central African Republic, Ethiopia, Malawi, Mali, Rwanda, Sierra Leone, and Zambia. Farmers in a number of countries also made progress in diversifying towards higher-value-added fruits, vegetables, and flowers for domestic and export markets. Kenya, for example, has become the world's third-largest exporter of cut flowers.

The revival in African agriculture is linked to a significant increase in policy attention to the sector, after a long period of neglect. The African Union's Comprehensive Africa Agriculture Development Programme (CAADP), launched in 2003, commits governments to invest at least 10% of their budgets in agriculture; strengthen their institutional capacity to support agriculture; and create a good enabling environment for more private investment in agricultural input supply, marketing, and agro-processing.

Donor aid flows for agriculture have also picked up strongly, and civil society activity has increased. Farmers and private companies are working together to develop and more widely distribute new hybrid seeds adapted for African conditions.¹²³

Despite increases in agricultural productivity, it remains far lower than in other regions. A significant part of the growth in cereal production continues to derive from expansion in cropland of about 2% a year – a much faster rate than the global

rate of cropland expansion. Key drivers of the expansion of agricultural land include rapid population growth, low yields, soil degradation, and depletion of nutrients. Expansion of land for arable and pastoral uses accounted for 70% of deforestation in sub-Saharan Africa between 2000 and 2010.¹²⁴ In addition to the loss of biodiversity and ecosystem services, the net loss of forest carbon from deforestation and forest degradation is the biggest source of greenhouse gas emissions in the region, representing over 30% of the total. Agricultural land expansion also exacerbates vulnerability to climate change and puts pressure on the fragile natural resource base in the region's vast drylands, which account for three-quarters of sub-Saharan Africa's cropland, including two-thirds of cereal production and four-fifths of livestock production. These areas already suffer frequent and severe climate shocks, including droughts.¹²⁵

African countries can link green industrialisation, agriculture, and poverty reduction by strengthening their focus on more rapid productivity growth – boosting yields per hectare – as the primary source of agricultural output growth, rather than continued rapid growth in croplands, combined with greater application of climate-smart agricultural approaches.

Climate-smart agriculture draws on a wide array of both existing and new production systems, institutions, and policies that aim to provide solutions that suit the needs of locations with different climatic, geographic, social, and other conditions. Proven existing approaches include mulching, intercropping, conservation agriculture, crop rotation, integrated crop-livestock management, agroforestry, improved grazing, and improved water management. Innovative approaches based on rapid progress in bioscience and agronomics include new, more productive, drought- and pest-resistant crop varieties and better practices for soil, water, and nutrient management, for example the System of Rice Intensification (SRI) developed in Madagascar.¹²⁶

Broader “landscape” approaches promote cooperative actions to manage soil and water across many farms. Many of these interventions involve planting trees on farmland (agro-forestry), where trees not only provide valuable products, such as fruit and timber, but also help to hold and restore soils, retain water, provide windbreaks, and sequester carbon (see Box 4). Better grassland management practices, improved livestock diets, and better breeding practices help to raise livestock productivity while moderating the increase in animal greenhouse gas emissions.¹²⁷

Box 4

Helping African farmers adopt innovative farming approaches through landscape management programmes

Since the 1990s, farmers in Niger have interplanted nitrogen-fixing trees on cropland or allowed roots and stumps to regenerate, increasing tree and shrub cover by a factor of between 10 and 20. The strategy has significantly increased agricultural productivity on 5 million hectares of farmland and helped restore at least 250,000 hectares of severely degraded land that had been of little use for agriculture or forestry. It increased biodiversity and improved soil fertility in the entire area. Farmers in the region now regularly produce at least 100 kilograms/hectare more grain than they used to. Gross real annual income in the region has grown by US\$1,000 per household for over a million households, more than doubling real farm incomes and stimulating local non-farm services.

Only modest additional government spending or business investment was needed. The main driver was revised legislation on tree ownership. Giving farmers more control of the resource provided them with incentives to take better care of the trees and engage in the sustainable partial harvesting of branches, which allowed the trees to keep growing. Estimates suggest that such agro-forestry and water-harvesting approaches could be scaled up to cover another 300 million hectares in sub-Saharan Africa, benefiting some 285 million people.¹²⁸

In Mozambique, the Zambezia Integrated Landscape Management Programme covers 3.8 million hectares, including 2.3 million hectares of forest. The programme aims to increase sustainable farming of cashews and sesame, combined with a new cashew-processing unit, established in partnership with the private sector, which will create more local jobs. Community mapping efforts and registration of farmers and land dwellers promote better forest management at the local level.

Ethiopia recently launched its Oromia Forested Landscape Program, a 10-year initiative that aims to reduce deforestation and greenhouse gas emissions from land use in the forested areas of Oromia state. An integrated landscape approach seeks to address trade-offs and synergies among forest, crop, livestock, water, and household energy needs. The programme includes payments for ecosystem services, in which farmers or landowners are offered incentives to manage their lands in ways that provide an ecological service, such as climate regulation, fresh water, or cleaner air.¹²⁹

That said, the uptake of climate-smart agriculture is a learning process and not without significant challenges. A comprehensive survey commissioned by the U.S. Agency for International Development (USAID) finds that smallholders are still slow to adopt climate-smart approaches or fail to sustain their use over time. Climate-smart agriculture programmes may place too much emphasis on technical factors while inadvertently overlooking social, cultural, and political factors that determine the attractiveness of the new approaches. The high initial costs of a new approach may cause highly risk-averse smallholders to reject it, even if it promises large long-term savings. Few solutions are universally applicable. Finding what works needs to be assessed on a case-by-case basis, taking into account the distinctive conditions of different locations.¹³⁰

The key entrepreneurs in the uplift of African agriculture are the hundreds of millions of smallholders who must undertake risky investments in new production methods and technologies. Government policies have a crucial role in creating an enabling environment for these entrepreneurs, by providing critical public goods, such as infrastructure and agricultural research and development (R&D) and extension services; helping strengthen rural credit systems; and reforming property rights.

Since agricultural solutions tend to be highly specific to location, there may be scope for domestic firms to emerge as suppliers of specialised services and inputs for climate-smart agriculture. In Kenya, for example, the needs of conservation agriculture have created a market for companies such as Ndume Limited, a large agricultural implements and machinery manufacturing company.¹³¹

4. Summing up: Fostering green industry, markets, and entrepreneurship

This section summarises our recommendations and provides some ideas for fostering green entrepreneurship.

4.1 DEVELOPING GREEN MARKETS

Beyond absorption of global green knowledge, the development of green markets is likely to depend significantly on the implementation of environmental policies by governments. Such policies fall under four main rubrics.

Broad cross-cutting policies that strengthen market incentives to preserve natural capital

Cross-cutting policies include the reform of energy subsidies, the use of energy taxes that reflect the harm to human health caused by fossil fuel burning, and the creation of incentives for efficient water use. Fossil fuel subsidies in 30 sub-Saharan countries totalled about US\$75 billion in 2015, or around 5% of regional GDP.¹³² These subsidies represent a serious misallocation of resources because they promote wasteful consumption of energy; increase pollution, with deleterious effects on human health and the environment; increase fiscal deficits; and divert public expenditure away from more productive uses, such as infrastructure, education, and health spending.

Fuel subsidies are sometimes justified by the desire to protect poorer consumers from high and volatile energy costs. But it is now recognised that they are usually regressive and represent an inefficient way to protect the poor.

A growing number of sub-Saharan African countries have attempted to reform energy subsidies in recent years. Such reforms are often politically contentious and have sometimes had to be partially reversed.

A growing body of international experience offers lessons on how to formulate reform strategies. This includes wide consultation and the use of complementary measures to provide financial support for people most likely to be hurt by reform, in particular social protection measures for the poor.¹³³

Water scarcity is already a serious problem in most African countries. With economic and population growth, it will become ever more urgent. Creating incentives for greater efficiency in water use is an important part of the solution, through such instruments as user tariffs or charges and elimination of subsidies that encourage excessive water consumption. Lack of water pricing is sometimes justified as a form of social protection, but the result is often a reduction in access to water for the poor, because lacking a revenue stream, water utilities are unable to build out water supply infrastructure and politically well-connected elites capture the limited supply. Protection for poor water consumers is better provided through well-designed

water tariff structures and targeted direct assistance. More realistic water pricing would also stimulate private sector innovation and adoption of new water-conserving technologies in agriculture (e.g., new drought-resistant, water-saving crop varieties and irrigation methods); industry; and power generation.¹³⁴

Expansion of green infrastructure and improvements in infrastructure efficiency

Most African countries urgently need much more infrastructure investment, including in key sectors such as electricity generation (especially in low-carbon sources such as hydro, geothermal, wind, and solar), water supply and waste management, combined with reforms to greatly improve the efficiency of infrastructure use. Utility reform is at the heart of any high-ambition power scenario in sub-Saharan Africa, both to raise the very low levels of efficiency in electricity generation and distribution in the region and to attract large new investment inflows. Efforts to improve planning, development, and operational efficiency need to be combined with more realistic tariff-setting, as well as structural reforms to boost competition and unbundle generation from distribution activities. Public and private investment in power-generating capacity and distribution networks needs to be dramatically increased to keep up with development and expand energy access.

Countries can take advantage of low-cost clean energy technologies to exploit Africa's abundant clean energy resources. They can use off-grid and mini-grid distribution options to rapidly increase access by the poor. Meeting ambitious power sector goals will require a vast scaling-up of the levels of financing and investment in the region's power sector, drawing on domestic and foreign resource mobilisation from public and private sources. The international community has a strong incentive to invest in developing Africa's abundant clean energy assets, since this will reduce greenhouse gas emissions associated with Africa's industrialisation, which will benefit not only Africa but the world as a whole, a global public good.

A big scaling up in innovative water infrastructure is also needed, in line with the African Union's Agenda 2063 and policy agendas such as the Africa Water Vision 2025 and its Framework of Action.¹³⁵ Investments are needed in innovative water collection and storage capabilities (including investments for climate-smart approaches in agriculture); the build-out of the water supply; distribution and sanitation infrastructure; water treatment; and wastewater recovery, treatment, and reuse.

Appropriate price incentives for water use can help to reduce the danger that politically influential groups of private users capture publicly funded water infrastructure. The private sector can play a pivotal role as providers and operators of water infrastructure, although, given the high-fixed-cost structure of the industry, both public and private water utilities require good regulation to ensure efficient operation and pricing. Efforts to improve regulatory capacity will therefore be key in many countries.

Water development and management is rendered complex by the fact that three-quarters of sub-Saharan Africa lies in 53 international river basin catchments crossed by multiple borders, necessitating a strong emphasis on regional cooperation. A coherent policy approach is needed linking water supply policies to changes in demand in major water-using sectors, such as energy, agriculture, and cities. The adoption of wind and solar photovoltaic renewable energy sources can significantly reduce the power sector's demand for water, for example.¹³⁶

Modernisation of agriculture, adoption of climate-smart agriculture, and investment in key public goods

Implementation of the African Union's Comprehensive Africa Agriculture Development Programme (CAADP) should be accelerated in order to boost public investment, strengthen institutional capacity, and improve the enabling environment for private investment in agriculture. Priority should be given to strengthening agricultural and livestock R&D and extension services, increasing investments in rural transport and logistics infrastructure, building up rural credit and insurance institutions, and undertaking reforms to achieve more secure land tenure and property rights. The CAADP and other flagship programmes to mainstream climate-smart agriculture and landscape management approaches in national agricultural plans should be expanded. International financing for and African countries' participation in programmes to reduce emissions from deforestation and forest degradation (the so-called REDD+ agenda) should be increased, including for landscape-scale programmes that address trade-offs and synergies between forest, crop, livestock, water, and household energy needs.

Adoption of green urban policies

Africa is urbanising rapidly. Its urban population grew by 4.4% a year between 1980 and 2015 and is projected to increase by 800 million by 2050.¹³⁷

Ideally, economic transformation and urbanisation are mutually reinforcing, with growth in industry and services benefiting from agglomeration effects, the large increases in productivity that can come from clustering economic activity in cities. But urbanisation in sub-Saharan Africa has been a missed economic opportunity so far. Urban growth has not, for the most part, been accompanied by economic transformation because of lack of adequate governance, planning, and critical public goods.

Multiple reforms are needed. They include developing national urban development strategies; empowering and increasing the fiscal capacity of city governments; and greatly expanding urban infrastructure for transport (with a strong emphasis on public transit systems), water and sanitation, waste management, and energy, as well as “soft” infrastructure for education, health, and housing.

4.2 GREENING INDUSTRIAL DEVELOPMENT

As a latecomer to industrial development, Africa faces significant hurdles in attracting more global industry and raising the productivity of its existing firms. But it may also benefit from a number of technological and market changes that make it possible to industrialise in ways that are less costly than they once were. Section 2 discussed two major ways in which Africa’s industrialisation trajectory may differ.

First, structural transformation in Africa may follow a different path from that of today’s high-income countries and East Asia’s new industrialisers. Given Africa’s different resource endowments and because of changes in global transport and communications costs and technologies, countries in the region can develop comparative advantage in “industries without smokestacks” (tradable services, horticulture, agro-industry, and tourism), which are rapidly growing segments of international trade. It is therefore likely that structural transformation in African economies will follow a pattern that includes substantial shares of output and employment devoted to natural resource-based activities, modern agriculture, and tradable services.

The environmental footprint of such a transformation path may prove less energy intensive and pollution intensive than mass manufacturing. There are strong arguments for sustainable management of the natural assets on which many of these sectors depend. Oil, gas, and minerals are non-renewable resources with the potential for significant local environmental impacts. Arguments for the optimal depletion of the resource and local environmental regulation are well established and widely accepted. Soil and water conservation are critical to the sustainability of horticulture and agro-processing, and wildlife and cultural tourism depend on an abundance of wildlife and cultural assets. Private investors and the public sector will have similar incentives to achieve sustainable management of natural assets in some contexts, while in others there will be a clear need for strong public policies to resolve collective action problems.

Second, because “industries without smokestacks” share many characteristics with manufacturing, the types of industrial policies that have succeeded in other places appear to hold promise in Africa. Three policy initiatives are needed to attract a larger share of global industry:

- *Mount an export push – a coordinated set of public investments, macroeconomic policies, and regulatory and institutional reforms to boost the share of industrial exports in GDP.* Because many of the policy interventions associated with export push involve infrastructure and logistics, they are responsive to the same green interventions outlined above. In addition, governments can support green exports by developing initiatives to identify green markets and support certification and standards. Doing so may prove especially critical in markets for industries without smokestacks, such as horticulture.
- *Strengthen special economic zones (SEZs).* African governments can promote industrial agglomeration by concentrating investments in high-quality institutions, social services, and infrastructure in SEZs. African SEZs have failed to attract global investors. A first order of business is therefore to upgrade their performance to international standards. SEZs designed as green or eco-industrial parks can have significant environmental benefits by providing shared infrastructure, reducing transport and waste management costs, and facilitating recycling and waste recovery between firms. Ethiopia and South Africa have demonstrated that it is possible to improve the performance of SEZs while making them more environmentally friendly.
- *Attract foreign direct investment (FDI).* FDI is a key source of knowledge and other capabilities for domestic firms; therefore, policies and institutions for attracting FDI are essential. Most of Africa’s FDI agencies perform poorly. Reform of FDI promotion institutions is essential. In the course of doing so, it should be possible to target investors that can contribute to greener growth. The electrical power sector, renewable energy, decentralised off-grid electricity, and water infrastructure offer attractive opportunities.

Coherent action across government is needed. Strong links between the FDI agency; the environmental, finance, and planning ministries; the line ministries responsible for domestic industrial development; and the agency administering the SEZ programme are vital. This level of coordination is unlikely to occur without strong leadership by the head of state or government.

4.3 OPPORTUNITIES FOR GREEN ENTREPRENEURSHIP

Entrepreneurs are central to the success of green industrial development in Africa because economic transformation and green growth depend crucially on doing new things. Entrepreneurs are the agents of change. Each of the three types of firms in African economies – Elephants, Gazelles, and Survival Entrepreneurs – has a distinct role to play in greener industrialisation.

Evidence suggests that larger African firms – the Elephants – face too little competitive pressure. Product markets are highly concentrated and, imports notwithstanding, firms report little pressure from contestable domestic markets. For the Elephants to engage in green entrepreneurship, they need to face competitive pressure and regulatory and incentive policies that move them towards greener outcomes. Public policies can create the right incentives for firms and consumers to take into account the environmental costs of their actions – through elimination of fossil fuel subsidies, the imposition of taxes on pollution, or appropriate environmental regulations, for example.

Where incentive structures are appropriate, green markets are emerging, including for renewable energy, energy efficiency, water services, waste management, and climate-smart agriculture. Over the coming decades all of these markets will provide a major opportunity for green entrepreneurship, particularly for larger, more sophisticated domestic firms.

The first challenge in greening the Gazelles is finding them. Policies targeted at smaller firms with the potential for innovation and productivity growth could have large payoffs. MSME policy in Africa is not designed to identify such firms, however. Instead, the vast majority of interventions to support MSMEs – mainly through credit and training programmes – are untargeted. Evaluations suggest that such interventions are ineffective. To improve the efficiency of MSME support, programmes should be designed to be attractive to Gazelle firms, but not to firms that are unproductive and whose owners are not capable of growing their businesses.

Green development offers many opportunities for Gazelles in selling, installing, and servicing smaller-scale clean energy technologies, such as household solar units and clean stoves, as well as smaller-scale installations and services in water provision, sanitation, and waste management. There may also be scope for such firms to emerge as suppliers of specialised services and inputs for climate-smart agriculture.

Reducing the pressure for survival entrepreneurship will depend more on agricultural than industrial policy. Greater dissemination of established agricultural production systems and rapid progress in bioscience and agronomics are creating opportunities for sub-Saharan African countries to boost agricultural productivity and adopt climate-smart agricultural practices that can achieve “triple wins”: higher farm incomes, increased resilience to climate change, and reduced greenhouse gas emissions (including greater carbon storage in soil, plants, and trees). African countries can build on recent trends in productivity growth and climate-smart agricultural techniques to link green industrialisation, agriculture, and poverty reduction.

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ENDNOTES

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⁷⁶ Voigt et al. (2014) document the importance of energy efficiency improvements in driving lower energy intensity within specific industrial sectors. See: Voigt, S., De Cian, E., Schymura, M., and Verdolini, E., 2014. Energy intensity developments in 40 major economies: Structural change or technology improvement? *Energy Economics*, 41, 47–62. DOI: 10.1016/j.eneco.2013.10.015. Van Benthem (2015) provides an econometric evaluation of the energy leapfrogging hypothesis by separately estimating the income elasticities of energy demand for developing and industrial countries during periods when their per capita incomes overlapped. He notes that, despite the plentiful evidence for technological diffusion and energy leapfrogging *within* industrial sectors and for specific technologies and products, the energy leapfrogging hypothesis does not hold up at the aggregate national level: income elasticities for today's developing countries are the same as or higher than the elasticities for industrial countries in earlier times. He argues that the energy leapfrogging process within sectors has been offset by two other effects. The first is industrial outsourcing, the movement of energy-intensive (and carbon-intensive) production locations from developed to developing countries, combined with net exports of energy-intensive and carbon-intensive products from developing countries to consumers in developed countries. This particularly affected China and other successful manufactured goods exporters in East Asia. It was especially strong in the 1990s and the 2000s, leading up to the financial crisis of 2008, although it appears to have moderated significantly after the crisis. The second effect is a marked shift towards more energy-intensive consumption bundles by consumers in developing countries. This shift is hypothesised to result from various kinds of "rebound effects", in particular a "direct" rebound effect, in which efficiency improvements reduce the cost and increase the usage of energy-using products, and a "technology rebound" effect, in which efficiency improvements trigger new rounds of technological development that encourage further adoption and use of the product. See: Van Benthem, 2015. *Energy leapfrogging*.

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ABOUT THE NEW CLIMATE ECONOMY

The Global Commission on the Economy and Climate, and its flagship project The New Climate Economy, were set up to help governments, businesses and society make better-informed decisions on how to achieve economic prosperity and development while also addressing climate change. The project has released a major flagship reports as well as country reports on the United States, China, India and Ethiopia, and sector reports on cities, land use, energy and finance. It has disseminated its messages by engaging with heads of governments, finance ministers, business leaders and other key economic decision-makers in over 50 countries around the world.

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The *African Economic Outlook* (AEO) is the flagship publication of the African Development Bank (AfDB), the OECD Development Centre, and the United Nations Development Programme (UNDP), working in partnership to produce an annual report. The AEO analyses the current state of economic affairs in Africa and provides two-year forecasts of key economic outcomes, supported by extensive data. Each report focuses on a special theme. The 16th edition in 2017 explores the roles of entrepreneurship and industrialisation.

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